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Equity Financing of Technology-Based Firms in Ireland

Thesis presented by

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Abstract

This thesis investigates the financing of technology-based firms in Ireland, with an emphasis on equity, using novel data gathered through fieldwork methods with 153 equity and 141 non-equity financed firms. Equity finance is key in assisting technologically-intensive firms to overcome financial and resource constraints that potentially hinder their development. In Ireland, between 2003 and 2015, venture capital and private equity funds invested €5billion in Irish SMEs and, through syndication, attracted a further €3billion from international investors (IVCA, 2016). Even though it is recognised that equity finance plays a vital role in job creation, export growth and innovation, as it targets innovative, high-growth companies that can be scaled internationally, there is little rigorous demand-side research that examines the determinants and impact of equity. This thesis addresses this gap, making a number of contributions to the literature.

We begin with an in-depth profile of Irish technology-based firms. This details general characteristics (i.e. age, size, industry), the entrepreneurs behind these firms and financing patterns over distinct stages in the lifecycle. Additionally, an exclusive profile of equity investment is provided, describing the types of equity investors financing Irish technology-based firms, features of investment (for example, geographic proximity, co-investment, security selection), along with a unique account of entrepreneurs' perspectives on equity (for example, non-financial benefits, risk sharing, loss of control). Comprehensive data of this kind does not currently exist, and is particularly lacking in the Irish context.

Adopting a broad definition of equity, encompassing venture capital, angel and government-sponsored funding, and examining the impact of a multifaceted range of factors, from attributes of the firm's market/product to innovation, human capital, and financing, the empirical analysis expands on extant demand-side research, which focuses predominantly on venture capital and a narrow set of signals in isolation, to provide new evidence on determinants of equity financing. Results indicate that market rivalry, exports, innovation, R&D, education and experience of the founder and workforce, and the entrepreneur's financing preferences are significant factors. We also find that family and friends' investment represent a positive signal, while the opposite is the case for debt. This original evidence may be used to cultivate and enhance access to equity finance, and facilitate entrepreneurs' investor readiness attempts.

Disentangling the determinants of equity, multivariate probit models (with Heckman correction for sample selection) explore whether determinants differ according to source of equity (angel, venture capital, government-sponsored), stage of the lifecycle (seed, early-

growth, expansion) and given the relationship between the sources. Results indicate that, for angel financing, commitment (founder, family, friends' investment) and human capital are particularly noteworthy determinants. Larger firms occupying a market niche, with greater export activity, product differentiation and patents are more likely to obtain venture capital. For government-sponsored equity, it is found that non-equity sources of finance (founder, family/friends' during the seed and early-growth stages and debt at expansion) along with R&D activity are significant right across the lifecycle. Given the obvious gap in the literature, new evidence is also presented on the extent to which these sources act as complements or substitutes to each other in financing technology-based firms. At early-growth, we find a substitution effect with seed stage funding. Moving to expansion, results were mixed. Between the sources, prior angel funding complements subsequent private equity (i.e. angel and venture capital). Within the sources, however, the relationship appears to be of substitutes. Detailed empirical evidence of this kind does not currently exist and, as such, this thesis offers unique insight into the determinants of and relationship between the sources of equity.

Lastly, the novel data collected also allowed us to investigate the ways in which equity financing impacts on funded firms. In terms of performance, we provide new evidence that not only adopts a broad definition to compare the performance of equity with non-equity financed firms, but also new data by source of equity. We find that equity financed firms have a higher number of patents and higher growth (asset and employment) rates. As to impact according to source, venture capital significantly (positively) impacts on patenting. As regards entrepreneurial exit, entrepreneurs within non-equity financed firms are more likely to develop a plan for their own exit. Furthermore, results indicate that entrepreneurs with equity investors are more likely to expect to pursue a financial harvest exit strategy (i.e. IPO or acquisition) and it is the presence of private equity (angel and venture capital) that impacts this choice. By showing how the presence of equity financiers impacts on entrepreneurial exit decision we provide novel evidence in a particularly underdeveloped area.

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To my cherished son, Rían, the sunshine of my life. Thank you for brightening every day.

Finally, and by no means least, I am eternally grateful to my wonderful parents Ralph and Esther Power. They have encouraged and championed me from day one and have always been there for me. Without them, none of this would have been possible.

This thesis is dedicated to my late father, Ralph Power.

Declaration

This is to certify that the work I am submitting is my own and has not been submitted for another degree, either at University College Cork or elsewhere. All external references and sources are clearly acknowledged and identified within the contents. I have read and understood the regulations of University College Cork concerning plagiarism.

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CHAPTER 1 :
INTRODUCTION

1.1 Introduction

This dissertation makes a significant contribution to the literature on entrepreneurial financing, based on empirical evidence from primary source data on technology-based firms in Ireland. With particular emphasis on equity financing, a number of key research themes are addressed. The over-reaching objectives are: (1) to identify the factors which determine whether the technology-based firm is equity financed; (2) to examine whether the determinants differ according to source of equity (angel, venture capital, government-sponsored funding), stage of the lifecycle (seed, early-growth, expansion) and given the relationship between the sources of equity; and, finally, (3) to explore how equity financing impacts on the performance of funded firms and upon entrepreneurial exit intentions.

It has become something of a stylised fact over the second half of the twentieth century that technology-based sectors are a panacea for boosting economic growth and productivity (see Coad and Reid, 2012; Frenkel, 2012; Eurostat, 2016a). Technology-based firms are seen as offering an important contribution in four key areas: innovation, job creation, exports and regional development (see Audretsch, 1995; Knockaert *et al*., 2010). Lack of necessary resources, however, may hinder the formation and survival of these firms, with obvious negative effects on social welfare (Colombo *et al*., 2010; Hummel *et al*., 2013). Specifically, technology-based firms typically suffer from financial constraints (see Carpenter and Petersen, 2002a; Bertoni *et al*., 2010) and a lack of commercial and managerial competences (see Gans and Stern, 2003; Colombo *et al*., 2006) that hinder their growth past the technology development stage (see Carpenter and Petersen, 2002b; Bjørgum and Sørheim, 2015). These gaps in both financial and non-financial resources may be addressed through equity financing.

For technology-based firms, the combination of high levels of risk and uncertainty, information asymmetry and a lack of collateral often result in well-known market imperfections that lead to severe credit rationing, especially in the case of bank loans (see

Colombo and Grilli, 2007; Demirel and Parris, 2015). Furthermore, technology-based founders are more likely to come from a technical or scientific background (see Oakey, 2003; Siepel *et al*., 2017), which gives them superior ability to identify opportunities for new innovations (Colombo and Grilli, 2005a) but means that they may lack commercial and managerial expertise (Colombo *et al*., 2006). It is generally accepted that equity is the source of external financing capable of dealing with these features (see Gompers and Lerner, 2001; Lerner, 2010). Equity investors not only provide much-needed financial resources but, through their active involvement, also engage in important value-adding activities post-investment (see Large and Muegge, 2008; Knockaert and Vanacker, 2013). With this in mind, this thesis reports upon an investigation into the financing of Irish technology-based firms, paying particular attention to equity financing.

A distinctive feature of this investigation is the unique data utilised. All issues are explored using one body of primary-source evidence gathered through structured survey instrumentation (Woolcott, 2005). The fieldwork was undertaken from a demand-side perspective (i.e. from the viewpoint of the technology-based firm). The evidence presented is based on interviews with 294 Irish technology-based firms, across technology-based manufacturing and knowledge-intensive service sectors. The vast majority (84%) operate in the latter sectors. This is consistent with data provided by the Central Statistics Office (CSO), which shows that in 2011 technology-based manufacturing represented 7.8% of active businesses in technology sectors, with knowledge-intensive services accounting for 92.2% (CSO, 2013). This also equates reasonably well with figures provided by Eurostat (2013), which reports that throughout the European Union there are almost 5,000 enterprises in technology-based manufacturing sectors but over 800,000 in knowledge-intensive service sectors. These firms can, for the most part (89%), be classed as micro (52% of firms have less than 10 employees) or small (37% had between 10 and 49 employees) enterprises. This is hardly surprising, given that small and medium-sized enterprises (SMEs) account for 99.8% of all active enterprises in Ireland (CSO, 2011). The sample is further categorised as those that are equity-financed and those that are not. In total, there are 153 (52%) equity and 141 (48%) non-equity financed firms. The data collected from equity-financed firms was obtained through direct contact with respondents (face-to-face interviews) while a self-administered survey was used for non-equity financed firms. An original feature of the survey instrument was the collection of data on a wide array of sources of finance, covering internal (personal investment, director's loan, retained profits), f-connections, trade credit, debt (business overdraft, mortgage, business loans), equity (angel, independent venture capital, corporate venture capital, government-sponsored equity funding), and Government grant support according to stage of the firm's lifecycle (see Chapter 3, Subsection 3.2.2). Not only does this allow for a unique and detailed characterisation of the financing patterns of technology-based firms within a lifecycle framework (Berger and Udell, 1998), it also facilitates a broader and comprehensive analysis of equity finance, away from the focus on (independent) venture capital that tends to characterise the existing research (see Hsu, 2004; Patzelt, 2010; Ozmel *et al*., 2013; Zhang *et al*., 2019).

Overall, there is a paucity of evidence on the financing of Irish technology-based firms. Hogan and Hutson (2005a) examine the determinants of venture capital for a sample of 119 Irish software firms. Recently, using the same database, Hogan *et al*. (2017) revisited the issue of funding for software firms, extending the analysis to the determinants of external equity funding, where external equity is defined as "*equity financing obtained from external sources: private equity and venture capital*" (Hogan *et al*., 2017, page 243). Mac an Bhaird and Lynn (2015) investigate financial bootstrapping in Irish computer software companies that have adopted cloud computing for the development and delivery of application software. Based on data collected from 18 Irish privately-held cloud computing start-ups, the authors focus only on the use of internal funds and angel finance. No data is presented concerning venture capital or government-sponsored equity. This study fills this void.

The thesis is divided into eight Chapters, as follows: Here we detail the context, contributions and structure of this thesis. Following this, Chapter 2 considers the theoretical and empirical literature to develop a framework within which to conduct this research. Chapter 3 describes the sampling procedures, design of survey instrumentation and methods deployed in working in the field. Chapter 4 characterises the technology-based firm, their capital structure and equity financing. In Chapter 5 the determinants of equity financing are examined through a probit model, estimated based on the full sample of 294 technology-based firms. Building on this, Chapter 6 drills down into the determinants of equity financing by exploring how these determinants vary across source of equity (angel, venture capital, government-sponsored equity) and stage in the lifecycle (seed, early-growth, expansion) and given the relationship between the sources of equity. In short, analysis is carried out through multivariate probit models (MVP) estimated by stage, with a Heckman correction for sample self-selection (N=294 with N=153 equity financed firms in stage two of the two step procedure). Moreover, the analysis examines the extent to which the determinants of equity vary when the relationship (i.e. substitutes or complements) between the sources of equity is taken into consideration. Next, Chapter 7 explores the impact of equity financing on the performance of funded firms, measured through innovative output (patents), growth (assets and employment), and survival. Additionally, the potential impact of the presence of equity financiers on entrepreneurial exit intentions is considered. Lastly, Chapter 8 summarises the main findings and indicates avenues for further research.

The development of the remainder of this Chapter is as follows: Section 1.2 reflects on contextual and research aspects of this study; Section 1.3 presents the structure and contribution of the Chapters in greater detail; and, finally, Section 1.4 concludes.

1.2 Contextual and Research Issues

The technology-based sector plays a pivotal role in entrepreneurship and innovation and, by extension, to economic growth and job creation (see Revest and Sapio, 2012; Eurostat, 2016a). Technology-based firms are defined as businesses whose products or services largely depend on the application of scientific and technological knowledge (Revest and Sapio, 2012). For the purposes of this study, technology-based firms are classified using the sectoral approach. Briefly, in Europe firms are categorised based on the NACE Statistical Classification of Economic Activities system, derived from the United Nations' International Standard Industrial Classification (ISIC) of economic activities. Under the NACE Rev. 2 system, Eurostat (2015) provides a classification of sectors aggregated into technology-based manufacturing and knowledge-intensive service industries by NACE Rev. 2 codes. This categorisation is outlined in Chapter 3 (Section 3.2.1).

As mentioned briefly in the opening, technology-based firms are likely to experience greater difficulty in obtaining external finance than those in more traditional sectors, due to their distinctive characteristics. Specifically, asymmetric information is exacerbated in technology-based investment, not only because technical knowledge is necessary to understand the project but also because entrepreneurs normally want to keep the full details of their project secret (Müller and Zimmermann, 2009). Moreover, the assets of technology-based firms are predominantly intangible, mainly knowledge assets partly embedded in the human capital of the firm and ordinarily very specialised to the firm in which they reside (see Kortum and Lerner, 2000; Hall, 2002). Furthermore, technology-based firms are associated with greater uncertainty, partly because returns are skewed and highly uncertain but also because projects are risky and have a low probability of success (Carpenter and Petersen, 2002a). Finally, because these firms are usually introducing new and innovative products or processes, latent demand is unknown ex-ante, which results in considerable market uncertainty (Winston Smith, 2011). Essentially, with technology-based firms, not only does one not know the possibilities associated with eventual outcomes but often even the forms of that potential outcome are not completely evident (Kerr and Nanda, 2015). Consequently, technology-based firms are those most likely to be financially constrained, with capital market imperfections potentially curtailing their contribution to economic growth (North *et al*., 2013). Given this, the technology-based sector presented an interesting entity, and indeed impetus, for this research. This brings us, naturally, to the question – How do technology-based firms, given their distinctive characteristics, finance their activities?

There are compelling reasons to believe that the assumptions behind the Modigliani-Miller (1958, 1963) theorem are violated by technology-based firms. The available evidence provides preliminary support for the pecking order hypothesis[1] (see Myers, 1984; Myers and Majluf, 1984) in that it appears that technology-based firms primarily rely on internal funds (see Giudici and Paleari, 2000; Colombo and Grilli, 2007). Once internal capital resources have been exhausted, however, evidence shows that technology-based firms are more likely to turn to external equity than debt (see Roberts, 1991; Hogan and Hutson, 2005a). Equity investors provide not only capital, but also hands-on help and expertise in turning technology-based ventures into successes (see Gompers and Lerner, 2001; Hellmann and Puri, 2000; Baum and Silverman, 2004). The high-risk/high-return profile tends to suit equity investors (Zackrisson, 2003). Indeed, evidence suggests that equity finance not only plays an important role in alleviating impediments faced by technology-based firms in obtaining external capital but in helping firms to become established in the first place (Bottazzi and Da Rin, 2002).

It seems pertinent at this point to define what is meant by 'equity finance'. The OECD (2015, page 142) defines equity financing as "*financial resources that are provided to firms in*

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[1] Asymmetric information and credit market failures are central tenets of the POH, which posits that firms apply for debt only when they run into deficits of internal funds and issue equity only as a last resort (see Myers, 1984; Myers and Majluf, 1984). The reader is referred to Chapter 2 (Section 2.2) for a discussion.

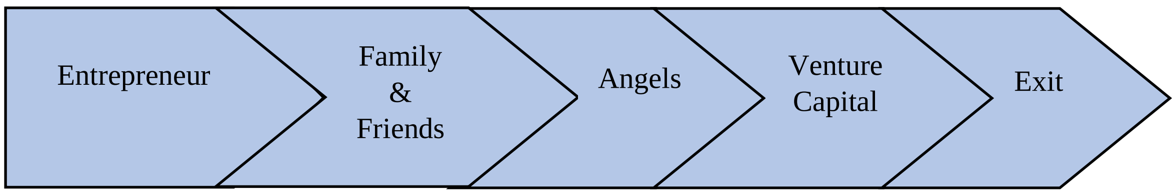
return for an ownership interest". Equity financing can be classified as public or private. While the former involves companies that are traded on a stock exchange, the latter refers to capital provided to unlisted companies (Cumming, 2012).[2] Although we lack a generally accepted definition of private equity finance (Bottazzi and Da Rin, 2002), a detailed classification, particularly fitting to this study, is provided by the Irish Venture Capital Association (IVCA). According to the *Guide to Venture Capital* (IVCA, 2018), private equity financing is the commitment of monies to unquoted companies, categorised as: business angels; venture capital; corporate ventures; and Government agencies. These sources are generally referred to as formal (independent, corporate, government-sponsored venture capital) and informal (business angel) equity finance (see Harrison and Mason, 2000; Landström, 2007).

The equity financing of firms can best be understood and discussed within the framework of the equity financing cycle (Mulcahy, 2005). The cycle, shown in Figure 1.1, illustrates that financing typically starts with the entrepreneur investing personal capital into their business, before turning to family and friends. When larger amounts of capital are required to finance further development, the entrepreneur may seek investment from external equity investors. The first option is usually an angel investor. Business angels are defined as high net worth individuals who invest their own money in unquoted businesses in which there is no family connection and who, after making the investment, generally take an active involvement in the business (Mason *et al*., 2016). In one form or another, angel investors have been around for centuries. Queen Isabella and King Ferdinand of Spain launched the first angel-based venture when, in 1492, they backed Christopher Columbus's expedition to the West Indies (Landström and Mason, 2016). Two Boston-area angel investors backed the inventions of Alexander Graham Bell and, in 1877, they provided the capital needed to start

[2] Private equity can further be divided into two broad categories – venture capital, which is primarily devoted to equity or equity-like investments in young growth-oriented companies; and other private equity called growth capital, devoted to investments that cover later stages for established businesses, including management buyouts, replacement capital and turnarounds (Landström, 2007). It is the former that we are interested in in this study.

the Bell Telephone Company of Boston (Smith *et al*., 2011). Moving forward, corporations including the Body Shop, Amazon and Google were launched thanks to capital from angel investors (Landström and Mason, 2016). The term angel was originally used to describe individuals who provided high-risk investment to finance theatre productions on Broadway (Landström and Mason, 2016). Subsequently, Wetzel (1983) coined the name '*business angel*' to describe people providing the same kind of risk investment to young entrepreneurial ventures. Lerner (2000, page 515) defines a business angel as "*a wealthy individual who invests in entrepreneurial firms. Although angels perform many of the same functions as venture capitalists, they invest their own capital rather than that of institutional or other individual investors*".

Figure 1-1. Equity Financing Cycle



Source: Adapted from Mulcahy (2005)

Moving through the cycle, following angel investment the entrepreneur may turn to formal sources of equity, namely independent, corporate or Government venture capital funds. Independent venture capitalists (IVCs) raise funds from limited partners (for example, university endowments, pension funds, etc.) and, acting as general partners, invest in unquoted businesses, with the primary aim of providing a return to these investors through selective investments into a portfolio of young, innovative ventures (see Gompers and Lerner, 2000; Tykvová *et al*., 2012). Typically, a fund has a ten-year lifespan, at the end of which the partnership dissolves and distributes its assets to the partners (OECD, 2015). The first true venture capital firm was American Research and Development (ARD), established in 1946 by

MIT President Karl Compton, General Georges F. Doriot, who was a professor at Harvard Business School, and local business leaders (Gompers and Lerner, 2001). Over half a century later, IVC has become the form of financial intermediation associated with dynamic entrepreneurial start-ups, funding many of today's most successful corporations during their initial stages, including Apple, Starbucks, e-Bay and Microsoft (Bottazzi and Da Rin, 2002).

Corporate venture capital (CVC) refers to equity investment by established corporations into unquoted businesses while remaining involved in commercial activity as their main business (see McNally, 1997; Wadhwa *et al*., 2016). Large incumbents, such as Google Ventures, Intel or Johnson and Johnson, take a stake in innovative firms, which remain independent, and provide finance to help them develop (Block *et al*., 2018). In contrast to IVCs, rather than pursuing purely financial objectives, CVCs generally aim to capture the value from strategic assets, open a window on new technologies, respond more competitively in dynamic industries and accelerate market entry (see Toschi *et al*., 2012; Munari and Toschi, 2015). Also, in contrast to IVCs, CVC funds have longer time horizons and are usually not restricted by a contractually-enforced ten-year lifespan (Chemmanur *et al*., 2014).

Finally, evidence that more available equity finance allows for an increase in entrepreneurial activity (see Levine, 1997; Kortum and Lerner, 2000) has led governments to implement programs to mobilise equity investment (Buzzacchi *et al*., 2013), establishing funds that seek to support the equity market through the formation of government-managed equity investment schemes. These are equity funds set-up and managed by a company entirely possessed by governmental, or public administration, bodies (Cumming *et al*., 2017). The main fund in Ireland is the Seed and Venture Capital Scheme available through Enterprise Ireland.[3]

[3] Since 1994, Enterprise Ireland has invested in four Seed and Venture Capital Schemes, making commitments to venture funds of €1.34bn (Enterprise Ireland, 2018). All funds are independently managed by private sector investors who make decisions regarding investments. In these investments, Enterprise Ireland assumes the role of limited partner, and supplies capital provided it is at least matched (50:50 split) with private sector investment. Enterprise Ireland then outsources the investment and management functions to private sector investors.

Economic theory suggests two primary rationales for direct public intervention in the venture capital market. First, the presence of the public investor in a venture capital fund should enhance the capacity to attract private equity capital resources, referred to as the seeding hypothesis (see Leleux and Surlemont, 2003; Cumming, 2007). Second, public investment can play a role in directing private capital towards investment opportunities that otherwise may not have been considered, referred to as the herding hypothesis (Buzzacchi *et al*., 2013).[4]

To close, let us briefly consider Ireland's equity finance market. Early developments included the setting up of the ICA's Enterprise Development Programme in 1978; the establishment of the National Enterprise Agency in 1987, its replacement by the National Development Corporation in 1986 and its amalgamation with the IDA in 1991; the introduction of the Business Expansion Scheme in 1984; and the Seed Capital Scheme in 1993 (Barry *et al*., 2012). The Irish Venture Capital Association (IVCA) was formed in 1985 to represent venture capital in the Republic of Ireland and Northern Ireland.

The equity market expanded dramatically in the mid-1990s, just as a flow of promising opportunities emerged, primarily in the indigenous software sector (see Crone, 2002; Ó Riain, 2004). The recognition of pension funds as a form of finance (Murphy, 2000), the new approach within the State's industrial development agencies towards equity participation to support the supply of venture capital (Barry *et al*., 2012), and the establishment of Enterprise Ireland's Seed and Venture Capital Measure 1994-1999 contributed greatly to the development of the Irish equity market. The amount invested by venture capitalists into Irish companies rose from €32 million in 1979 to over a quarter of a billion in 2000, and remained at this level even after the technology stock crash in the early 2000s (IVCA, 2006).

[4] A noted concern regarding this type of public intervention is that direct government-sponsored investment might actually be counterproductive if they substitute for, or crowd out, private equity investment (see Gilson, 2003; Leleux and Surlemont, 2003). Studies that examine this impact (i.e. crowding-in or crowding-out effect) have found mixed evidence (see Jeng and Wells, 2000; Cumming and MacIntosh, 2006; Brander *et a*l., 2015).

The main source of data on equity in Ireland is the IVCA's VenturePulse survey.[5] From Figure 1.2 we see that there was a steady rise in investment from €226 million in 2007 to €310.2 million in 2010 when, coinciding with the global credit crunch, there was a decrease in funds invested in 2011 (€274.4m) and 2012 (€268.9m), before a slight increase in 2013 (€284.9m). The following year, total investment rose by over 40% to €400.7 million, and this was followed by a more marked rise through to 2017. Since the onset of the credit crunch in 2008, in excess of 1,400 Irish SMEs raised equity financing totalling €3.5 billion (IVCA, 2019b).

Figure 1-2. Venture Capital Investment 2007–2017, by value (€m)

Source: IVCA Venture Pulse (2007 - 2017)

Looking at investment activity in greater detail, summary statistics provided in Table 1.1 show that the number of companies raising equity funds each year steadily increased from 2008 to 2012, even throughout the crisis period. Interestingly, while the total amount invested was increasing, the number of investees was falling from 2012 through to 2014. This coincided with a decrease in the proportion of equity devoted to seed stage funding. By percentage of amount invested, seed stage funding fell from a high of 38% in 2011 to a low of 8% by 2015. This coincided with seed funds supported by the banking sector and EI's Seed and Venture

[5] Each year the IVCA produces the VenturePulse survey, which measures private equity funding raised from venture capital funds, AIB and Bank of Ireland seed capital funds and Enterprise Ireland, and, where the data is available, from private investors (angels). This is the main source of data on equity investment activity in Ireland.

Capital Programme of 2006–2012 coming close to being fully invested. This also suggests a withdrawal of equity funding from the smaller-deal end of the market, which typically, and inevitably, means a withdrawal from seed and start-up financing (Reid, 1998).

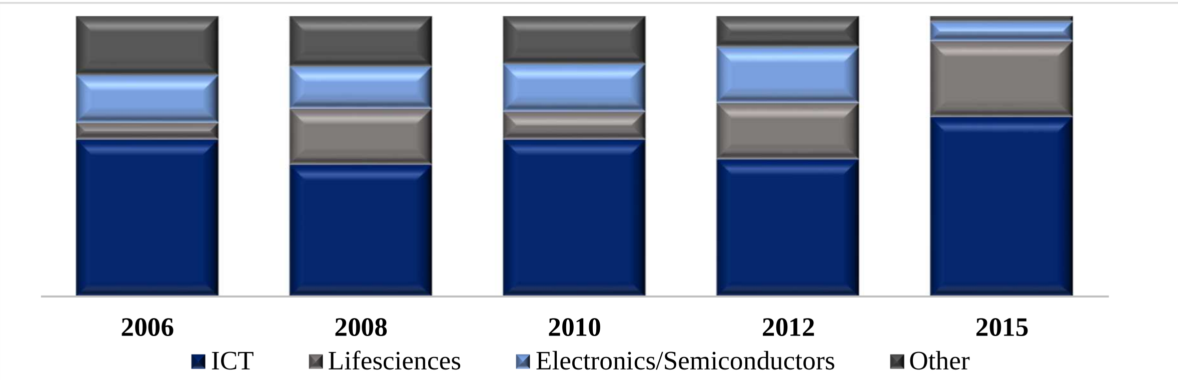
Table 1.1. Summary Statistics of Investment in Ireland 2008–2016

	2008	2009	2010	2011	2012	2013	2014	2015	2016
Funds (€m)	243	288.1	310.2	274.4	268.9	284.9	400.7	522.1	888.1
Total Firms	93	139	156	159	189	161	142	165	221
Seed Funding	21%	25%	17%	38%	20%	18%	17%	8%	8%

Source: IVCA Venture Pulse (2008 - 2016)

Investment is mostly concentrated in the ICT sector (Figure 1.3) which has received a relatively stable share of the pool of annual investment - 56% in 2006 to 64% in 2015. The life sciences sector has taken a growing share in recent years, increasing from 6% of funds raised in 2006 to 27% in 2015. This reflects a fast-growing sector in Ireland. Overall, equity investment is mainly focused on technology-based sectors which, overall, account for over 90% of the funds raised annually (IVCA, 2007–2016).

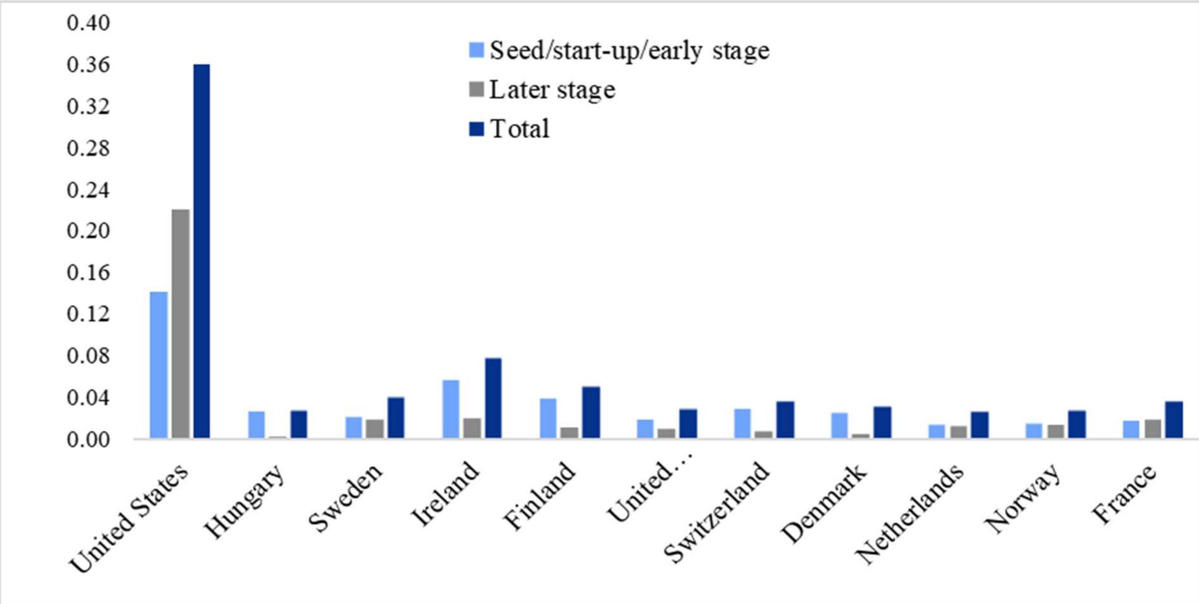
Figure 1-3. Investment in Ireland by Sector



Source: IVCA Venture Pulse (various years)

Finally, OECD figures show that Ireland is ranked highly in terms of venture investment within Europe. In Figure 1.4 data shows that, although below levels in the U.S., Ireland had one of the highest proportions of venture capital investment in 2012 among European countries, exceed only by Hungary (0.07%).

Figure 1-4. Venture Capital as a Percentage of GDP by Stage



Source: OECD, Entrepreneurship at a Glance 2013

1.3 Contributions and Form of Thesis

This thesis consists of eight chapters. Following this introduction, Chapters 2 and 3 present the theoretical and empirical framework and fieldwork methods. Next, Chapters 4 to 7 detail and analyse the data. Finally, Chapter 8 concludes. We now outline each in turn.

1.3.1 Theory and Evidence

Chapter 2 develops a framework within which the entrepreneurial financing of technology-based firms can be explored. Interdisciplinary in nature, discussion begins with the consideration of leading capital structure theories, from the irrelevance propositions of Modigliani and Miller (1958, 1963) through to trade-off (see Baxter, 1967; Kraus and Litzenberger, 1973), pecking order (see Myers, 1984; Myers and Majluf, 1984) and agency (Jensen and Meckling, 1976) theories. There is an emphasis on the latter. Specifically, particular attention is paid to the role of signalling (Spence, 1973) and screening pre-investment, along with monitoring and contractual mechanisms post-investment, in mitigating agency issues.

Organisational lifecycle theory (see Penrose, 1952; Downs, 1967; Greiner, 1972) and the financial lifecycle (see Roberts, 1991; Berger and Udell, 1998) are also considered. Because capital structure theories largely neglect to control for the lifecycle aspect of a firm's financing decisions, this provides a framework within which to examine financing over time. This is particularly important not only in the design of survey instrumentation (Chapter 3) but is also influential in exploring how financing patterns evolve over stages in the firm's development (Chapter 4) and in guiding empirical analysis of the extent to which the determinants of and relationship between sources of equity vary over the lifecycle (Chapter 6).

We then come to equity financing. The principal goal is to provide an overview of relevant aspects and research pertaining to equity, focusing on two main elements. The first entails consideration of the evidence on the potential determinants of equity finance, based on both supply- (i.e. criteria employed by investors in selection and due diligence) and demand-side (i.e. signals used by entrepreneurs in attempting to obtain equity) research. These subsequently inform hypothesis development in Chapters 5 and 6. The second part of this Section explores the impact of equity on the funded firm and entrepreneur, beyond the provision of financial resources. Specifically, discussion focuses on the role of equity investors in enhancing funded firm performance and in influencing entrepreneurial exit strategies. This association is examined empirically in Chapter 7.

In summary, Chapter 2 contributes to this study by firstly developing a theoretical framework within which the financing of technology-based firms may be examined and secondly by collating evidence pertaining to equity financing, which forms the basis for data analysis (Chapters 4, 5, 6 and 7).

1.3.2 Fieldwork

Chapter 3 details the fieldwork activities for this study. The main body describes the process involved in data collection (Section 3.2). The starting point is composition of a sample (Subsection 3.2.1). The target population are technology-based firms, operating within specified NACE Rev. 2 codes. This is further stratified into two groups – equity and non-equity financed. The sampling procedure behind each is detailed. In total a sample frame of 685 technology-based firms was compiled, composed of 313 equity and 372 non-equity financed firms. For data collection, two structured survey instruments were developed, one for equity financed firms and a condensed version for non-equity (Subsection 3.2.2). Questions were designed to extract information on the characteristics of the firm and entrepreneur, sources of financing used retrospectively over the lifecycle, innovation, performance and exit. Instrumentation for equity financed firms contained an additional section devoted to equity.

With the instrumentation designed, attention turned to the next task – the data gathering process (Subsection 3.2.3). After careful piloting, the author travelled throughout Ireland to meet and conduct face-to-face interviews with the founder-CEOs of 153 equity financed firms (response rate 49%). For non-equity firms, a self-administered condensed version was disseminated online (postal/telephone version upon request). A total of 141 firms completed the survey (response rate 38%). Overall, from the sample frame of 685, a total of 294 firms participated (response rate 43%). Primary-source data is supplemented with secondary data. Two main resources were used, FAME and the patent databases, each of which are described herein (Section 3.3).

The unique design of the sample, survey instrumentation and method of data collection are the key contributions arising from fieldwork. The sample frame is comprehensive, including firms operating in technology-based manufacturing and knowledge-intensive service sectors. The unique instrumentation designed for data collection, and resultant novel data, is also a major contribution. Finally, the interactive nature of data collection (face-to-face interviews with entrepreneurs from equity financed firms) not only allowed the author to gain a unique perspective and insight into the entrepreneur's experiences of equity financing but also provided access to unique and one-of-a-kind primary-source micro-micro data.

1.3.3 Descriptive Analysis

Chapter 4 personifies technology-based firms and their capital structure. An in-depth profile of equity investment is also provided. Discussion begins with a detailed description of the general characteristics of the technology-based firms in the sample, including an in-depth sectoral, geographical, age and size profile. Following this, and inspired by the financial lifecycle paradigm (see Roberts, 1991; Berger and Udell, 1998), a depiction of the financing patterns of technology-based firms over distinct stages is provided. Next, attention turns to building a profile of those factors that distinguish equity from non-equity financed firms. Attributes explored include human capital, market extent, competitive environment, intangible assets, incubation, innovation and financing preference. These feed into Chapters 5 and 6 which aim to identify determinants of equity and sources of equity respectively.

Finally, novel evidence characterising equity financing is presented. The first part of the discussion is focused on characteristics of equity investment, including the application for equity, spatial proximity, co-investment, staging of capital infusions, security selection, board representation and monitoring. The second part presents a unique account of the entrepreneur's perspectives on equity financing. Issues pertaining to considerations in pursuing equity funding, risk sharing, perceptions of non-financial value added by equity investors, along with opinions on and attitudes towards equity investors are detailed. Taken together, this sheds light on the nuances of equity finance from the entrepreneur's perspective.

Chapter 4 offers three important contributions. First, new primary-source data is used to provide a detailed and unique characterisation of Irish technology-based firms. Second, a novel profile of the financing patterns of technology-based firms over four distinct stages in the lifecycle is provided. Finally, a comprehensive and original profile of the type of equity investors active in the financing of Irish technology-based firms, along with nuances of equity investment and entrepreneurial attitudes towards external equity financing is presented.

1.3.4 Quantitative Analysis

The empirical results of this study are presented over three chapters. This begins with **Chapter 5** which presents an empirical examination of the determinants of equity. The analysis examines the influence of a multifaceted assortment of factors (market/product, human capital, innovation, etc.) on the probability of the technology-based firm being equity financed. As such, this can serve to augment our grasp of factors influencing equity funding, which may, in turn, be exploited in cultivating and supporting entrepreneurs' access to equity. Moreover, the empirical model is used to compute a correction term to correct for selectivity bias (Heckman, 1976, 1979) in analysis (Chapters 6 and 7) where estimations are based solely on equity financed firms. The novelties of Chapter 5 lie in three directions: First, using a broad definition of equity finance (encompassing angel, venture capital and government-sponsored funding) analysis provides greater insight into the determinants of equity. Second, analysis investigates the impact of a diverse range of factors, from incubation, market, product, and innovation to human capital, along with financing-related aspects as signals for equity financing. Third, the sample spans Irish technology-based manufacturing and knowledge-intensive service sectors, building on existing sector-specific studies (Hogan and Hutson, 2005a; Mac an Bhaird and Lynn, 2018).

There is an increasing recognition among practitioners and academics that equity financing is far from being a homogenous group (see, Bottazzi *et al*., 2008; Knockaert *et al*., 2010; Bertoni *et al*., 2013). Within this context, **Chapter 6**, extending on analysis undertaken in its predecessor, focuses on assessing whether the determinants of equity differ by source and stage in the firm's lifecycle. Additionally, econometric models examine the relationship between the sources, specifically the extent to which they complement or substitute each other over stages of the lifecycle. Essentially, drilling down into the '*who*' and the '*when*' of equity funding, this Chapter undertakes a more micro-micro analysis of the determinants of equity. The novelties lie in three directions: First, it untangles the determinants of equity tested in Chapter 5 by examining their impact across the sources of equity. Second, the analysis is unique in that multivariate probit (MVP) models are estimated for distinct stages in the lifecycle, illustrating how the determinants differ not only by source but also over time. Finally, by investigating whether the sources complement or substitute each other over the lifecycle we provide original evidence of the extent to which the determinants of equity differ given the relationship between the sources. No study, that we are aware of, has undertaken such a detailed analysis.

In **Chapter 7**, the focus is on the impact of equity on the funded firm. First, analysis explores whether equity enhances funded firm performance, measured through innovation, growth and survival. We also investigate whether the effect differs according to source. Existing research is largely segmented, with the vast majority of evidence based on venture capitalists (see Engel and Keilbach, 2007; Bertoni *et al*., 2010). The first contribution of this Chapter is to provide unique evidence on the impact of equity on performance, beyond the influence of venture capital. To the best of our knowledge, we are the first to undertake such an empirical analysis that incorporates these three sources. Second, analysis considers how equity influences entrepreneurial exit intentions. An entrepreneurial exit is defined as the process through which the founder of a business leaves that business, thereby removing themselves, in varying degrees, from the primary ownership and decision-making structure of their business (DeTienne, 2010). Although there has been an increased interest in entrepreneurial exit (see Wennberg and DeTienne, 2014; DeTienne *et al*., 2015; Leroy *et al*., 2015), a noticeable limitation is the conceptualisation of the exit decision as revolving around the entrepreneur (Mason and Botelho, 2016). We undertake a novel empirical examination of the factors that affect entrepreneurial exit intentions, taking into account equity financing. This brings us to the second contribution – not only do we provide new evidence regarding the impact of equity investors on entrepreneurial exit intentions but, by taking into consideration the source(s) of equity obtained, we also provide unique evidence regarding how this impact differs by investor type. Evidence of this kind does not currently exit.

1.3.5 Conclusion

Lastly, **Chapter 8** provides a synthesis of the key research findings and assesses the contributions of this research to the existing literature, along with areas and directions for future research. It draws together the observations from the work as a whole and indicates, as appropriate, strategies or courses of action which may support and enhance access to and use of equity financing. The discussion also outlines suggestions as to how policy makers can support technology-based firms seeking entrepreneurial financing.

1.4 General Conclusions

It is generally accepted that a dynamic technology-based sector is pivotal to enhancing entrepreneurship and innovation, leading to economic growth and the creation of new jobs (see North *et al*., 2013; Eurostat, 2016a). One of the key challenges for technology-based firms is, however, access to resources and competences (see Pierrakis and Mason, 2008; Colombo *et al.*, 2014). Equity financing is considered to be the most appropriate source of external finance for these firms (see Gompers and Lerner, 2001; Revest and Sapio, 2012). In short, equity investors have the ability to effectively deal with information issues associated with entrepreneurial financing, selecting firms with high growth potential and providing much-needed financial and non-financial resources (see Baum and Silverman, 2004; Colombo and Grilli, 2010).

The main themes of this thesis have now been sketched. After compiling a detailed profile of Irish technology-based firms and their financing patterns, including equity finance, quantitative analysis explores: (1) the determinants of equity financing; (2) the extent to which these determinants differ when examined according to source of equity, stage of the lifecycle, and given the relationship between the sources, and (3) the role of equity in impacting funded firm performance and entrepreneurial exit intentions. These issues are explored primarily within a principal-agent (Jensen and Meckling, 1976) framework, while also relying on the concept of the financial lifecycle (Berger and Udell, 1998). The testing of these aspects requires collecting data 'in the field' using appropriately designed instruments. The resultant novel data gathered is a key contribution. In general, the thesis provides an in-depth and thorough treatment of issues pertaining to the equity financing of technology-based firms. To the best of our knowledge, this study is the first in an Irish, and indeed international, context to empirically compare the determinants and impact of equity financing across angel, venture capital and government-sponsored equity. Attention now turns to the substantive work, which involves taking these themes and developing and exploring them.

CHAPTER 2 : LITERATURE REVIEW

2.1 Introduction

This Chapter presents the theoretical and empirical background for this thesis, the principal goal of which is to explore the financing of technology-based firms. The initial sections focus on the underlying theoretical literature, setting the scene for the study. Specifically, Section 2.2. explores capital structure theory, with a particular emphasis on agency theory (Jensen and Meckling, 1976), while Section 2.3 considers organisational lifecycle theory (see Penrose, 1952; Downs, 1967) and the associated financial lifecycle (see Roberts, 1991; Berger and Udell, 1998). Thereafter, attention turns to equity financing, focusing in particular on the factors that determine whether a firm is equity financed and the impact of equity finance in terms of funded firm performance and entrepreneurial exit (Section 2.4). Overall, this Chapter forms the base for data collection (Chapter 3) while also providing a foundation for data analysis (Chapters 4, 5, 6 and 7).

Discussion begins with an examination of the leading theories of capital structure, setting the scene by considering the factors that potentially affect the choice between debt and equity finance. Although there is no universal theory of capital structure (and no reason to expect one), there are useful conditional theories (Myers, 2003). Weaving the fabric of modern corporate finance is the perfect market theorem of Modigliani and Miller (1958, 1963), stating that, except for specifically identified costs or imperfections, the firm's financing choice does not impact firm value. Their work subsequently led to a vast literature focused on releasing the restrictive assumptions made and three theories came to dominate. Briefly, under trade-off theory (see Miller, 1977; DeAngelo and Masulis, 1980), firms choose target debt ratios by trading off the tax benefits of debt against the costs of bankruptcy (or financial distress). According to the pecking order hypothesis (see Myers, 1984; Myers and Majluf, 1984) capital structure adapts to mitigate problems created by asymmetric information such that a financing hierarchy emerges, where internal finance is preferred to external and, if external are necessary, debt is preferential to equity funding. Finally, agency theory (Jensen and Meckling, 1976) recognises the role of agency costs. Considered particularly relevant for investigation of equity finance (Arthurs and Busenitz, 2003), agency theory has provided a framework for research in this area for decades (see Sahlman, 1990; Fiet, 1995; Amit *et al*., 1998; Van Osnabrugge, 2000; Hsu *et al*., 2014) and is thus the primary focus herein. Two aspects draw particular attention – adverse selection, which emerges prior to signing the contract; and moral hazard, which arises because of opportunism post contracting (Jensen and Meckling, 1976). In particular, we are interested in the mechanisms the equity market has developed in mitigating the effects of agency problems (Gompers and Lerner, 2001).

Whilst these theories offer valuable insight into capital structure, they largely ignore the issue of how financing choices vary over the firm's lifecycle. To fill this gap, Section 2.3 considers organisational lifecycle theory and the financial lifecycle paradigm. Numerous organisational theorists have proposed models which attempt to categorise the lifecycle of organisations (see Penrose, 1952; Downs, 1967; Churchill and Lewis, 1983; Hanks *et al*., 1990). While they vary as to the number of stages and specific lifecycle characteristics, most agree on the basic concept that organisations are born (Miller and Friesen, 1984), grow and develop (Downs, 1967), and renew themselves or go into decline (see Quinn and Cameron, 1983; Mintzberg, 1984). Subsequently, researchers approached the issue of how lifecycle stage impacts capital structure. The financial lifecycle paradigm emerged, outlining how financial needs and options change as the business grows, acquires experience, and becomes less informationally opaque (see Roberts, 1991; Berger and Udell, 1998). Both concepts are discussed herein. The lifecycle provides a base not only for survey design (Chapter 3) but also a framework for understanding the financing patterns of technology-based firms in Chapter 4 and empirical investigation of the determinants of different sources of equity financing in Chapter 6.

Moving on, attention turns to equity finance (Section 2.4). The discussion begins with an exploration of the potential determinants of equity (Subsection 2.4.1). To this end, two strands of literature are considered. The first focuses on supply-side research relating to equity investor screening, specifically the criteria employed during the selection and due diligence process (see MacMillan *et al*., 1985; Muzyka *et al*., 1996; Van Osnabrugge, 2000; Franke *et al*., 2006; Petty and Gruber, 2011). The second is the demand-side perspective. Although not as extensive as work focused on the supply-side (Rasmussen and Sørheim, 2012), researchers have identified a variety of signals used by entrepreneurs in their attempt to obtain external equity financing. Early studies by Leland and Pyle (1977) and Ross (1977) concentrated on how the firm's financing decisions constitute a signal to external investors. Subsequent work established the signalling role of human, intellectual and social capital (see Prasad *et al*., 2000; Higgins and Gulati, 2006; Zhou *et al*., 2016). These studies are considered herein with a view to ascertaining those attributes of the firm and entrepreneur that act as signals to external equity investors. Overall, the aim is to identify the potential determinants of equity financing. These will, in turn, inform the design of survey instrumentation (Chapter 3) and subsequent hypotheses development and data analysis (Chapters 5 and 6). Following this, attention turns to consideration of the impact of equity financing (Subsection 2.4.2). Equity investors not only provide financial resources, but also assistance to enhance the development and performance of portfolio firms (see Lerner, 1995; Gompers and Lerner, 2001; De Clercq *et al*., 2006) and the proposition that equity investors are able to increase firm value beyond the provision of financial resources has gained considerable support in the related literature (see Gorman and Sahlman, 1989; Sahlman, 1990; Baum and Silverman, 2004; Croce *et al*., 2013). The expectation of a positive impact on funded firm performance originates in the idea that equity investors are active financial intermediaries who provide not only finance, but additional services of value to entrepreneurs who are often technologically competent but commercially inexperienced (see Keuschnigg, 2004; Peneder, 2010). In most general terms, equity investors specialise in the skills of screening, contracting, monitoring and coaching, while also offering access to valuable resources which, ultimately, serves to enhance the performance of their portfolio firms (see MacMillan *et al*., 1987; Baum and Silverman, 2004; Alperovych and Hübner, 2013). The related research mostly provides evidence that equity financed firms outperform non-equity financed (see Peneder, 2010; Bertoni *et al*., 2011; Croce *et al*., 2013; Croce *et al*., 2018a). These studies are considered herein with a view to gaining an insight into the ways in which equity financing impacts funded firm performance. The issue of entrepreneurial exit is also discussed. Although no study, to the best of the author's knowledge, considers the impact of equity on entrepreneurial exit, research on entrepreneurial exit is outlined with a view to providing a background for empirical analysis. Overall, the aim of the discussion is to gain an understanding of how equity financing can impact on funded firms, which will subsequently inform hypotheses development and empirical analysis in Chapter 7.

Finally, Section 2.5 concludes by summarising the theories, concepts and evidence considered in the main body. As a group, these core sections consider pertinent issues that arise in the equity financing of ventures.

2.2 The Entrepreneurial Choice Between Debt and Equity Finance

The purpose of this Section is to outline the theoretical background for the examination of entrepreneurial financing decisions. Discussion centres on four main theories, namely: (1) Modigliani and Miller's (1958, 1963) theory of capital structure irrelevance; (2) trade-off theory, under which firms balance the tax advantages of debt against the costs of financing distress; (4) pecking order theory, in which financing decisions follow a preferential hierarchy; and (5) agency theory, in which agency costs drive financing decisions. Beginning with a brief consideration of early theories of capital structure (Subsection 2.2.1), the chief focus is on agency theory (Subsection 2.2.1), which provides the main theoretical underpinning for this thesis.

2.2.1 Early Theories of Capital Structure

The capital structure literature finds its foundation in the famous Modigliani and Miller theorem. Briefly, in their original proposition, Franco Modigliani and Merton Miller (1958) hypothesised that, in a perfect and complete market setting[6], firm value is determined by the profitability and riskiness of real assets, not by capital structure. Accordingly, the theorem basically proposes that, in an ideal world without taxes or information problems, the way a firm is financed does not matter. This proposition, however, rests on a set of very specific assumptions, namely: an efficient market lacking taxes, bankruptcy costs and asymmetric information. The assumption of perfect markets is particularly essential in this reasoning as it establishes the conditions necessary for effective arbitrage – in frictionless capital markets, any financial innovation would quickly extinguish deviation from the predicted equilibrium (Myers, 2001). Five years later, recognising the assumption as unrealistic, Modigliani and

[6] 'Perfect' requires that capital markets are not only competitive and frictionless but also complete in that the risk characteristics of every security issued by the firm can be matched in capital markets by purchase of another existing security or portfolio, or by undertaking a dynamic trading strategy (Myers, 2003).

Miller (1963) amended their proposition with the introduction of taxes. Within the tax system, interest payments on debt are allowable against corporate tax whilst, in comparison, dividend payments are not.[7] Essentially, the tax system provides a shield whereby those firms with debt financing face a lower corporate tax bill compared to similar equity financed firms, *ceteris paribus*.

This theorem is considered a highly unrealistic proposition which does not describe reality very well (Hart, 2001). To illustrate, the relatively low use of debt observed in practice suggests that other factors impinge on capital structure (see Rajan and Zingales, 1995; Myers, 2001). If Modigliani and Miller (1958, 1963) were empirically accurate, we might expect firm's capital structure to consist of no debt or large amounts of debt, or debt-equity ratios to be random (Hart, 2001). Nonetheless, the work of Modigliani and Millers (1958, 1963) was ground-breaking at the time and paved the way for alternative capital structure theories, which were, for all intents and purposes, produced by focusing on elements missing from the irrelevance theorem (Hart, 2001). As Merton Miller (1989, page 7) observed "*… showing what doesn't matter can also show, by implication, what does*". The most notable propositions emanating from their work are: the trade-off theory (see Baxter, 1967; DeAngelo and Masulis, 1980); the pecking order hypothesis (see Myers, 1984; Myers and Majluf, 1984); and agency theory (Jensen and Meckling, 1976). Each of these are now considered in turn.

[7] Although Modigliani and Miller (1963) recognised the potential value of interest tax shields, they ignored taxes paid by investors (i.e. only the corporate interest tax shield matters for financing decisions).

Trade-off Theory

Trade-off theory introduces an offsetting cost of debt into Modigliani and Miller's (1963) theorem such that there arises a trade-off in the firm's financing decisions: the firm regards the debt-equity decision as a trade-off between the interest tax shields debt brings and the costs of financial distress (Frank and Goyal, 2007). This theory is essentially based on the notion that firms balance the marginal benefits from using lower cost debt instead of equity against the marginal cost of greater debt, which involves bankruptcy and possible agency costs (Bartholdy *et al*., 2014). Baxter (1967) was one of the first to propose the notion of capital structure based on bankruptcy costs, referred to as "*risk of ruin*" (page 395). The risks associated with excessive leverage increase the cost of capital such that, once the tolerable level of debt has been passed, the rate of interest will begin to rise, increasing the cost of capital and, by extension, risk of ruin. Essentially, when reliance on debt is minimal, the tax effect is likely to dominate but, as leverage increases, the risk of bankruptcy becomes more significant, raising the cost of capital (Baxter, 1967). A more sophisticated model was introduced by Kraus and Litzenberger (1973), who describe the theory as optimal leverage reflecting a trade-off between the tax benefits of debt and deadweight costs of bankruptcy. Other early work is presented by Miller (1977), Scott (1977) and Kim (1978). A dynamic approach to the original static trade-off theory was subsequently proposed to allow for the possibility that firms adjust their level of debt towards a target debt ratio (see Leary and Roberts, 2005; Frank and Goyal, 2007).

Inherent in trade-off models is a predicted inverse relationship between intangible assets and financial leverage (Myers, 1993), such that we would expect firms with more tangible assets to have higher debt ratios than those with greater dependence on intangibles. Additionally, the theory predicts that more profitable firms, possessing a larger debt-serving capacity and greater levels of taxable income to shield, will have a higher debt ratio (Niu, 2008). This is not always the case and the most compelling evidence against the theory has been the inverse correlation found between profitability and leverage (Myers, 2001). Fama and French (1998, 2002), initially showing that debt tax shields do not contribute to a firm's market value, later reported that more profitable firms have less book and market leverage. Rajan and Zingales (1995) and Barclay *et al*. (1995) also report findings of highly profitable firms operating at low debt ratios. Furthermore, studies of the applicability of the theory to small and medium-sized enterprises by Michaelas *et al*. (1999), Jordan *et al*. (1998) and López-Gracia and Sogorb-Mir (2008) report a negative relationship between debt and profitability.

Overall, it appears that the simple tax story is too simple (Hart, 2001) and, although tax incentives may influence capital structure, they are not the priority or of first-order importance (Graham, 2003). The theory may, as explained by Myers (1993, page 84), be considered "*a weak guide to average behaviour*". One conclusion is that bankruptcy costs alone are too limited to offset the value of tax shields and, therefore, factors such as information asymmetries and agency costs must be introduced to enhance our understanding of capital structure (Ju *et al*, 2005). As such, researchers began to focus on an alternative departure from Modigliani and Miller's (1958, 1963) theorem, introducing information and agency problems (see Jensen and Meckling, 1976; Myers, 1984; Myers and Majluf, 1984).

Pecking Order Hypothesis

The original Modigliani and Miller (1958, 1963) theorem assumed homogenous (i.e. symmetric) information. Focusing on the presence of imperfect information[8], Myers (1984) and Myers and Majluf (1984) proposed the pecking order hypothesis under which information asymmetry in the market for entrepreneurial finance triggers a hierarchical order of financing preferences such that internal funds will be preferential to external; should external finance be

[8] Myers (1984) and Myers and Majluf (1984) assume that financial markets are perfect except for the presence of asymmetric information.

necessary, the firm will first seek debt, only issuing equity as a last resort.[9] As the need for external financing increases, the firm will simply work down the pecking order, from safe to riskier debt until debt capacity is reached, at which point it will issue equity (Myers, 2003). Should internally generated cashflow exceed capital investment, the firm will work back up the pecking order, with excess funds used to pay down debt rather than repurchase/retire equity (Myers, 2003).

The proposition holds that costs associated with information asymmetries impact financing decisions. Insiders are assumed to know the true value of the firm's assets and growth potential, while outsiders can only guess. Consequently, if the firm seeks equity, outsiders must ask why they are doing so – typically, overvalued firms are happy to sell equity, whereas undervalued firms are not (Frank and Goyal, 2007). Thus any new equity issue will be viewed negatively by outsiders, who assume that firms will only sell stock if they believe it is overvalued by the market.[10] According to Myers (1984, page 585) "*you will refuse to buy equity unless the firm has already exhausted its "debt capacity" – that is, unless the firm has issued as much debt already that it would face substantial additional costs in issuing more*". Given that it is difficult for outsiders to fully ascertain the value of the firm due to incomplete information (Denis, 2004), if debt is an alternative, attempts to sell shares will reveal that these are not a good buy (Myers, 2003). Thus, debt is preferred to equity as it is less susceptible to undervaluation and, in equilibrium, only debt will be issued (Myers, 2003). Announcement of a stock issue will immediately drive stock price down, and this price drop will be greater the

[9] Under this hypothesis dividends are assumed to be 'sticky' such that dividend cuts will not be used as a source of capital and changes in cash requirements are not soaked up in short-run dividend changes.
[10] Myers and Majluf (1984) derive an equilibrium in which firms can issue shares but only at a marked-down price. Consequently, share price falls because of information asymmetry inferred by the decision to issue equity, not because investors' demand for equity is inelastic.

more pronounced information asymmetries are (Myers, 2003).[11] The firm's debt ratio therefore reflects its cumulative requirement for external financing (Myers and Majluf, 1984).

Though the theoretical reasoning behind the pecking order appears logical, empirical examination has produced contradictory results. While some find support for the original, or a less restrictive, proposition (see Shyam-Sunder and Meyers, 1999; Fama and French, 2002; Bartholdy *et al*., 2015), others report little evidence (see Frank and Goyal, 2003; Fama and French, 2005; Leary and Roberts, 2010). Some conclude that small and medium sized firms, due to their nature, naturally follow a pecking order (see Cosh and Hughes, 1994; López-Gracia and Sogorb-Mira, 2008). According to Frank and Goyal (2003) the theory is a poor descriptor of financing behaviour. The authors tested Shyam-Sunder and Myer's (1999) time-series specification and found that small, high-growth firms do not behave according to the theory, with net equity issues tracking the financing deficit quite closely while net debt does not.[12]

Congruently, others demonstrate support for a loose, or less restricted, interpretation. Bartholdy *et al*. (2015) find that Portuguese firms generally move from lower to higher cost debt when external finance is required, although they do not tend to exhaust one type before moving on to the next. Others argue that firms operate under a somewhat constrained pecking order and simply do not consider raising external equity finance (see Holmes and Kent, 1991; Howorth, 2001). Brierley (2001) posits a reversal of the order for technology-based firms. If equity providers possess superior information in certain respects than banks and entrepreneurs – for example, entrepreneurs may have better knowledge of project-specific aspects such as the feasibility of the technology, but equity investors may have greater comprehension of the project's marketability and operational implementation – then equity may be preferential.

[11] The price drop also depends on the value of growth opportunities versus assets in place. According to Myers and Majluf (1984), growth firms are more credible issuers and so the impact of stock announcement is lessened (Myers, 2003).

[12] However, Frank and Goyal (2003) do note that their specification worked reasonably well for large firms, who provide the greatest support for the pecking order.

Hogan and Hutson (2005a) proposed a modified pecking order whereby firms with specific characteristics (technology-based firms with potential high growth potential and risk) prefer internal equity, followed by external equity, and finally debt. Analogously, Frank and Goyal (2003) and Fama and French (2005) argue that small, high-growth firms are more sensitive to information asymmetry problems. These firms, therefore, rely on equity rather than debt when they require external financing (Devos *et al*., 2012) as a reflection of financial constraints rather than in contradiction to the pecking order hierarchy (Chang and Song, 2013). Overall, it appears that the proficiency of the pecking order hypothesis depends on whether one interprets the proposition in a strict or liberal manner (Leary and Roberts, 2010).

2.2.2 Agency Theory

Theories considered thus far assumed that the interests of firm insiders and shareholders are perfectly aligned, and that financing decisions are in the shareholders' interests. Jensen and Meckling (1976), however, argued that this assumption is implausible in theory and impossible in practice as the separation of ownership and control gives rise to an agency relationship with associated agency costs. In a principal-agent relationship, one party (i.e. the agent) acts on behalf of another (i.e. the principal). Agency problems arise because, if both parties are utility maximisers, "*there is a possibility that the agent will not always conduct business in a way that is consistent with the best interests of the principals*" (Jensen and Meckling, 1976, page 308). In short, under an agency relationship: one party (principal) delegates to another (agent); the goals of the principal conflict with those of the agent; and informational asymmetries result in difficulties for the principal to fully monitor the agent (see

Jensen and Meckling, 1976; Eisenhardt, 1989). Essentially, corporate managers, as agents for shareholders (principals), will act in their own interests and seek private benefits.[13]

Jensen and Meckling (1976) developed a trade-off between debt and equity finance. With equity, conflicts of interest and agency costs between the firm and shareholders can be analysed by comparing the behaviour of an owner-manager when he owns 100% of the residual claim on the firm with his behaviour when he sells equity. If the firm is completely held by the owner-manager, s/he will make operating decisions which maximise their utility; if they sell equity (decreasing ownership stake), agency costs will arise from the divergence between interests of the owner-manager and those of shareholders. These agency costs develop because the owner-manager will now only bear a fraction of the costs of non-pecuniary benefits incurred in maximising his utility. Therefore, the owner-manager has an incentive to act in their own interest, rather than in those of shareholders. Inefficiencies in owner-manager behaviour are reduced the larger the fraction of their equity ownership (Harris and Raviv, 1991). As the owner-manager's equity share is reduced, rather than endeavouring to maximise firm value, they may tend to appropriate larger amounts of corporate resources in the form of perks whose costs are borne at least partially by others (Hart, 2001). According to Jensen and Meckling (1976), inconsistencies in the agent's behaviour can be controlled through debt.

Agency costs of debt arise because of the nature of the contract, which gives holders the incentive to invest sub-optimally (Harris and Raviv, 1991). Briefly, once debt providers advance capital, the owner-manager has a strong incentive to engage in risky activities which have the potential for high payoffs if successful (even if they have a low probability of success) (Jensen and Meckling, 1976). Owner-managers tend to prefer high-risk projects, in conflict with creditor preferences (Graham and Harvey, 2001), attempting to capture returns above

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[13] These can include higher-than-market salaries, perquisites, job security and, in extreme cases, direct capture of assets or cashflow although there can also be non-pecuniary private benefits such as reputation or the personal satisfaction of running a corporate empire (Myers, 2003).

those necessary for debt repayments but, at the same time, with limited liability where returns are insufficient to fully pay debtholders. This is known as the asset substitution problem (Leland, 1998). If it succeeds, the owner-manager captures most of the gains; if it fails, they default and debt holders bear most of the costs/losses. As such, firms are unlikely to be financed entirely by debt because of the effect this would have on owner-manager's behaviour. Instead, the optimal debt-equity ratio is determined at the point where the marginal benefit of keeping the owner-manager from taking perks is offset by the marginal cost of causing risk behaviour.

Within this principal-agent relationship, two problems arise – adverse selection and moral hazard. Arrow (1984) equates these with hidden information and hidden action, respectively; Stiglitz (2000) describes them as problems concerning information about quality and about intent. In short, adverse selection implies that one party is not fully aware of the characteristics of the other; with moral hazard, one is concerned with the other's behaviour or intentions (Elitzur and Gavious, 2001). Thus, adverse selection arises when an agent possesses more information than the principal; moral hazard arises when actions undertaken by the agent are unobservable and have a differential value to the agent as compared to the principal (Darrough and Stoughton, 1986).[14]

In the context of entrepreneurial financing, adverse selection refers to the difficulty external investors experience in evaluating potential investees (i.e. when confronted with a pool of investment opportunities, equity investors cannot distinguish between a good and bad prospect (Hyytinen and Väänänen, 2006)). In attempting to obtain funding, the entrepreneur may manipulate the information they provide to potential investors (Cable and Shane, 1997) who, given incomplete information, are unable to fully verify such claims (Van Osnabrugge,

[14] In some circumstances, the two problems can be complementary – adverse selection can translate into moral hazard, as shown by Diamond (1989) and Petersen and Rajan (1995).

2000). For example, the entrepreneur might allude to having greater knowledge of a technology than is the case (Arthurs and Busenitz, 2003). This may ultimately result in worsening the pool of firms that demand external finance (Stiglitz and Weiss, 1981).

Moral hazard arises after the investment has been made and describes situations where parties act in their own self-interest, regardless of the effect their actions have on others (Elitzur and Gavious, 2003). Because the agent's incentive to maximise effort is an increasing function of their residual claim in the venture (Cumming and Johan, 2013), once they have obtained finance from the principal, they may have a tendency or incentive to misallocate funds by spending on activities that benefit themselves but not necessarily the firm (Denis, 2004). Specifically, they might use the funds for activities other than the indicated purpose or take actions that endanger repayment (Hyytinen and Väänänen, 2006). When all possible outcomes cannot be foreseen, and effort of the agent cannot be ascertained with complete confidence, it can be difficult to write contracts governing the financing of the firm (Hart and Moore, 1998).

It should be noted at this juncture, given the focus of this thesis, that agency problems tend to be particularly severe for technology-based firms (Gompers and Lerner, 2001). Briefly, because such projects are difficult to evaluate and embody new proprietary knowledge, entrepreneurs possess superior understanding (Carpenter and Petersen, 2002a) and informational issues tend to be particularly germane (Revest and Sapio, 2012). First, potential investors may find it difficult to assess available information simply because they lack the necessary technological background (Knockaert *et al.*, 2010) and are thus unable to fully appraise the technology or understand commercial implications of strategic choices (Knockaert *et al.*, 2006). Second, reducing informational opacity via fuller disclosure is not always feasible due to concerns regarding imitation of ideas/innovations (Hall, 2002), with entrepreneurs normally wanting to keep complete details of their project confidential (Müller and Zimmermann, 2009). Exacerbating informational issues is the fact that these projects are risky.

Returns to investment are skewed and highly uncertain, in part because technological projects are precarious and have a low probability of success (Carpenter and Petersen, 2002a). Furthermore, these sectors are typically characterised by fierce competition and short technology lifecycles (see Yang *et al*., 2009; Lee and Kang, 2015). Additionally, because these firms are usually introducing new and innovative products/processes, latent demand is unknown *ex ante* resulting in considerable market uncertainty (Winston Smith, 2011), which makes it difficult to assess the marketplace (Sjögren and Zackrisson, 2005). Essentially, not only does one not know all the possibilities associated with eventual outcomes but often even the forms of that potential outcome are not evident (Kerr and Nanda, 2015). Thus, informational and agency problems tend to be particularly pronounced.

Although agency problems cannot be avoided altogether, they can be alleviated somewhat. Jensen and Meckling (1976) describe two general solutions – monitoring and bonding. As such, the principal can establish appropriate incentives for the agent and incur monitoring costs to limit pursuit of sub-optimal activities; in concert, the agent can expend resources (bonding costs) which demonstrate that they will act in the best interest of the principal (Jensen and Meckling, 1976). The equity industry has developed various mechanisms to overcome agency issues (Gompers and Lerner, 2001). Indeed, it is generally believed that equity investors are best equipped to deal with the nuances of technology-based investment (Cumming *et al*., 2017).[15] Mechanisms through which investors attempt to mitigate agency conflicts are generally classified under the headings of screening, contracting and monitoring (Kaplan and Strömberg, 2001). From the entrepreneur's perspective, a popular mechanism is signalling, whereby they create signals (Spence, 1973) which communicate attributes that prompt trust in their qualifications, potential and future behaviour (Bender, 2011). Effectively,

[15] Scholars generally agree that, given the high degree of information opacity, uncertainty and intangible assets, external equity is a more suitable source of funding than debt (see Cressy, 2002; Hyytinen and Pajarinen, 2003).

they use their superior knowledge of the project to convey, through a costly action, a signal of quality to principals (Riley, 2001). Signalling theory (Spence, 1973) has been widely applied in identifying those attributes (i.e. signals) that are effective in resolving the adverse selection problem that arises for ventures seeking external funding (Jain *et al*., 2008).

Thus, in mitigating agency problems, the principal typically employs screening and monitoring devices while the agent engages in signalling activities (Connelly *et al*., 2011). Specifically, in alleviating adverse selection, investors carry out screening *ex ante* and monitor *ex post* to relieve moral hazard (Bellavitis *et al*., 2017). Concurrently, in easing adverse selection, an entrepreneur invests in information that will communicate (i.e. signal) quality/ability (Amit *et al*., 1990). Attention now turns to consideration of these mechanisms.

Signalling

Attempting to capture informational aspects of market structure, Spence (1973) introduced the concept of signals, demonstrating how a job applicant might engage in behaviours to reduce information asymmetries that hamper the selection ability of prospective employers. In his seminal work on signalling, Spence (1974, page 1) refers to signals as "*activities or attributes of individuals in a market which, by design or accident, alter the beliefs of, or convey information to, other individuals in the market*". Signals, then, serve to reduce information gaps or asymmetries between two parties (i.e. the audience receiving the signals and the signal sender). Briefly, potential employers lack information regarding the quality of job candidates whereas job seekers possess superior knowledge of their productive capability. High-quality candidates can distinguish themselves from low-quality prospects via the costly signal of higher education (presumed to be a reliable signal as lower quality prospects would be unable to withstand the rigors of obtaining a higher education).

The validity of a signal depends on its inherent credibility – "*it must be unprofitable for sellers of low-quality products to imitate it. That is, high quality sellers must have lower costs for signalling activities*" (Spence, 1976, page 592).[16] An effective signal possesses four attributes: it is observable to outsiders; it reveals hidden information; it is reliable and hard to mimic; and it is feasible (i.e. the benefits obtained from the exchange of the signal must exceed the signal cost).[17] The distinctiveness of the theory arises from its emphasis on a signalling equilibrium, which specifies how signal senders and observers can distinguish between high and low-quality actors based on an observable signal.[18] Broadly, a signalling equilibrium occurs when: participants weight the returns and costs of the signal and make optimising decisions with respect to the signal; signal senders and receivers have beliefs about the relation between the signal and unobserved characteristics of the signaller; and post-signal data and experiences confirm expectations [19] (Bergh *et al*., 2014). Spence's (1973, 1974) work triggered a large volume of research applying the concept of signals in reducing information problems (Bird and Smith, 2005). The concept is advantageous in that specific signals can be identified that reduce uncertainty regarding quality and potential in the eyes of key stakeholders (Ko and McKelvie, 2018). The work of Connelly *et al*. (2011) offers a concise synthesis of work.

A considerable stream of research investigates the role of signals in financial markets, exploring the ways in which capital providers consider signals of underlying quality communicated by entrepreneurial ventures (see Jain *et al*., 2008; Ozmel *et al*., 2013; Ahlers *et al*., 2015). Specifically, because of the high levels of uncertainty and information asymmetry surrounding organisations, scholars have applied signalling theory logic to advance the idea

[16] The costs of credible signals are inversely related to the quality of the signal sender (Spence, 1973).
[17] To maintain their effectiveness, the costs of signals must be structured in such a way that dishonest signals do not benefit the sender (Connelly *et al*., 2011).
[18] This signalling equilibrium is also referred to as a 'separating equilibrium' (Bergh *et al*., 2014)
[19] In his Nobel Prize acceptance lecture, Spence (2002) stressed that beliefs about the relationship between the signal and productivity must, in the signalling equilibrium, be confirmed by incoming data and subsequent experience, and be accurate. In his labour market model, the signal is confirmed if the high-quality employee performs at a level that justifies his wage.

that signals can be used as a mechanism for differentiating firms' quality (Drover *et al*., 2017). External investors tend to rely on observable signals prior to committing funding (see Amit *et al*., 1990; Higgins and Gulati, 2006) because separating, a priori, high-quality firms from those with less potential can be difficult (Davila *et al*., 2003). The appeal of this concept lies in the potential of signals to provide a sorting mechanism which helps investors to derive expectations regarding the quality of the firm/entrepreneur (Hottenrott *et al*., 2016). Thus, signals assist entrepreneurs in alleviating informational problems as effective signals have the potential to partly substitute for information opacity while also distinguishing high-quality ventures (see Certo *et al*., 2001; Busenitz *et al*., 2005).

Early work in this area focused on how capital structure might constitute a signal. Ross (1977) was the first to show that financing choices could signal inside information to investors. In his model, managers convey private information through the proportion of debt in the firm's capital structure. Debt constitutes a costly signal in distinguishing high-quality from low-quality firms as successful firms with higher revenues can support greater leverage than those with lower revenues. According to this model, only high-quality firms can make interest payments over the long-term, while low-quality firms will be unable to sustain such payments. Thus, the value of the firm increases as the level of debt rises (Ross, 1977). A similar model is provided by Bhattacharya (1979) and John and Williams (1985) using dividend payments as the signal.[20] Harris and Raviv (1985) proposed a model based on convertible debt, wherein the immediate conversion of the debt conveys bad news to the market and is perceived as a signal of unfavourable private information.[21]

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[20] According to these models, taxable dividends signal firm quality as only higher quality firms are willing to accept a smaller increase in firm value in return for accumulating greater tax liabilities (i.e. a higher dividend). Miller and Rock (1985) provided a similar model, within which higher quality firms must increase dividends to distinguish themselves from lower quality alternatives. Empirically, however, evidence is weak, and the dividend puzzle remains (Riley, 2001).

[21] Ofer and Natarajan (1987) and Acharya (1988) also provide models which confirm the signalling function of delay of conversion.

Leland and Pyle (1977) offer a model based on entrepreneurial risk aversion. Here, entrepreneurs seek financing for a project whose true value and quality are known only to them and it is the entrepreneur's willingness to invest in their own project that acts as the signal of quality. Entrepreneurs are risk adverse and so will only invest in their own project if they believe that the return from doing so outweighs the risk. If insiders are risk adverse, it is costly to commit to holding a sizable fraction of their portfolios in the firm, rather than be fully diversified. However, the marginal cost of holding more shares is higher for entrepreneurs who have lower quality firms. Hence, the value of the firm increases with the share of the firm held by the entrepreneur, whose willingness to invest acts as a positive signal of future returns.[22] Additionally, Leland and Pyle (1977) show that firms with riskier returns will have lower debt levels. Essentially, greater levels of debt signal firm quality as debt allows entrepreneurs to retain a larger percentage of equity in the firm.

Overall, these early models demonstrate how financing decisions can act as signals. In the years following, the role of signals has been extensively researched, with the consensus being that the signals entrepreneurial ventures send to the market can be an important factor in their ability to attract and obtain external financial resources, particularly equity funding (see Amit *et al.*, 1998; Busenitz *et al.*, 2005; Moss *et al.*, 2015). This research identifies a range of potential signalling mechanisms through which entrepreneurs can communicate their private information to prospective investors. These include: proportion of equity retained by the entrepreneur (see Prasad *et al.*, 2000; Jain *et al.*, 2008); reputation (Fischer and Reuber, 2007); strategic and research alliances (see Ozmel *et al.*, 2013; Hoenig and Henkel, 2015); the human capital of the entrepreneur and management team (see Certo, 2003; Higgins and Gulati, 2006); prestige of the firm's board of directors (Certo *et al.*, 2001); characteristics of corporate

[22] Incidentally, signalling and agency postulate a positive role for insider ownership in mitigating informational problems – agency theory suggests that higher insider ownership reduces agency conflicts and thus enhances organisational performance, while signalling theory posits that higher ownership is a credible signal of insiders' confidence regarding the prospects of the firm (Jain *et al.*, 2008).

governance (Filatotchev and Bishop, 2002); intellectual property (see Hottenrott *et al*., 2016; Zhou *et al*., 2016); social ties (Bruton *et al*., 2009); geographic scope (Bell *et al*., 2008); pricing of an initial public offering (Cohen and Dean, 2005); and private equity placements (Janney and Folta, 2003). The empirical evidence relating to these signals is considered in detail in Section 2.4, with a view to building a profile of potential demand-side determinants of equity financing which will, ultimately, inform hypotheses development in Chapters 5 and 6.

Screening

The mirror image of signalling, screening simply differs in the view of which party moves first (Sanders and Boivie, 2004). Screening theory, like signalling, was developed in the context of labour markets (see Stiglitz, 1975; Weiss, 1995), with employers actively screening job applicants based on observed characteristics (for example, educational attainment) when information on the truly desired attribute is unobservable. Essentially, when individuals cannot assess unambiguous information regarding intrinsic quality, they filter offerings based on the presence of other attributes assumed to be correlated with desired, but unobservable, characteristics and actions (Weiss, 1995). To limit information asymmetry, particularly to mitigate adverse selection, a principal can utilise screening devices (the identification of an individual's qualities is referred to as screening and devices that sort individuals according to these qualities as screening devices (Stiglitz, 1975)). In screening, a principal typically uses a set of observable characteristics, correlating with parameters of interest, to screen and rank agents' perspective performances and ability based on their endowment with those characteristics (Padilla, 2002).

A widely shared view is that equity investors possess superior screening capabilities (Chan, 1983) which allow them to more effectively mitigate information asymmetries compared to traditional financial intermediaries (see Sahlman, 1990; Gompers and Lerner, 2001; Guerini and Quas, 2016).[23] Prior to committing to an investment, equity investors spend a significant amount of time and effort evaluating and screening the opportunity (see Tyebjee and Bruno, 1984; Haines *et al*., 2003; Paul *et al*., 2007). In general, screening is considered a two-step process (Tyebjee and Bruno, 1984) – the first is the initial screen, through which investors reduce the large set of proposals they receive, excluding those that do not fit the purpose of their fund (Minola *et al*., 2017); the second is in-depth due diligence, through which investors comprehensively evaluate the investment proposals that passed through the initial screening stage (Paul *et al*., 2007). Basically, screening and due diligence refer to activities undertaken by the principal to gather information to better evaluate the characteristics/motivation of the agent as well as the quality of the project (Bender, 2011).[24] The initial screening stage effectively drives the outcome of the investment process as it lowers the probability of picking low-performers (Zacharakis and Meyer, 2000).

The fundamental aim of screening is to eliminate proposals which do not meet the investor's specific criteria (Fried and Hisrich, 1994), accepting only those that fit their purpose and excluding the lowest number of promising investments (Zacharakis and Meyer, 2000). Essentially, investors attempt to identify potential deal breakers while scrutinising the attractiveness of the venture or its commercial position (Klonowski, 2007). According to Cosh *et al*. (2009) the firm's ability to access capital depends primarily on the degree of information asymmetries faced by investors and their ability to do due diligence to mitigate informational problems. Through the process investors attempt to minimise investment risk by getting to know the business, entrepreneur/management and the product/market of the investment proposal (Manigart *et al*., 1997). A popular topic over the last four decades has been the exploration of the investment criteria applied by equity investors during this screening and due

[23] Moreover, as banks typically hold large portfolios of investments, they can lack the time to involve themselves sufficiently to screen candidates to proficiently reduce risk (Hyytinen and Pajarinen, 2003).
[24] Interestingly, some researchers define screening and self-selection synonymously (for discussion see Bender, 2011).

diligence process (see Tyebjee and Bruno, 1984; MacMillan *et al*., 1985, 1987; Hall and Hofer, 1993; Muzyka *et al*., 1996; Landström, 1998; Shepherd, 1999; Franke *et al*., 2006; Dimov *et al*., 2007; Mitteness *et al*., 2012; Hsu *et al*., 2014). Research pertaining to equity investors' selection criteria are explored in detail in Section 2.4 with a view to providing an insight into the determinants of equity financing from the supply-side standpoint which will, subsequently, facilitate hypotheses development in Chapters 5 and 6.

Monitoring and Contractual Mechanisms

Contractual terms and conditions (for example investment structure, monitoring rights) can be designed to enforce information transfer (Neher, 1999), thus alleviating informational problems. Common mechanisms utilised include: syndicating or co-investing with other equity investors; contracting (for example, staging investment, taking seats on the firm's board of directors, preferred securities); obtaining a referral from a mutual social connection; closely monitoring and interacting with portfolio firms; and geographic proximity (see Sahlman, 1990; Harrison and Mason, 2000; Gompers and Lerner, 2001; Shane and Cable, 2002; Wang and Zhou, 2004; Fritsch and Schilder, 2008; Cumming and Dai, 2010). These are synopsised herein.

In a syndicated investment, multiple investors invest in a firm (Deli and Santhanakrishnan, 2010). Syndication can take place in the same round or sequentially, with new investors coming in at later rounds (Casamatta and Haritchabalet, 2007). A key incentive for syndication is risk avoidance (Wilson, 1968), whereby investors attempt to share risk by involving others (Lockett and Wright, 2001). The rationale is that equity investors undertake syndication to diversify their portfolios, reducing overall risk (Brander *et al.,* 2002). Moreover, co-investing improves due diligence by allowing investors to share judgements on potential investments (see Lerner, 1994; Gompers and Lerner, 2001). By bringing together complementary skills and expertise, screening and due diligence can be enhanced (Cumming, 2006) and adverse selection lessened (Sah and Stiglitz, 1986) by facilitating superior selection of investment. Chiplin *et al*. (1997) report a relationship between risk reduction and syndication while Bygrave (1989) indicates that syndication is both a function of the desire to spread financial risks as well to share information. Overall, syndication has long been considered an important control mechanism (Sahlman, 1990) which can lead to superior selection of investments (Lerner, 1994) and reduction of the risks inherent in entrepreneurial financing (Lockett and Wright, 2001) thus mitigating adverse selection (see Manigart *et al*., 2002; Wright and Lockett, 2003; De Clercq and Dimov, 2004). Moreover, investors also benefit through subsequent shared management of investment (see Bygrave, 1987; Lockett and Wright, 2001).

Organisational theorists posit that investors use social ties and information transfer through social relationships to overcome informational problems (Venkataraman, 1997).[25] Under conditions of information asymmetry and uncertainty, social ties can provide an advantage to those who seek to obtain resources from others (Podolny, 1994).[26] These connections are an important mechanism by which interpersonal feelings of cohesion, trust and obligation are generated among parties (see Reagans and McEvily, 2003; Tinkler *et al*., 2015). Evidence shows that the source of the proposed investment (i.e. unsolicited or referred) can have a significant influence on the investor’s decision to consider the opportunity further (see Mason and Rogers, 1997; Mason *et al*., 2016). Research indicates that those approaching investors with social ties to or referrals from mutual associates have lower rejection rates and are more likely to obtain investment (see Fried and Hisrich, 1994; Croce *et al*., 2017). A

[25] More generally, sociologists have long argued that referrals by people in whose judgement the decision maker has confidence makes them more favourably disposed to the individual referred (Blau, 1964).
[26] Socials ties can be direct (i.e. a personal relationship between the decision maker and the party about whom the decision is being made (Larson, 1992)) or indirect (i.e. a relationship between two individuals who are connected through a social network of each party’s direct ties (Burt, 1987)) in nature.

network of social ties provides an important mechanism through which information asymmetry is overcome primarily because these connections provide reliable information regarding the firm's and entrepreneur's quality and legitimacy, thus informing parties of potential value (see Filatotchev and Bishop, 2002; Park *et al*., 2016). Having a social tie or reference that can vouch for the entrepreneur may increase investor confidence, thus mitigating the level of uncertainty in the funding decision at hand (Tinkler *et al*., 2015).

Equity investors seek to protect their interests and mitigate moral hazard using contractual rights (i.e. rights accorded to enable investors to oversee the entrepreneur's management of the firm (Wong *et al*., 2009)) and monitoring (i.e. procedures employed to evaluate the entrepreneur's behaviour and performance to keep track of their investment (Wright and Robbie, 1998)). From an economic perspective, contract provisions and monitoring facilitate the reduction of informational and agency problems by shifting the risk of inappropriate behaviour to the entrepreneur (see Gompers and Lerner, 2000; Shane and Cable, 2002). As Sahlman (1990, page 510) observes, "*it would be foolish for the entrepreneur to accept these terms if they were not truly confident of their own abilities and deeply committed to the venture*". Common mechanisms include staging (Gompers and Lerner, 2001), board representation (Lerner, 1995), security ownership (Gompers, 1997), and continual monitoring of and communication with portfolio firms (Shepherd and Zacharakis, 2001).

Staging entails the sequential disbursement of capital, whereby investors stage investment based on receipt of new information (see Sahlman, 1990; Gompers and Lerner, 2001). A prevailing view is that staging is an effective method in mitigating agency problems as it allows the investor to maintain the option to abandon the investment if the entrepreneur fails to meet specific targets (see Kaplan and Strömberg, 2001; Tian, 2011). The literature begins with Gompers (1995), who focuses on staging as a form of monitoring. In financing high-risk companies with pervasive moral hazard, staging allows investors to gather information and monitor progress while maintaining the option to abandon the investment. Here, staging is related to expected agency costs, which are increasing with: the ratio of intangible assets; value of growth options (measured by market-to-book ratio); and asset specificity (measured by R&D intensity). Gompers (1995) finds that firms with higher agency costs receive investment in a greater number of rounds. Neher (1999) proposes a theoretical model on use of staging to overcome a commitment problem which arises due to the role of the entrepreneur in determining success. Once the investment is made, the entrepreneur can hold-up the investor by threatening to leave. While upfront financing gives the entrepreneur a hold-up opportunity, staging allows for the gradual embodiment of their human capital in the physical capital of the venture, mitigating the hold-up problem and reducing the amount of the investor's investment in the project at any given time.[27] Overall, staging gives investors not only an opportunity to monitor portfolio companies (Gompers, 1995) but also preserves their option to abandon the investment (Kaplan and Strömberg, 2001).

Another mechanism is board membership (Baker and Gompers, 2003). Board seats give investors the ability to influence corporate decisions and are considered particularly important in environments characterised by heightened uncertainty, where it is not feasible to specify all possible contingencies in the *ex-ante* contract (Wong *et al*., 2009). Board rights, and associated voting rights, give the party the right the decide on any action that is not pre-specified in the original contract and thus beneficial in an incomplete contract world, where it is not feasible or credible to specify all possible actions and contingencies in an ex ante contract (Kaplan and Strömberg, 2003).

[27] Wang and Zhou (2004) present a model which considers the role of staged financing in controlling risk and moral hazard. Using parametric functions and comparing staged with upfront financing, the authors show that there are cases in which upfront financing may be superior. Staged financing can enhance efficiency, reduce risk and moral hazard, and induce greater effort from entrepreneurs only in highly promising ventures. Conversely, upfront financing can be a socially better choice for less promising ventures, as staged financing may lead to underinvestment from venture capitalists, potentially dooming the venture to failure.

Aside from their presence on the board, interacting with their portfolio firms is another avenue utilised in dealing with informational issues and monitoring investees.[28] Personal interactions with the management of the portfolio firm serves numerous purposes by allowing the investor to become personally familiar with what is going on in the business, understand how management CEO operates and thinks, build rapport, and influence decisions (Sapienza *et al*., 1996). According to Fiet (1995), equity investors manage agency risks post-investment through face-to-face interaction, a form of contact that provides an opportunity to gather information and create a personal understanding of the business and its people.

Third, rights are conferred through type of security. Investors can obtain common or preferred shares, or a combination of both (Cumming and Johan, 2013). Preferred stock embodies a more senior claim as stockholders must be paid the full liquidation value before common stockholders receive anything (Finnerty, 2008). This essentially controls for agency costs by providing downside protection (see Lerner, 2000; Metrick, 2007). Convertible securities, which delay the entrepreneur's compensation until the outcome of the investment is revealed, are common (see Gompers, 1997; Kaplan and Strömberg, 2003). The conversion of preferred to common equity can be triggered by superior performance, providing the entrepreneur with the right to purchase control of the firm (Black and Gilson, 1998). If the firm's performance reaches a pre-specified level, the investor gains only those rights associated with their common stock, whilst poor performance will transfer control to the investor (Kaplan and Strömberg, 2003). Whereas venture capitalists mostly utilise convertible securities (Sahlman, 1990) angels typically use common (see Lumme *et al*., 1998; Casamatta, 2003).

Investors may also limit activity to certain geographical region (see De Clercq *et al*., 2001; Bender, 2011). Existing studies emphasise the localised nature of investment as a means

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[28] Furthermore, in his theoretical model Lambert (1986) shows that where high-risk causes executives to underinvest in the more profitable projects that the shareholder would prefer then improved communications will increase the willingness of the executives to choose the risky projects.

of reducing investor risk (see Martin *et al*., 2002; Mason, 2007). Briefly, investors who are geographically close to investees face lower risks and information costs (see Kang and Kim, 2008; Agarwal and Hauswald, 2010). Where long distance investing does occur, deals are typically syndicated, with the presence of a local investor to lead the deal (see Florida and Kenney, 1988a; Fritsch and Schilder, 2012). Aside from the risks and information costs involved, travel costs may play a role in investment selection. Because equity investors are active shareholders (Tykvova and Schertler, 2014), greater geographical distance tends to make coordination and monitoring more challenging (Ceci and Prencipe, 2013). Tian (2011), using geographic distance as a proxy for monitoring costs, examines how staging depends on proximity between the investee and venture capitalist. Using a sample of U.S.-based venture capital financed firms, he shows that staging is more likely when there is greater geographic distance between the investee and investor. In short, an investor who is located farther away from an investee tends to finance that firm with a larger number of rounds, with a shorter duration between those rounds and smaller amounts of investment in each round.

2.2.3 Conclusions

Corporate financing and capital structure literature describes the mix of securities and sources of financing used to fund real investments by corporations, attempting to explain proportions of debt and equity utilised (Myers, 2003). The leading theories of capital structure are as follows: capital structure irrelevance (Modigliani and Miller, 1958, 1963); trade-off theory (see Baxter, 1967; Kraus and Litzenberger, 1973); pecking order theory (see Myers, 1984; Myers and Majluf, 1984); and agency theory (Jensen and Meckling, 1976). Under their irrelevance proposition, Modigliani and Miller (1958, 1963) posit that financing does not matter in perfect capital markets. With trade-off theory, firms choose target debt ratios by trading off the tax benefits of debt against the costs of bankruptcy and financial distress. Actual debt moves towards the target until the firm reaches debt capacity, when equity will be issued. Under pecking order, financing adapts to mitigate problems created by information asymmetry between firm insiders and outside financing providers. As such, a hierarchy emerges whereby the firm turns first to the financing sources where differences in information are lowest.

Agency theory (Jensen and Meckling, 1976) holds that agency costs drive financing. In a principal-agent relationship, one party (agent) acts on behalf of another (principal). Within this relationship, there exist two potential problems – adverse selection and moral hazard. The former arises because the agent naturally possesses more information regarding their ability and intentions than the principal; the latter arises because actions undertaken by the agent (who is not fully supervised) are largely unobservable and have a differential value to the agent as compared to the principal (Stiglitz, 2000). Jensen and Meckling (1976) describe two general solutions – monitoring and bonding. The principal can attempt to attenuate agency issues by establishing appropriate incentives for the agent and incurring monitoring costs designed to limit the pursuit of sub-optimal activities while the agent may expend resources (bonding costs) to reduce informational differences. The investor-investee relationship can naturally be described as that of principal-agent (Reid, 1998) and agency theory has been a common framework for equity financing research (see Amit *et al*., 1998; Shane and Cable, 2002; Hsu *et al*., 2014). Of particular interest are the methods advanced to mitigate agency issues which arise between firms and equity investors (Gompers and Lerner, 2001). First, the investor can engage in information collection prior to investing (Bender, 2011). Second, the investor can structure contracts to monitor the investee (Kaplan and Strömberg, 2001). Finally, from the entrepreneur's perspective, signals can communicate valuable information to investors and help them access financial resources (Elitzur and Gavious, 2003). Agency theory provides a framework, firstly, for the consideration of attributes of equity investment in Chapter 4 vis-á-vis monitoring and contracting tools utilised. Secondly, research pertaining to screening and signalling enhances identification of potential drivers of equity financing for hypotheses development in Chapters 5 and 6.

To close our discussion, a limitation of this literature is noteworthy. While theories pertaining to capital structure decisions deal with static (see Miller, 1977; Scott, 1977) or dynamic (see Myers, 1984; Myers and Majluf, 1984; Leary and Roberts, 2005; Frank and Goyal, 2008) convergence to an optimal debt-equity ratio, or agency problems associated with a single financing decision (Jensen and Meckling, 1976), these theories leave lifecycle issues aside, failing to address the lifecycle aspect of financing decisions (Hirsch and Walz, 2011). Furthermore, most of this research assumes that firms raise capital primarily from outside investors, not from the firm's entrepreneurs, managers or employees (Myers, 2003). Incorporating these elements, the next section explores the notion of the organisational lifecycle, paying attention to changes in use of and access to sources of both internal and external financing over developmental stages.

2.3 The Organisational Lifecycle

Lifecycle theory asserts that organisations inevitably evolve and transition from one phase of development to another (Porter, 2008), much like living organisms, in a linear fashion from birth to decline (see Penrose, 1952; Downs, 1967; Miller and Friesen, 1984). Here, we consider organisational lifecycle theory (Subsection 2.3.1) and the associated financial lifecycle (Subsection 2.3.2) which provide an important framework for this study. Specifically, the lifecycle is instrumental in the design of survey instrumentation (Chapter 3), helps us in understanding data on the financing patterns of technology-based firms (Chapter 4), and facilitates hypotheses development for empirical investigation of the determinants of equity financing (Chapter 6).

2.3.1 Organisational Lifecycle Theory

Marshall (1890), according to Loabsy (1990), emphasised that firms go through a lifecycle (birth, growth and dissolution). Subsequently, lifecycle models were developed to describe the lifecycle of organisations, the underlying premise of which is that organisations grow in response to their environment, following certain patterns of evolution and development (Bedeian, 1984). Numerous models have been created – Downs (1967) and Lippitt and Schmidt (1967) propose a three-stage model while Lynden (1975) and Quinn and Cameron (1983) advocate four-stages. Five-stage models are presented by Churchill and Lewis (1983), Greiner (1972) and Lester *et al*. (2003, 2008). Adizes (1979) outlines ten-stages. An in-depth review of over 40 years of research provided by Levie and Lichtenstein (2010) concludes, based on analysis of 104 models, that most include three, four or five stages.

To illustrate, Greiner (1972) proposed a model consisting of five stages of sequential development, namely: creativity, direction, delegation, coordination, and collaboration. This model is based on five key dimensions: age of the organisation, size of the organisation, stages of evolution and revolution[29] and industry growth rate. Each stage, other than the first, is both the effect of the previous phase and a cause of the next – future growth will be determined more by past decisions than by present events or outside forces. Moreover, each stage is followed by a transitional phase arising from a major organisational problem – it is only by solving this problem that the organisation can advance to the next stage.[30] The creativity stage ends with a crisis of leadership; the direction phase with a crisis of autonomy; a crisis of control follows the delegation phase; and a crisis of red tape follows coordination. Finally, the organisation moves towards stage five, collaboration, which emphasises spontaneity and experimentation with new practices – the major crisis here does not have a name or specific resolution attached to it. Rather, according to the author, issues at this stage revolve around the psychological saturation of employees, exhausted from the intensity of team work. In these phases "*a major solution in one time period becomes a major problem at a later date*" (page 40). Organisations must move forward introducing new solutions, they cannot move backwards and "*evolution is not an automatic affair, it is a contest for survival*" (page 45). As each phase is strongly influenced by the previous one, management with an understanding of the organisation's history can anticipate and prepare for these developmental crises and problems, turning them into opportunities for growth.[31]

Overall, organisational lifecycle theory is built on the concept of stages that firms evolve through over time in a predictable, linear and consistent manner. As firms move through their lifecycle, organisational characteristics, problems, structural configurations and strategic

[29] Greiner (1972, page 38) distinguishes between evolutionary and revolutionary periods: evolutionary periods are characterised by "*long periods of growth where no major upheaval occurs in the organisation practices*" whereas revolutionary periods are characterised by "*periods of substantial turmoil in organisation life*". The speed at which the organisation experiences these periods depends on the speed at which the industry environment is growing.

[30] Conversely, in his study Kazanjian (1988) concluded that, firstly, there may exist a hierarchical ordering of problem factors and, secondly, that problems may not only influence stage characteristics at one time but could increase and decrease in importance from one stage to another.

[31] According to Hall (1995), the model is ultimately about changes in response to growth and most of the crises described would not occur if the company has maintained stable sales and grown older.

priorities change and evolve (see Adizes, 1979; Quinn and Cameron, 1983; Miller and Friesen, 1984). Most models share a common reasoning that the organisation must overcome successive challenges in each stage to progress to the next and make growth possible. Although numerous models exist researchers have not yet arrived at a consensus on how many stages are appropriate (Rutherford *et al*., 2003).[32] Essentially, the notion of a lifecycle stage is a complex one, and there remain questions regarding how to effectively apply this concept in practice (Frielinghaus *et al*., 2005). The paradigm has also been criticised for implicitly assuming that all organisations pass uniformly through predetermined stages (see O'Farrell and Hitchens, 1988; Gibb and Davies, 1991). Some argue that firm development is stochastic, rather than the linear progression described by the organisational lifecycle model (see Reynolds and Miller, 1992; Katz, 1993; Gersick, 1994). Indeed, according to Levie and Hay (1998), researchers have not yet succeeded in proving the existence of a general model of lifecycle stages. Hanks *et al*. (1994) contend that specifying a universal model is difficult due to intra-industry differences. Moreover, the determinants of a firm's position in a stage and the factors which precipitate a move from one stage to another are at best implied in theoretical models (Kazanjian, 1988). Building on this shortcoming, models began to emerge which take account of the role of industry, technology and other situational variables on lifecycle models.

Lifecycle models were also developed which focus solely on technology-based firms. An illustration of four such models is presented in Table 2.1. In general, these move from product development, through introduction and commercialisation, into sales and, finally, growth. Technology-based start-ups differ to those in more traditional sectors in that they are characterised by an intensive period of research and development (Kazanjian and Drazin, 1990), particularly during their formative years. These innovative firms are under pressure to

[32] Miller and Friesen (1984) studied and integrated previous lifecycle models. The authors proposed five generic stages (birth, growth, maturity, revival and decline) and claimed that not all organisations would move through the same stages in a linear fashion.

develop rapidly along their lifecycle, with swiftly aging technologies making them increasingly vulnerable to obsolescence (Castro *et al*., 2015). According to Kazanjian (1988), when a product is technically feasible and has achieved market acceptance, a period of high growth will typically result. As the growth rate slows to a level consistent with market growth, the firm enters the maturity stage. Introduction and decline are generally less important stages, as they are frequently shorter than for firms in more traditional sectors (Castro *et al*., 2015).

Briefly, Roberts (1991) proposes a three-stage model as follows: first is the seed stage, characterised by product development, with the firm working out its basic technology, formulating initial strategy and establishing a start-up team; moving to the second stage, initial growth begins once the firm has completed the development of a product line and has achieved sufficient sales to justify an expectation of rapid growth; finally, if the firm solves its initial start-up and early growth problems, it emerges as a growth business and thus enters the third phase, the sustained growth stage. Mayer (2002) posits a four-stage model, with stages defined as seed, start-up, early and established. Accordingly, at the seed stage a concept has still to be proven and developed; moving into the start-up stage, products are developed, initial marketing takes place; at the early stage, the firm is expanding and producing, although is likely to remain unprofitable; finally, the firm reaches the expansion stage, where it may have grown enough to enable an initial public offering after six months or a year. Interestingly, researchers have commented that the synchronous progression of stages that is portrayed in lifecycle models appears to be a more conspicuous phenomenon among fast-track, high-technology firms (see Kazanjian, 1988; Eggers *et al*., 1994) than those in more traditional sectors.

Table 2.1. Lifecycle Models for Technology-Based Firms

Galbraith (1982):	
Proof-of-Principal Stage	Hopeful entrepreneur with an idea and faces the basic task of developing proprietary technology
Prototype Stage	Entrepreneur continues to invent to make a prototype
Model-shop Stage	Produce and test models
Start-up Stage	Production begins, and first commercial sales occur
Kazanjian (1988):	
Conception and Development	Resource acquisition and technology development
Commercialisation	Production related start-up
Growth	Sales/market share growth and organisational issues
Stability	Profitability, internal controls and future growth base
Roberts (1991):	
Seed Stage	Product development, formulation of initial strategy and establishment of start-up team
Initial Growth Stage	Complete product development and begin selling
Sustained Growth Stage	Foothold in the market, sales growth and
Mayer (2002):	
Seed Stage	Concept established and proven
Start-up Stage	Product development and initial marketing
Early Development Stage	Firm expands although likely remains unprofitable
Expansion Stage	Growth

Source: Author's Own

2.3.2 The Financial Lifecycle

The financial lifecycle depicts the firm's evolution through a succession of developmental stages with parallel adjustment in financing needs (Berger and Udell, 1998). This framework has become an increasingly popular tool in the analysis of entrepreneurial financing (see Bozkaya and Van Pottelsberghe de la Potterie, 2008; Hirsch and Walz, 2011; Coleman and Robb, 2012) and provides a useful structure not only for the design of the survey instrumentation (Chapter 3) but also for both qualitative (Chapter 4) and quantitative (Chapter 6) data analysis. We will briefly illustrate two models herein, before detailing a lifecycle model for this thesis.

Roberts (1991) posits a model showing how the general characteristics of the technology-based firm over three distinct stages influence the sources of finance available. At the start-up phase, the entrepreneur may have sufficient personal finance to initiate trading. However, personal funds are usually quite limited and, once these have been exhausted, relatives and friends are typically the "*most available*" (page 131) sources of capital. Business angels and seed funds[33] can also be important. Moving into the initial growth stage, angels and private funds continue to fund firms at the beginning of this phase, with venture capital and non-financial corporations[34] becoming key sources as the firm grows. More audacious banks may provide short-term loans secured by projected accounts receivable based on contracts or orders received. The bank's motivation for lending is primarily future-oriented, with the bank hoping to retain the firm's banking business when it grows. By the sustained growth stage sources of external financing do not differ substantially from the previous stage. Venture

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[33] The author provides an outline of the workings of the Zero Stage Capital Equity Fund as an example of a seed fund. Co-founded by Roberts himself, the fund focuses on providing advice and assistance to entrepreneurs and investing small amounts of capital in seedling enterprises.

[34] Described by Roberts (1991, page 139) as "*major manufacturing firms……interested in supplying venture capital to young technological companies*" who typically "*avoid providing initial capital, often because they do not see the opportunities soon enough or because they cannot act fast enough, instead preferring somewhat later growth financing*"

capitalists still provide finance as the firm enters this phase, but the primary financial resources throughout maturity are non-financial corporations, commercial banks and the stock market.

Berger and Udell (1998) present a model depicting firms on a size/age/information continuum. Within this continuum, smaller, younger and more opaque firms lie towards the left, being the most informationally opaque. At start-up, firms typically rely on insider finance, described as "*funds provided by the start-up team, family and friends prior to and at the time of the firm's inception*" (page 622). Externally, trade credit and business angel are the most likely sources of funding. As firms mature and grow and establish a track record (become less informationally opaque), they gain access to formal equity (venture capital) and debt. Eventually, if the firm is successful and continues to grow, it may gain access to public equity and debt markets. A central tenant of the model is that the inter-connectedness and substitutability between different sources of financing is crucial to funding the continuous development of the firm, especially those with high-growth potential (and associated high risk). The authors illustrate this using the examples of contracts between entrepreneurs and business angels being made in anticipation of future venture capital financing and debt from commercial banks being predicated on having sufficient equity funding from angels and venture capitalists to reduce risks associated with information asymmetry. Empirically, the authors find that the three main sources of funding for small firms are the owner, commercial banks and trade creditors. Surprisingly, and contrary to conventional wisdom, debt is identified as an important source of funding for very young firms. However, the authors conclude that the fact that this debt is typically secured using the personal wealth of the entrepreneur through pledges of personal collateral or guarantees provides a solution to this finding.

Empirical evidence generally supports the notion that capital structure evolves over time with the firm's changing characteristics. In their analysis of South African public and private firms, Frielinghaus *et al*. (2005) report an increase in the observed debt ratio as firms move through their lifecycle, concluding that findings are consistent with the financial lifecycle. Bozkaya and Van Pottelsberghe de la Potterie (2008) examine the financing of Belgian technology-based firms over four stages in the lifecycle (defined as seed, start-up, early growth, and development/expansion). In collecting data, they presented respondents with a description of each stage and asked them to self-select that which best described their current position. They then asked respondents to indicate the sources of financing utilised during their stage, from a list of ten options (personal funds; family and friends; retained earnings; commercial bank loans; government subsidies; non-financial institutional funds; other debt-finance funds; business angels; venture capital; and other equity-finance funds). The authors conclude that, in line with the financial lifecycle, as firms age the proportion of internal finance decreases whereas external finance first increases at start-up, peaks at the early growth stage and gradually decreases into the later stage, when retained earnings replace external finance. Hogan and Hutson (2010) examine the financing of Irish software firms within a lifecycle framework. They categorise firms into four stages based on age at the time of survey as follows: start-up (< 2years); commercialisation (2-4 years); growth (5-9 years); and maturity (> 10years). Their analysis examines use of three sources of internal (i.e. savings, consultancy revenues; retained profits) and four sources of external (i.e. bank loans, venture capital, private investors, and government grants) finance and is based on a comparison of venture capital and non-venture capital backed firms. Overall, the authors find that non-venture capital backed firms tend to follow the traditional lifecycle (with internal sources dominating external at start-up and mature stages), while those with venture capital financing remain highly dependent on external sources of funding throughout the stages. In his study of Irish SMEs, across all sectors, Mac and Bhaird (2010) reports that the single most important source of finance for younger firms are the personal savings of the founder(s) along with funds from f-connections. Internal funding (in the form of retained profits) becomes the most important source of financing over time, augmented by short-terms debt. Equity finance is employed by firms in specific sectors (technology) and is most important at the younger stages. Overall, Mac an Bhaird (2010) concludes that his findings are broadly in line with the financial lifecycle.

While these studies provide evidence on the workings of the financial lifecycle, a number of gaps are noticeable. First, we lack empirically based research which follows the firm through the distinct stages to present a retrospective portrayal of financing patterns across the lifecycle. Second, we lack an in-depth description of the financing patterns of technology-based firms, across both manufacturing and service sectors, within a lifecycle framework. Third, the financial lifecycle's premise that financing evolves over time with the firm's changing characteristics insinuates that the determinants of the sources of financing utilised may potentially depend on the firm's stage. Specifically, heterogeneity across stages raises the question of whether the factors significant in obtaining equity apply in any stage or depend on stage-specific attributes. To the best of the author's knowledge, no research to-date has attempted to disentangle the changing nature of the determinants of equity by examining potential determinants over different stage. This is a notable gap as factors that are significant determinants of equity in one stage may be less relevant in others. This research seeks to address these gaps in the literature, using the financial lifecycle as a base, through qualitative (Chapter 4) and quantitative (Chapter 6) analysis.

The financial lifecycle also highlights the relationship between the sources of financing and how financing decisions made at one stage may impact on future (subsequent) financing decisions. Specifically, an interesting facet of the financial lifecycle is the connection between the sources of financing over the stages (i.e. the progression from one source of funding to another). In essence, this suggests a complements/substitutes relationship between the different financial sources as the firm moves through the lifecycle. In short, informal investors (angels) play a specific role at very early stages of development, not only providing initial funding but also serving a screening and signalling role which opens the field to formal investors and acts to mitigate informational and agency issues (see Berger and Udell, 1998; Harrison and Mason, 2000; Freear *et al*., 2002; Schmidt, 2014).[35]

Correspondingly, several studies provide evidence showing that those that obtain angel funding are more likely to go on to access venture capital (see Van Osnabrugge and Robinson, 2000; Heukamp *et al*., 2007). In an early study, Freear and Wetzel (1990) find that sources of equity financing shift as firms mature. Specifically, while angels are in control in the earlier stages, venture capitalists play a more prominent role in later stages. Madill *et al*. (2005) report that 57% of the firms in their sample which had received angel funding went on to obtain venture capital whereas only 10% without initial angels received venture capital. Kerr *et al*. (2014) find that angel funded firms are 70% more likely to receive venture capital than firms who are rejected by angels. Croce *et al*. (2017) report that investment proposals brought to the attention of angels by venture capitalists are more likely to get through the pre-screening stage. Chemmanur and Chen (2014) posit a model based on the different roles played by venture capitalists and angels. Under the assumption that only venture capitalists add value, their model explains why, in choosing the optimal financing path, entrepreneurs first obtain angel funding and then switch to venture capital. Schwienbacher (2009) offers a similar model, although he assumes that angels and venture capitalists both add value, but only venture capitalists have enough money to refinance the deal. Within this model, angels endogenously provide more value-adding effort, because of the need to attract venture capital funds at later stages. Hellmann and Thiele (2015) model the interaction between angels and venture capitalists, wherein companies want to proceed from angel to venture capital. A key insight from this model is that the bargaining dynamic between the two sources may determine

[35] Hirsch and Walz (2011) provide a model based on the importance of start-up debt financing in serving as a commitment device, which allows credible discontinuation of unsuccessful firms, and overcome agency problems in subsequent stages.

whether the relationship is one of complements or substitutes. Using a costly search model, they highlight two dimensions of the relationship: on the one hand, the two investor types are 'friends', relying on one another for investments; on the other, they are 'foes', as angels are no longer required by venture capitalists once follow-on investment is made. Although, in general, the theoretical and empirical evidence suggests a complementary relationship between informal and formal sources of equity funding[36], research on the signalling role of equity investors in facilitating access to future equity financing is limited to the analysis of the relationship between angels and independent venture capitalists. To the best of the author's knowledge, no evidence exists on the impact of affiliation with venture capitalists, business angels and government-managed funds as a determinant of subsequent equity financing acquisition. Feasibly, given that relationships with investors not only play an important role in signalling prospects and capabilities (Baum and Oliver, 1991) but can also improve legitimacy (see Plummer *et al*., 2016; Fisher *et al*., 2017) these relationships may impact on the determinants of equity financing as the firm progresses through its lifecycle. Empirical analysis in Chapter 6 aims to fill this void in the literature, exploring the extent to which the determinants of the sources of equity differ given the relationship between angel, venture capital and government-sponsored equity over distinct stages in the lifecycle (Chapter 6).

Overall, the financial lifecycle model serves to emphasise potential sources of finance relevant at distinct stages in the development of the firm and how the stage of the firm may be a determinant of its capital structure. The lifecycle also demonstrates the potential relationship between the sources of financing. Although it has been described as an idealised model which "*assumes a seamless progression from one funding source to the next*" (Mason *et al*., 2010, page 36), the paradigm nonetheless provides a straightforward framework within which to

[36] Conceptually, given the popularity of syndication and co-investment as a risk reduction mechanism in equity financing (see subsection 2.2.2) it is reasonable to envisage a possible complementary relationship between the different sources of equity financing. This issue is considered in further detail in Chapter 6.

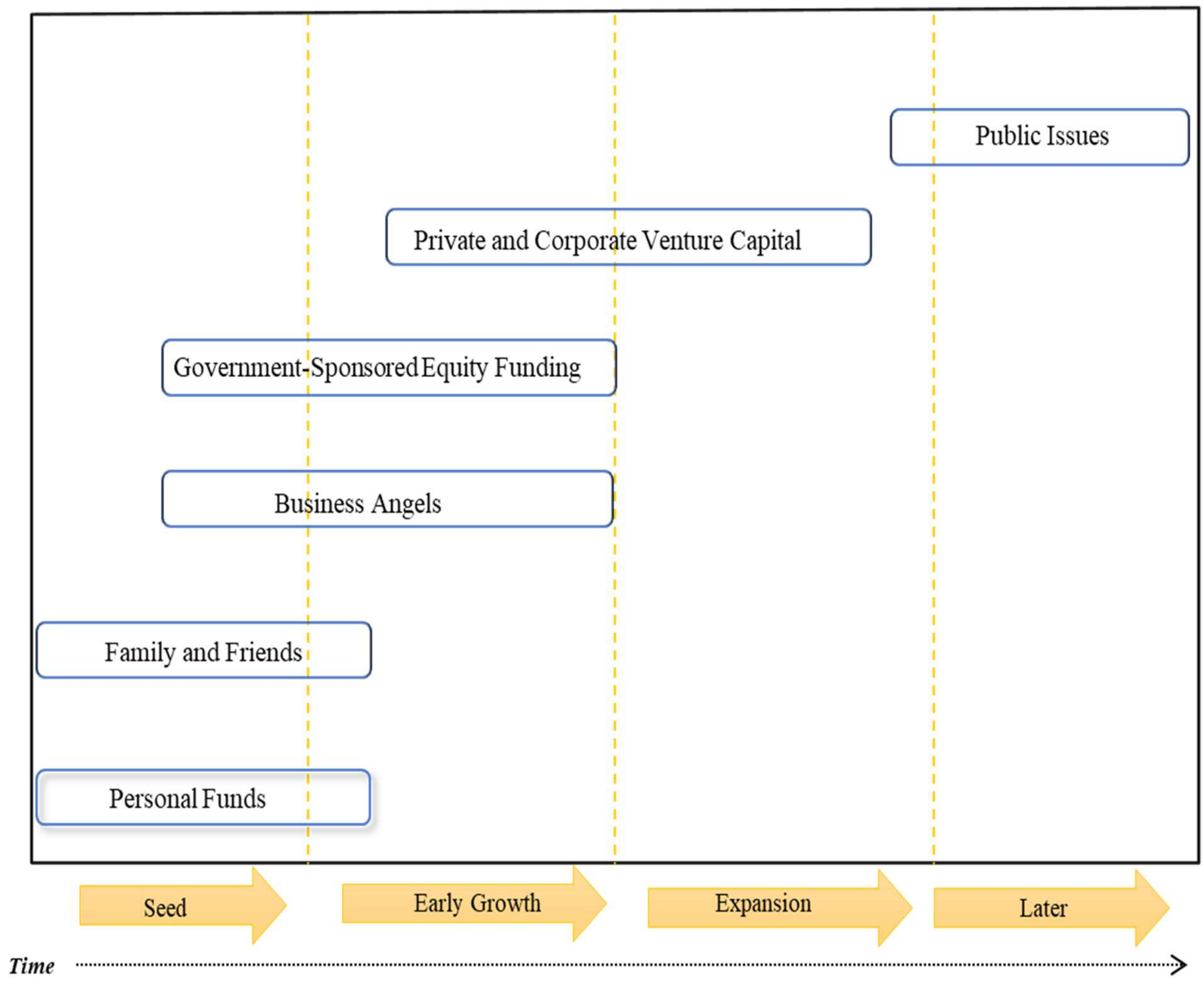
examine the financing of technology-based firms. Using the financial lifecycle as a base, this study presents a unique depiction of the financing patterns of technology-based firms as they progress through stages of the lifecycle (Chapter 4). The lifecycle is also used as a framework for hypotheses development and quantitative analysis of the extent to which the determinants of equity financing differ when examined according to source of equity (angel, venture capital, government-sponsored), stage of the lifecycle (seed, early-growth, expansion), and given the relationship (substitutes/complements) between the sources of equity (Chapter 6).

Finally, it is opportune at this juncture to outline a lifecycle for this study, to be used in data collection (Chapter 3) and analysis (Chapters 4 and 6). Based on the models of Roberts (1991) and Berger and Udell (1998)[37] the following lifecycle is proposed (Figure 2.1): Following prior studies (see Mayer, 2002; Hogan and Hutson, 2005b; Bozkaya and Van Pottelsberghe de la Potterie, 2008) firms are categorised within four stages as follows: seed (first year of operation); early-growth (years 2 – 5); expansion (years 6 – 9); and later (year 10 onwards). Attempts to assign specific age groups to developmental stages tends to be confined to particular sectors (Hanks *et al*., 1994). Thus, the time bands specified here are based on estimates provided in the related literature (see Roberts, 1991; Mayer, 2002; Hogan and Hutson, 2005b).[38] We use an age continuum as proposed by Berger and Udell (1998) not only to classify each stage but because this classification is an efficient approach for ease of data collection and analysis. Founder(s), family and friends (3Fs) are typically the primary sources of initial funding, although the firm may also raise angel and government-sponsored equity funding. Typically, at this stage, the business concept is too risky for either debt or formal equity finance (North *et al*., 2013). Although angels may continue to invest in the initial years

[37] The work of Mayer (2002) is also of note.
[38] According to Miller and Friesen (1984), each stage lasts approximately six years; Evans (1987) defines young firms as being six years or younger and older firms as being seven years and older. According to Bulan and Yan (2009), stage lengths can be estimated as four, six, eight or ten years in length. According to Hank *et al*. (1994), intra-industry differences must be considered in specifying age categories for each stage.

of the early-growth stage, formal equity (private or corporate venture capital) becomes available from early-growth right through expansion, funding not only sales and marketing but also expansion into new markets (North *et al*., 2013). Finally, once the firm has established a proven market with profit generation, public equity markets may be accessed to raise larger amounts of funding (Mason *et al*., 2010).

Figure 2-1. The Financial Lifecycle



Source: Adapted from Roberts (1991); Berger and Udell, (1998); and Mayer (2002)

2.3.3 Summary

The lifecycle is an appealing construct, depicting the organisation as progressing through a sequence of developmental stages, much like the model proposed by the biological sciences (see Greiner, 1972; Quinn and Cameron, 1983; Hanks, 1990; Lester *et al*., 2008). The literature is replete with different models, which range from three (see Downs, 1967; Lippit and Schmidt, 1967) to ten-stages (Adizes, 1979). At a basic level, organisational lifecycle theory contends that the development of organisations proceeds through a predictable pattern which can be related to the problems the firm finds pressing at sequential stages (Kazanjian, 1988). Emanating from organisational lifecycle theory, the financial lifecycle model postulates that financing choices evolve over time with the firm's developmental stage and changing characteristics but also that financing decisions may be dependent on prior financing decisions (see Roberts, 1991; Berger and Udell, 1998).

Overall, the concept provides a useful structure for the analysis carried out in this research as it depicts the developmental movement and potential evolution of financing decisions in a predictable pattern. The framework is not only applied in building an in-depth, chronological portrayal of the sources of entrepreneurial financing utilised by technology-based firms over different phases of their development (Chapter 4) but is also used in quantitative analysis to determine whether drivers of different sources of equity (angel, venture capital, government-sponsored) vary across stages of development and given the relationship (i.e. complement or substitute) between the sources (Chapter 6).

2.4 Equity Financing

This Section focuses solely on equity financing. The OECD (2015, page 142) defines equity financing as "*financial resources that are provided to firms in return for an ownership interest*". The main categories of equity financing are public and private equity. While the former involves companies that are traded on a stock exchange, the latter refers to equity securities provided to unlisted companies (Cumming, 2012). In turn, private equity can be divided into four sources as follows: business angels; independent venture capital funds; corporate venture capital funds; and Government agencies (i.e. government-sponsored equity) (IVCA, 2012).[39] The purpose of the ensuing discussion is to set out the two aspects of equity financing that are of interest in this thesis. The first concerns the determinants of equity financing, examined herein through consideration of both the supply- and demand-side perspectives (Subsection 2.4.1). The second focuses on the impact of equity investment on the funded firm (Subsection 2.4.2). Overall, this will inform not only data collection (Chapter 3) but also provide the basis for data analysis (Chapters 4, 5, 6 and 7).

2.4.1 Determinants of Equity Financing

According to Eckhardt *et al*. (2006), the process of raising external financing comprises two steps. In the first, the entrepreneur decides to seek financing from external sources. In the second, an external investor decides to provide financial capital. Initially, because obtaining external financing is costly (Bhide, 1992), entrepreneurs will seek investors if they believe that the value of their venture justifies incurring the costs that external finance entails (Eckhardt *et*

[39] Business angels are individuals who invest their personal capital directly in unquoted ventures in which there is no family connection (see Mason and Harrison, 1994; Månsson and Landström, 2006). In terms of venture capital funds, comprised of professionals who raise capital from third parties to invest in entrepreneurial ventures, one of the most important aspects to consider is heterogeneity based on ownership and governance structure (see Gompers *et al*., 2009; Munari and Toschi, 2015; Colombo and Murtinu, 2017). As such, we differentiate between independent venture capital, where the capital is provided by limited partnerships, corporate venture capital, funded by the internal resources of a parent organisation, and governmental venture capital, which is funded and controlled by government-owned agencies (see Hellmann and Puri, 2002; Guerini and Quas, 2016). The reader is referred to Chapter 1 (Section 1.2) for details of the definitions adopted in this thesis.

al., 2006). Once they decide to seek external funds, they pick signals which capture the attributes of themselves and their venture that communicate quality and potential (see Higgins and Gulati, 2006; Drover *et al*., 2017). Next, in deciding whether to provide funding, investors use specific evaluation criteria to select investees (see Zacharakis and Meyer, 2000; Petty and Gruber, 2011). It follows that it is important to bear both perspectives in mind in identifying the factors that potentially lead to a firm being equity financed.

Beginning with the supply-side, research on equity investors' decision-making can, in general, be classified into two broad streams – processual and criteria (Silva, 2004). The former focuses on describing the course of events which constitute investors' decision-making process, from deal origination to exit (see Haines *et al*., 2003; Klonowski, 2007, 2010).[40] Criteria research focuses on the factors used by investors at the screening and due diligence phases (see Feeney *et al*., 1999; Van Osnabrugge, 2000).[41] It is this latter stream that we focus on. Specifically, the aim is to ascertain potential determinants of equity by examining research that offers insight into the selection criteria applied by investors in choosing investees.

Interest in equity investors' selection criteria began in the 1970s and continues to interest scholars (see Tyebjee and Bruno, 1984; MacMillan *et al*., 1985; Muzyka *et al*., 1996; Clark, 2008; Maxwell and Lévesque, 2014). Briefly, equity investors typically use a set of observable attributes, correlating with parameters of interest, to assess and rank prospective performance and potential (Padilla, 2003). The most widely cited studies in this area are Tyebjee and Bruno (1984), MacMillan *et al*. (1985) and Muzyka *et al*. (1996). Tyebjee and Bruno (1984) identify the following factors: market attractiveness (size, growth, accessibility);

[40] The most relevant facts revealed and agreed by researchers are: (1) the process consists of multiple phases; and (2) the investment proposal assessment itself involves two main phases – screening and evaluation (Hall and Hofer, 1993). The initial screen aims to reduce the number of proposals to a manageable few for detailed evaluation (Tyebjee and Bruno, 1984). The purpose is to filter out '*no hopers*' (Harrison *et al*., 2015, page 531) and reduce the probability of picking low performers (Zacharakis and Meyers, 2000).

[41] Although most studies are positioned within one of these streams, some combine the two, providing models outlining the phases of the decision-making process and the criteria used within the phases (see Tyebjee and Bruno, 1984; Boocock and Woods, 1997).

product differentiation (uniqueness, profit margin, patentability); managerial capabilities; environmental threat resistance; and cash-out potential (ability to liquidate the investment). Macmillan *et al*. (1985) cite twenty-four factors within five categories, namely: personality of the entrepreneur; experience and qualifications of the entrepreneur; characteristics of product/service; characteristics of market; and financial considerations. They find that five of the top ten factors relate to entrepreneur's experience or personality, including familiarity with market, evidence of staying power and leadership capability. Muzyka *et al*. (1996), examine thirty-five factors within seven categories, namely: financial; product-market; strategic-competitive; fund; management team; management competence; and deal. Their results showed that all factors relating to management ranked among the top seven, followed by a product with an ability to sustain a competitive market position and team capable of delivering this in the marketplace. Based on this early work researchers generally group supply-side factors into four broad categories, namely: product/service; market; human capital; financial dimensions (see Franke *et al*., 2008; Carpentier and Survet, 2015 Woike *et al*., 2015).

From the demand-side, researchers have applied signalling theory (Spence, 1973, 1974) to argue that entrepreneurs obtain external capital by communicating signals that reflect the quality and viability of their venture (see Prasad *et al*., 2000; Busenitz *et al*., 2005; Audretsch *et al*., 2012). Although not as extensive as the supply-side literature, demand-side studies identify four broad categories of signals used by entrepreneurs in their attempt to obtain external financial resources.[42] The first group, identified in early work by Ross (1977) and Leland and Pyle (1977), are signals based on the firm's capital structure. Essentially, financing choices (in this case the use of debt or personal funding respectively) constitute signals of firm quality for external investors. The second comprises signals based on human capital (see Shane

[42] As discussed in Subsection 2.2.2, signals (Spence, 1973) may provide a sorting mechanism based on easily observable attributes that allow external investors to derive expectations about the qualities of the entrepreneur/firm that are not immediately observable (Hottenrott *et al*., 2016).

and Stuart, 2002; Gimmon and Levie, 2010). Characteristics of the entrepreneur, such as educational background or industry-specific experience, signal entrepreneurial quality and potential to external investors (see Gimmon and Levie, 2010; Maxwell *et al*., 2011). The third group consists of signals based on proprietary protection of the firm's product offering, such as patents (see Mann and Sager, 2007; Audretsch *et al*., 2012) and trademarks (Zhou *et al*., 2016). Intellectual property is an observable and readily available proxy for the assessment of innovation and R&D activities as such protection is costly to obtain and differentiates the firm from competitors (Long, 2002). The fourth group consists of signals based on affiliations with third parties, also referred to as social capital, which can signal legitimacy (see Shane and Cable, 2002; Baum and Silverman, 2004). These studies demonstrate how firms can effectively signal to acquire external resources.

The aim of the proceeding discussion is to identify the attributes of the firm and entrepreneur that are potential determinants of equity financing. This will ultimately feed into the design of survey instrumentation (Chapter 3) and will also provide a basis for the comparison of the characteristics of equity and non-equity financed firms (Chapter 4) along with the development of hypotheses for empirical analysis (Chapters 5 and 6). Through consideration of the existing supply- and demand-side literature, the following grouping is used to categorise potential determinants, not only as this is typically applied in the associated literature but also because it provides an organised structure for proceeding to empirical investigation: (1) Product; (2) Market; (3) Affiliation; (4) Human Capital; and (5) Finance. Overall, the aim is to provide an identify those factors that potentially determine whether the firm is equity financed prior to consideration of their signalling role and the formalisation of associated hypotheses in Chapters 5 and 6.

Product

In general, the findings from studies of equity investors' evaluation and decision-making process highlight the importance of attributes of the product offering, particularly competitive advantage, uniqueness and differentiation (see Van Osnabrugge and Robinson, 2000; Mason and Stark, 2004; Carpentier and Suret, 2015). Kaplan and Stromberg (2004) estimate that in at least 40% of investments venture capitalists are attracted by the product or technology on offer. According to Petty and Gruber (2011), product-related factors play a key role in the investment decision making process of European venture capitalists, with a lack of product differentiation being a primary cause for proposal rejection. This is consistent with Lumme *et al*. (2013) who find that a unique product offering is one of the top three investment criteria for venture capitalists in Finland. In their analysis of the Australian business angel market Hindle and Wenban (1999) report that, after the management team, the market potential and uniqueness of the product are the most important non-financial criteria employed by angels. Hindle and Lee (2002) report a similar result in their study of business angels in Singapore. According to Sudek (2006) angels opt for product offerings that create a barrier to entry for potential competitors. Thus, it appears that product differentiation (or uniqueness) is an important factor for equity investors in their assessment of potential investees. Unfortunately, to the best of the author's knowledge, no demand-side evidence currently exists regarding the role of product differentiation as a signal to external equity investors. Empirical analysis in Chapters 5 and 6 will address this gap in the literature. Nonetheless, based on the available supply-side evidence, it seems plausible to expect that product differentiation will represent a a positive signalling for firms in their attempt to access equity financing.

There is also evidence that innovativeness is an important factor in accessing equity finance. Indeed, equity financing is generally considered a particularly important and appropriate source of funding for innovative firms (see Brown *et al*., 2009; Zhou *et al*., 2016).

Hellmann and Puri (2000) report that innovators are more likely to obtain venture capital financing than are imitators. Peneder (2010), based on a sample of Austrian firms, reports that those with above average levels of innovation are more likely to obtain venture capital. Mina *et al*. (2013), examining firms in the UK and U.S., find that product and process innovations constitute signals that significantly help firms to attract external investment. Relatedly, evidence shows a positive correlation between R&D activity (as an input to innovation) and equity financing. In their analysis of publicly-traded UK firms, Aghion *et al*. (2004) find that R&D-intensive firms are more likely to issue equity, with the use of equity increasing with R&D intensity. Casson *et al*. (2008) and Wang and Thornhill (2010) also find a positive relationship between R&D and equity financing. Both supply- and demand-side evidence identifies the important role of proprietary protection of the product offering (see Petty and Gruber, 2011; Audretsch *et al*., 2012). Evidence generally reports that patents increase the likelihood of obtaining equity finance (see Baum and Silverman, 2004; Mann and Sager, 2007; Conti *et al*., 2013). Engel and Keilbach (2007), using a sample of German firms, find that those with a higher number of patent applications have a higher probability of obtaining venture capital. Similarly, Häeussler *et al* (2009) investigate how patent applications and grants improve the ability of capital seeking biotechnology firms in Britain and Germany to attract venture capital financing. Their results suggest that firms obtain venture capital earlier if they filed applications for patents whereas ultimate grants do not have an additional effect on the financing decisions of venture capitalists. Zhou *et al*. (2016) show that start-ups that apply for both patents and trademarks yield higher venture capital funding than those that apply for only one of the two IP rights. In general, the findings indicate that innovativeness, R&D activity, and intellectual property positively impact on the likelihood of the firm being equity financed.

Market

Researchers investigating equity investors' decision-making also emphasise criteria based on the firm's market (see Van Osnabrugge, 2000; Mason and Stark, 2004; Sudek, 2006). Specifically, the evidence suggests that equity investors consider attributes including the presence of an existing large market (Feeney *et al*., 1999) or new market with high-growth potential (Mason and Rogers, 1997) to be advantageous (Maxwell *et al*., 2011). Competition within the market segment is also an important factor (see Van Osnabrugge, 2000; Sudek, 2006). In their analysis of European venture capitalists, Petty and Gruber (2011) find that a market deemed too crowded is a common reason for the rejection of investment proposals. To the best of the author's knowledge, no demand-side evidence exits of the signalling role of market competition (or of occupying a market niche) in obtaining external equity financing. In general, it appears that the extent of rivalry within the firm's main market is a potential determinant of equity financing. Specifically, a market deemed too crowded will likely represent a negative signal to potential equity investors (Carpentier and Suret, 2015).

Affiliation

Entrepreneurs often depend on signals from social ties and third-party certification to overcome information asymmetry and uncertainty prevalent in entrepreneurial financing (see Venkatarman, 1997; Shane and Cable, 2002; Hsu, 2007). Third-party intermediaries can mitigate information and agency issues by virtue of their reputation capital (see Megginson and Weiss, 1991; Jain and Kini, 1995; Jain *et al*., 2008). Essentially, affiliation with reliable third parties reduces uncertainty by endorsing the quality of the firm and affording it a measure of legitimacy (Plummer *et al*., 2016). For the purpose of this study, we examine the impact of affiliation with an incubation centre. Incubation centres confer image benefits on tenants, enhance credibility and provide crucial support and assistance for development (see Ferguson and Olofsson, 2004; Hackett and Dilts, 2004). Incubators can also provide entrepreneurs with access to a valuable network which can facilitate access to external investors (Hansen *et al*., 2000). Unfortunately, existing evidence on the role of incubators as a determinants of equity financing is extremely limited. McAdam and McAdam (2008) examine high-technology firms based in university incubation centres in Ireland and the UK and find that incubators play a key role in facilitating access to venture capitalists. From the supply-side, evidence presented by Croce *et al*. (2017) reveals that proposals brought to the attention of angels by incubators are more likely to progress through the screening stage. More generally, Aerts *et al*. (2007) survey European incubators and report that the majority claim to provide tenant firms with support in raising external financing, particularly grants and venture capital. In general, it seems that the support of an incubation centre may provide a third-party endorsement effect which can positively impact on access to external equity investors.

Human Capital

Human capital theory posits that the education and experience of organisational members are a key ingredient for performance (Becker, 1993). Human capital reflects that knowledge and skills of the organisation's members that is valuable for the organisational and cannot easily be copied or imitated by others, thus constituting an important source of competitive advantage (see Barney, 1991; Behrens *et al*., 2012). Both supply- and demand-side work emphasises the vital role of human capital for firms attempting to access equity financing. In the former, evidence has consistently shown that the knowledge and experience of the entrepreneur/management team is crucial for equity investors in screening potential investees (see Zacharakis and Meyer, 2000; Haines *et al*., 2003; Maxwell *et al*., 2011). A key finding from MacMillan *et al*. (1985) and Muzyka *et al.* (1996) was the fact that, above all, it is the quality of the entrepreneur and entrepreneurial team that ultimately determines the funding decision. In brief, the evidence suggests that investors are looking for teams who appear knowledgeable and competent (Mason *et al*., 2017), have industry-specific experience and a strong educational background (see Franke *et al*., 2008; Petty and Gruber, 2011). From the demand-side, empirical evidence generally confirms that the education (see Audretsch and Lehmann, 2004; Engel and Keilbach, 2007; Colombo and Grilli, 2010; Gimmon and Levie, 2010) and experience, both industry-specific (see Hsu, 2007; Behrens *et al*., 2012) and international (Patzelt, 2010), of the founding/management team have a positive impact on the likelihood of obtaining equity. Thus, it appears that organisational human capital – the education and experiences of organisational members (Becker, 2009) – constitutes an important (positive) signal in obtaining external equity investment.

Finance

As discussed in Subsection 2.2.2, early work by both Ross (1977) and Leland and Pyle (1977) show that the firm's financing choices are potential signals – debt finance for the former and personal investment in the latter. Ross (1977) showed how the proportion of debt in the firm's capital structure acts as a signal to external investors. Specifically, debt can be considered a signal in distinguishing high-quality from low-quality firms because it is only those successful firms with higher revenues that can support greater leverage. Thus, the value of the firm increases as the level of debt rises. In a recent paper, Epure and Guasch (2019), using data collected through the Kauffman Firm Survey, report that a positive relationship exists between debt and external equity financing.

Another source of financing that can constitute an important signal is personal investment. Leland and Pyle (1977) show that, with the existence of high levels of information asymmetry between entrepreneurs and investors and a majority of 'poor' projects, one way to signal quality is to invest directly in one's own project and keep equity. Effectively, the venture's value is positively related to the equity share held by the entrepreneurs which, in turn, reduces the level of uncertainty and signals commitment to an optimism in the venture (Busenitz *et al*., 2005). In a recent study, Conti *et al*. (2013) present evidence of the positive signalling effect of founder, family and friends' ('FFF') funding in accessing external equity investment. The authors find that FFF funding is a particularly important signal for angel investors (on the other hand, their results indicate that patents represent the important for venture capitalists). Overall, although it appears that successfully obtaining non-equity sources of financing will be an important positive signal of firm quality to external equity investors (Stuart *et al*., 1999), few empirical tests of this signalling effect currently exit.

Thus, a variety of factors, from the attributes of the firm's market and product offering, its affiliations, through to characteristics of the entrepreneur and their financing decisions appear to represent potential determinants of equity financing. A summary of these factors, along with preliminary hypothesised effects and supporting evidence, is provided in Table 2.2.

Table 2.2. Potential Determinants of Equity Financing

Factor	Evidence	Hypothesised Effect
Product:		
Unique selling position or differentiation	Fried and Hisrich, 1994; Mason and Stark, 2004; Knockaert *et al*., 2010	+
Innovation	MacMillan *et al*., 1985; Kollmann and Kuckertz, 2010; Croce *et al*., 2017	+
R&D	Aghion et al., 2004; Casson et al., 2008; Wang and Thornhill, 2010	+
Proprietary features (patent)	Tyebjee and Bruno, 1984; Maxwell *et al*., 2011; Hoenig and Henkel, 2015	+
Market:		
Competition (rivalry)	Muzyka *et al*., 1996; Petty and Gruber, 2011; Carpentier and Suret, 2015	-
Affiliation:		
Incubation Centre	McAdam and McAdam, 2008; Croce *et al*., 2017	+
Human Capital:		
Educational background	Audretsch and Lehmann, 2004; Hsu, 2007; Franke *et al*., 2008	+
Industry-specific Experience	Sudek, 2006; Maxwell *et al*., 2011; Hsu *et al*., 2014	+
International Experience	Patzelt, 2010	+
Finance:		
Personal Investment	Leland and Pyle, 1977; Busenitz et al., 2005	+
F-Connection Investment	Conti *et al*., 2013	+
Debt Finance	Ross, 1977; Epure and Guasch, 2019	+

Source: Author’s Own

2.4.2 Impact of Equity Financing

The literature on equity financing has long acknowledged that, in addition to financial resources, equity investors provide portfolio firms with a complex bundle of value-adding activities (see Gorman and Sahlman, 1989; Denis, 2004). With this in mind, the aim of the proceeding discussion is to present an overview of the research pertaining to the ways in which equity financing can impact on the funded firm. Ultimately, this will inform the design of measures to be included in the survey instrumentation (Chapter 3) while also providing a foundation for hypotheses development and empirical analysis in Chapter 7.

As discussed in Subsection 2.2.2, under agency theory, facing information asymmetries and agency risk, equity investors deploy specialised mitigation mechanisms, such as screening investment targets, writing complex contracts and monitoring investees (see Gorman and Sahlman, 1989; Sapienza *et al*., 1996; Sørensen, 2007). These mechanisms may also ultimately result in the enhanced performance of funded firms. In order to avoid adverse selection in the pre-investment stage, equity investors conduct comprehensive multi-phase evaluations of the firm, and the executive team (Rosenbusch *et al*., 2013) and are typically highly selective in the types of firms in which they will invest (Mason and Pierrakis, 2013). Once they have made the investment, equity investors monitor closely, control and involve themselves actively in portfolio firms to decrease the probability of moral hazard (see Jensen and Meckling, 1976; Bottazzi *et al*., 2008). On the one hand, they are active partners (Gorman and Sahlman, 1989), who have the expertise to monitor and control actions (Gompers, 1995). They make use of specific financial instruments and contractual clauses that protect their investments from opportunistic behaviours on the part of the entrepreneur (Kaplan and Strömberg, 2001).[43] This approach creates high-powered incentives for entrepreneurs to pursue growth (see Casamatta,

[43] Monitoring and control efforts by equity investors include (but are not limited to) board representation, staging of capital infusions, and the use of convertible securities, to name but a few (see Lerner, 1995; Hellmann, 2006; Alperovych *et al*., 2015). The reader is referred to Subsection 2.2.2 for a discussion of these mechanisms.

2003; Grilli and Murtinu, 2014b) and ensures that the firm is well-managed (see Jain and Kini, 1995; Hellmann and Puri, 2002). On the other hand, researchers emphasise that equity investors are particularly good coaches, skilled at injecting expertise and sound business judgement into ventures (see Hellmann, 2000; Baum and Silverman, 2004). Advisory and involvement benefits include assistance in strategic and operational management, professionalisation, headhunting, additional fundraising (see Hellmann and Puri, 2000; Alperovych *et al*., 2015). Thus, equity investors may impact funded firm performance both by acting as a '*scout*', able to identify future potential, and as a '*coach*', able to help the venture to realise it (Baum and Silverman, 2004).

Relatedly, having an equity increases the firm's bundle of resources (see Hellmann and Puri, 2002; Sørensen, 2007). According to the resource-based view (Penrose, 1959), which highlights the importance of a firm's resources and the circumstances under which they can create sustained competitive advantage (Barney, 1991), success depends on the characteristics of the firm's resource bundle. The task of the entrepreneur is to develop, assemble and acquire the resources and capabilities necessary to achieve competitive advantage (Barney, 1991). Equity investors can represent an attractive resource, not only providing capital but also offering non-financial benefits, such as expertise, competencies and know-how (see Bertoni *et al*., 2011; Rodríguez-Gulías *et al*., 2018). Effectively, both knowledge and funding gaps can be filled through changes in the firm's ownership structure (Colombo *et al*., 2014). Since equity investors typically possess strong business acumen and actively participate in a range of business functions, they are in a position to provide mentorship and guidance which can ultimately enhance the firm's intellectual capital and, consequently, performance (Baum and Silverman, 2004).

As such, beyond the provision of finance, equity investor involvement may additionally entail management support (i.e. 'smart money') (Bock *et al*., 2018). Consequently, equity financed firms have access to external resources and competencies that would be out of reach without the equity investor (Bertoni *et al*., 2011). For example, equity investors often consult their portfolio firms with respect to their financial management, or help them to establish contacts with key customers, suppliers, and additional investors (Hochberg *et al*., 2007). They may help the entrepreneur to expand more aggressively into the market, support the professionalisation of the organisation, or facilitate strategic alliances among firms within their own portfolio (see Hellmann and Puri, 2002; Bottazzi *et al*., 2008; Lindsey, 2008). Reviewing numerous empirical studies, Large and Muegge (2008) categorise these and other value-adding inputs into the eight salient types of legitimation, outreach, strategic planning, consulting, recruiting, mandating, mentoring, and operating. This specific aspect of equity financing will be considered in Chapter 4, through a description of data collected regarding the entrepreneur's opinions on the non-financial value-added activities of their equity investors. This provides a unique insight into the activities of equity investors, from the entrepreneur's perspective.

The literature investigating the impact of equity financing on funded firms generally starts from the dominant assumption that equity investors do add value beyond financial capital (see Sapienza *et al*., 1996; Baum and Silverman, 2004; Knockaert and Vanacker, 2013). Beginning with organisational performance, although being a multi-dimensional construct (see Combs, 2005; Davidsson *et al*., 2009), the following three dimensions appear frequently throughout the related literature – patents; growth; and survival. As to entrepreneurial exit, the conceptualisation of the exit as revolving around the entrepreneur may be inappropriate for those businesses that have raised financing from an equity investor. Although this area of the literature remains underdeveloped, the potential role of the equity investor in impacting the exit decision is also considered herein. Overall, the aim of this Subsection is to introduce the evidence regarding the ways in which equity may potentially impact on funded firms. This is intended to given an insight into measures to be included in survey instrumentation (Chapter 3) while also forming a foundation for hypotheses and analysis in Chapter 7.

Innovation

Among the different dimensions of performance that the literature has noted, a strong association has been identified between equity investment and innovation, typically measured by the firm’s patenting output (Lahr and Mina, 2016). In general, the existing evidence appears to indicate a positive association between patenting and equity financing. Mann and Sager (2007) find a strong positive relationship between patenting and venture capital financing among software firms in the U.S. Bertoni *et al*. (2011) also find that, for Italian venture capital and non-venture capital financed new technology-based firms, those with venture capital financing did not have a higher propensity to patent prior to venture capital investment. Following venture capital investment, however, there was a positive relationship with patenting. Similar results are presented by Arqué-Castells (2012) for Spain. In contrast, Engel and Keilbach (2007) and Caselli *et al*. (2009), for Germany and Italy respectively, find that venture capital financed firms had more patents than non-venture capital financed firms before the involvement of venture capital investors, but that there was no difference thereafter.

Growth

Several studies report on the impacts of equity financing on funded firm growth and efficiency, although the evidence is somewhat mixed. Lerner (1999) evaluates the long run success of firms participating in the Small Business Innovation Research (SBIR) program, a major public assistance initiative in the United States for high-technology firms. He finds that those receiving assistance from the SBIR achieved significantly higher employment and sales growth rates than similar firms that were not assisted by SBIR between 1983 and 1995. These differences are even more pronounced in regions with high venture capital activity. Chemmanur *et al*. (2011) show that venture capitalists select firms with higher total factor productivity, sales, and salaries, and the growth thereof after receiving venture capital is greater for venture capital financed firms. Manigart and Van Hyfte (1999) find that venture capital financed firms have higher asset growth than non-venture capital financed firms in Belgium. For the U.S., Davila *et al*. (2003) find a positive relationship between the growth of start-ups, as measured by labour growth, and venture capital financing. Engel and Keilbach (2007) report similar results for Germany. Alemany and Marti (2005) examine the role of venture capital in small firms in Spain and find that employment, sales, gross margin, total assets and corporate taxes grow faster in venture capital than non-venture capital financed firms over three consecutive years. Similarly, Puri and Zarutskie (2012) find that, after venture capital investment, companies saw a very rapid growth in employment relative to non-venture capital financed firms. Specifically, while venture capital and non-venture capital financed firms were matched at an average of 26 employees, three years later venture capital financed firms have on average 55 employees while non-venture capital financed have 38 employees.

Conversely, Bottazzi and Da Rin (2002), who analyse the growth performance of 270 venture capital funded firms listed on European Stock Exchanges, find no effect of venture capital backing on growth. Rosenbusch *et al*. (2011) analyse 76 studies in a meta-analysis and conclude that venture capital funded firms have higher growth rates compared to non-venture capital financed, but a large fraction of the difference is explained by venture capitalists selecting high-growth industries. They find little effect of venture capitalists selecting the best ventures within an industry, however.

Firm Survival

There is limited research on the link between equity financed and the survival of funded firms. Manigart *et al*. (2002), differentiating between bankrupt and surviving venture, find that the cumulative survival rate of venture capital financed firms is 56.15% whereas non-venture capital financed have a cumulative rate of 58.27%. Puri and Zarutskie (2012) likewise report that venture capital financed firms, although initially more likely to survive (first five years), have higher shut-down rates relative to non-venture capital funded firms. Pommet (2017), based on a sample of French companies that went public on the Nouveau Market, finds that among exiting venture capital back firms there is a higher probability of liquidation. Conversely, Kerr *et al*. (2014), based on data collected from two US-based angel groups (Tech Coast Angels and Common Angels) during the 2000-2006 period find that angel financing is associated with improved likelihood of survival for four or more years. Lerner *et al*. (2018) report similar findings. Overall, the limid evidence in this area is quite mixed and further investigation of the impact of equity financing on funded firm survival is warranted.

Entrepreneurial Exit

Entrepreneurial exit is defined as the process by which the founders of privately held firms leave the enterprise they helped create, thereby removing themselves, in varying degrees, from the primary ownership and decision-making structure of the firm (DeTienne, 2010). Entrepreneurs can exit in many ways, including family succession, trade or independent sale, management or employee buyout, selling their ownership stake via an IPO, bankruptcy or closure (Wennberg and DeTienne, 2014). In recent years, researchers have begun to investigate the factors that impact on the entrepreneur's choice of exit strategy from the entrepreneur's perspective (see Wennberg *et al*., 2010; DeTienne and Cardon, 2012; Leroy *et al*., 2015). A noticeable gap in the literature is the impact of equity on entrepreneurial exit.

Specifically, the conceptualisation of the exit decision and exit process as revolving around the entrepreneur is inappropriate for those businesses that have raised financing from equity investors, who require a harvest event to realise their financial return (Mason and Botelho, 2016). Indeed, the equity investor may force an exit event (Giot and Schwienbacher, 2007), with several studies documenting the widespread use of contractual arrangements that guarantee the equity investor explicit intervention rights regarding exit decisions (see Gompers, 1997; Kaplan and Strömberg, 2001; Cumming, 2008). Accordingly, as noted by DeTienne and Wennberg (2013), investor-led exits are a key issue for emerging entrepreneurial exit research.

2.4.3 Summary

This Section focused on equity financing. Discussion began with consideration of the determinants of equity financing (i.e. those factors that determine whether the firm is equity financed). In identifying potential determinants, the strategies adopted by both entrepreneurs and investors were considered. From the supply-side, evidence suggests that equity investors highlight aspects pertaining to the opportunity (e.g. product, market, financial dimensions) and entrepreneur (e.g. education, experience, capability) in making their decision (see MacMillan *et al*., 1985; Mason and Stark, 2004; Kollmann and Kuckertz, 2010; Maxwell *et al*., 2011). From the demand-side, researchers identify the signals used by entrepreneurs in attracting external equity investors. Although this research tends to examine one type of signal in isolation, the evidence shows the positive signalling effect of human, intellectual and social capital plays for entrepreneurs seeking external equity finance. Furthermore, the use of non-equity sources of funding can also provide useful signal to external equity investors. Overall, factors identified from both perspectives guide the design of the survey instruments, discussed in Chapter 3, and provide a foundation for hypotheses development and empirical analysis in Chapters 5 and 6.

Attention then turned to the impact of equity financing on the performance of funded firms. The literature suggests that investors add value by both screening and monitoring investees to improve their value (Baum and Silverman, 2004). Additionally, in accordance with the resource-based view, others posit that the skills and process that equity investors develop over time in managing portfolio firms represent distinctive capabilities which further enhance the performance of funded firms (see King and Zeithalm, 2001; Meglio *et al.*, 2017). While there are various ways in which equity investors can impact investees, those identified for the purposes of this thesis are firm innovation, growth and survival, along with entrepreneurial exit intentions. Chapter 7 examines the impact of equity financing, and the sources of equity, on these factors.

2.5 General Conclusions

The purpose of this Chapter was to develop a framework within which to explore the financing of technology-based firms. Interdisciplinary in nature, discussion began by setting the scene in terms of the theoretical background. Leading capital structure theories were considered, from the irrelevance propositions of Modigliani and Miller (1958, 1963) through to trade-off (see Baxter, 1967; Kraus and Litzenberger, 1973), pecking order (see Myers, 1984; Myers and Majluf, 1984) and agency (Jensen and Meckling, 1976) theories. There was particular emphasis on the latter, particularly the role of signalling (Spence, 1973) and screening pre-investment, along with monitoring and contractual mechanisms post-investment, in mitigating agency issues inherent in entrepreneurial financing. Next, organisational lifecycle theory (see Penrose, 1952; Downs, 1967; Greiner, 1972) and the financial lifecycle (see Roberts, 1991; Berger and Udell, 1998) were examined. The lifecycle framework is influential in the design of the survey instrument, outlined in Chapter 3. It is also used in building a profile of the financing patterns of technology-based firms in Chapter 4 and in guiding analysis in Chapter 6 of the extent to which the determinants of and relationship between the sources of equity vary according to stage.

The third part of the Chapter focused on equity financing, consisting of two segments. The first discussed evidence pertaining to the potential determinants of equity finance. Both the supply- (i.e. criteria employed by investors in selection and due diligence) and demand-side (i.e. signals used by entrepreneurs in attempting to obtain equity investment) perspectives were examined. Taken together, these provide insight into the factors that potentially determine whether a firm is equity financed, which subsequently inform not only the variables to be included in the survey instrument (Chapter 3) and characterisation of Irish technology-based firms (Chapter 4) but also hypothesis development (Chapters 5 and 6). The second discussed the implications of equity financing for funded firm performance and exit strategy.

Existing firm-level studies have demonstrated that companies backed by equity investors grow faster, are more innovative and more likely to go public than their non-equity backed counterparts (Alperovych *et al.*, 2015). In this thesis, analysis undertaken in Chapter 7 examines the impact of equity financing on the patenting, growth and survival of funded firms and explores the role of equity investors in influencing entrepreneurial exit intentions.

This thesis extends the existing literature in a number of ways. First, retrospective data is collected on the sources of financing used by technology-based firms across distinct stages in the lifecycle. Each firm is followed through consecutive stages, building on both Bozkaya and Van Pottelsberghe de la Potterie, (2008) and Hogan and Hutson (2006, 2010) who gathered present-day data and used that to compare firms in different stages. In this thesis, data gathered through fieldwork methods (Chapter 3) is used to compile a unique profile of the financing patterns of technology-based firms within a lifecycle framework (Chapter 4). Second, adopting a broader definition of equity financing than is typical in the related literature (encompassing venture capital, angel and government-sponsored funding), analysis in Chapter 5 explores the demand-side determinants of equity financing. The dearth in demand-side evidence is noted by researchers (see Howorth, 2001; Gregoire *et al.*, 2011; Rasmussen and Sørheim, 2012). Furthermore, those studies that do adopt a demand-side perspective are rather segmented, focused primarily on venture capital and a narrow set of signals in isolation (see Hsu, 2007; Patzelt, 2010; Behrens *et al*., 2012; Munari and Toschi, 2015). Third, extending this analysis, Chapter 6 delves deeper into the determinants of equity, exploring whether determining factors differ according to source of equity (angel, venture capital, government-sponsored), stage of the lifecycle (seed, early-growth, expansion) and given the relationship between the sources. The existing evidence focuses almost exclusively on (independent) venture capital. In practice, entrepreneurs typically raise equity funding from a multitude of sources (Bellavitis *et al*., 2017) and these sources differ along many dimensions, including investment targets, screening methods, skills and competencies, governance and objectives (Drover *et al*., 2017). Additionally, heterogeneity across the lifecycle stages raises the question of whether determining factors apply across the different stages or depend on stage-specific attributes. This issue has received little attention in the literature. Furthermore, as regards the relationship between these sources of equity, existing studies focus exclusively on the relationship between venture capital and angel financing. Given the obvious gap in the literature, Chapter 6 also examines the extent to which venture capital, business angel and government-sponsored equity financing act as complements or substitutes to each other in financing technology-based firms over the different stages in the lifecycle. Fourth, and finally, Chapter 7 investigates the impact of equity financing on the performance of funded firms and exit intentions of entrepreneurs. Existing research in this area is largely segmented, with the vast majority of evidence based on (independent) venture capitalists (see Engel and Keilbach, 2007; Bertoni *et al*., 2010). Analysis in Chapter 7 addresses this gap, adopting a broad definition of equity financing to explore impact on patenting, growth and survival of equity financed compared to non-equity financed firms, while also examining impact according to source of equity. Additionally, although there has been an increased interest in entrepreneurial exit (see Wennberg and DeTienne, 2014; DeTienne *et al*., 2015; Leroy *et al*., 2015), a noticeable limitation is the conceptualisation of the exit decision as revolving around the entrepreneur (Mason and Botelho, 2016). With this in mind, Chapter 7 also considers the role of equity financiers in impacting entrepreneurial exit. These elements are explored using primary source data gathered through fieldwork methods, the details of which we now turn to.

CHAPTER 3 : FIELDWORK

3.1 Introduction

Documenting procedures and techniques employed in data collection is regarded as a key component and one of the most visible parts of any research project (see Kirk and Miller, 1985; Easterby-Smith *et al*. 2015). With this is mind, this Chapter details the fieldwork activities for this thesis. The focal point is the process surrounding the collection of primary source data, with discussion centred on the three core elements involved – sampling, design of survey instrumentation and data collection. To end, an outline of the secondary source data compiled to complement primary data is provided. *Ipso facto*, these threads are woven together to explain the 'how' of this thesis.

A distinctive feature of this study is that analysis is based on primary source data, with evidence presented being fieldwork-based (Wolcott, 2005). The 'field', in this instance, is Ireland and the starting point for discussion herein is sample design (Subsection 3.2.1). The target population in building the sample frame was indigenous technology-based firms, defined using a sectoral classification (Tether and Storey, 1998) based on the Statistical Classification of Economic Activities (NACE) system (Eurostat, 2016b). The sample frame is further stratified into two groups, equity-financed and non-equity financed technology-based firms. A sample frame of 685 technology-based firms was compiled, composed of 313 and 372 equity and non-equity financed respectively. This comprehensive sample frame is a distinguishing feature of the study. In the study closest to this, Hogan and Hutson (2005a, b; 2006; 2010) utilise a sample frame of 257 Irish software firms. This study targets a unique, more inclusive, sample frame, across both technology-based manufacturing and knowledge-intensive service sectors, through application of a broader classification of technology-based firms.

Data employed in quantitative analysis was gathered utilising novel survey instrumentation, the design of which is the focus of Subsection 3.2.2. Two structured survey instruments were designed, one for administration to the equity financed sample frame, consisting of five sections, and a condensed version entailing four sections for dissemination among non-equity financed. Questions were fashioned to extract information on characterising attributes, entrepreneurial financing, innovation activity, performance indicators and exit strategies. Additionally, the survey designed for equity financed firms contained a section devoted exclusively to characterising equity finance and investors. Noteworthy and distinctive design features of instrumentation include: an original template devised to collect evidence regarding sources of financing utilised retrospectively over four stages in the lifecycle; innovative questions designed to collect micro-micro data by equity investor type (i.e. private venture capitalists; corporate venture capitalists; business angels; and government-sponsored equity); inventive questions which examine perspectives on information asymmetries and experiences in raising external debt and equity, along with financing preferences *vis-à-vis* internal versus external sources; and novel questions designed to gather information not only on the exit intentions of entrepreneurs but also equity investors. Essentially, this instrumentation was created to search inside the black-box of the firm to extract unique micro-micro data for quantitative analysis. Evidence of this nature does not currently exist in the Irish context.

The next crucial element in the fieldwork process is data collection, and this process is detailed in Subsection 3.2.3. In endeavouring to tease out potential issues prior to encounters in the field proper, survey instrumentation was carefully piloted before the data collection process began over two distinct phases. The first targeted equity financed firms, with the author personally collecting data through face-to-face interviews with founder-CEOs between October 2010 and April 2011. In total, 153 interviews were conducted, lasting an average of 1 – 2 hours, corresponding to a response rate of approximately 49% for this group. Next, a self-administered (condensed) questionnaire was disseminated online (postal or telephone version upon request) to non-equity financed firms. A total of 141 firms participated, corresponding to a response rate of approximately 38%. Overall, of the 685 technology-based firms identified in the sample frame, a total of 294 partook, corresponding to a response rate of approximately 43%. Finally, upon completion of data collection, all data was coded, recorded in SPSS (Statistical Package for the Social Scientist) and cleaned prior to conversion into Stata for quantitative analysis. The fact that data collection was undertaken personally by the author is a distinctive feature of this study. Specifically, personally conducting interviews not only allowed the author to gain a unique perspective and insight into the entrepreneur's experiences of equity financing but also provided access to the diversity of micro-micro data upon which this study is built upon. Such fieldwork offers a depth of exploration and understanding which can only be gained by engagement in the social world of research subjects (Ruane, 2016).

As a final note, this primary source data is supplemented with secondary source data, which provides additional background information. Sources serve to clarify data gathered in the field (for example, patent numbers), thus improving the accuracy of primary data. Two main resources were utilised, namely: (1) FAME; and (2) patent databases. These are outlined in Section 3.3. Finally, Section 3.4 provides general conclusions for this Chapter.

3.2 Primary Data

This Section details the process of collecting primary data. Discussion begins with consideration of sampling procedures (Subsection 3.2.1) before moving to design of survey instrumentation (Subsection 3.2.2) and ending with fieldwork methods (Subsection 3.2.3).

3.2.1 Sample Design

Sampling methods are intended to maximise efficiency and validity (Morse and Niehaus, 2009). Choosing a sample is an important aspect of any research project as it is rarely practical, efficient or ethical to study whole populations (Marshall, 1996). According to Webster (1985) a sample is a finite part of a statistical population whose properties are studied to gain information regarding the whole. The underlying principle of sample design is that a subset of the cases in a population can provide useful information which describes the entire population (Williams and Brown, 2019). Two sampling procedures were employed in this study – sampling of technology-based firms which have received equity financing at some stage in their lifecycle and sampling of those which have not.

The unit of analysis here is the indigenous technology-based firm. A clear-cut, broadly accepted definition of exactly what constitutes a technology-based firm does not currently exist, either in the academic area or economic policy in general (European Commission, 2002), although researchers propose various options. For example, in 1977 the Arthur D. Little Group coined the term 'new technology-based firm' (NTBF), which they defined as having the following characteristics: (1) have been established for less than 25 years; (2) be a business based on potential invention or one having substantial technological risk over and above those of normal businesses; (3) established by a group of individuals and so must not be a subsidiary of an established company; and (4) established for the purpose of exploiting an invention or technological innovation (Little, 1977). Subsequently, researchers adopted this classification in studying technology-based firms (see Hogan and Hutson, 2005b; Grilli and Murtinu, 2014a), although it has been noted that it is unclear whether the term 'new' applies to the firm, the technology or indeed both (Storey and Thether, 1998), pointing to a rather subjective aspect of this definition. According to Shearman and Burrell (1988) the term should refer only to new independent enterprises developing new industries. Other classifications used in the literature include number of patents issued, investment in research and development, and percentage of workforce consisting of scientists and engineers (Chapple *et al*., 2004). Conversely, others employ an approach which identifies technology-based firms by sector of operation based on industry classification code (see Butchart, 1987; Tether and Storey, 1998).

In selecting a classification for use in this thesis, a degree of pragmatism was necessary, with considerations of simplicity and data availability key in the decision. Based on careful deliberation of the literature, the sectoral approach was deemed the most efficient and clear-cut option. This broad definition offers not only ease of identification and categorisation of the target population but also ensures that an adequate number of units can be identified to build a sufficient sample frame. Several researchers employ this industrial classification, using either NACE, SIC or NAICS codes (see Carpenter and Petersen, 2002a; Sjögren and Zackrisson, 2005; Bozkaya and Van Pottelsberghe de la Potterie, 2008; Bertoni *et al*., 2011; Coleman and Robb, 2012; Mason and Brown, 2012; Luukkonen *et al*., 2013; North *et al*., 2013; Ejermo and Xiao, 2014).

As such, for the purposes of this study a sectoral classification is employed, based on the NACE system. In Europe, firms are categorised based on the NACE Statistical Classification of Economic Activities system. NACE is an acronym for the French title: '**N**omenclature générale des **A**ctivités économiques dans les **C**ommunautés **E**uropéennes'. First introduced in Europe in 1970, there have since been several revisions, with NACE 1970 being replaced by NACE Rev. 1 in 1990 which was again updated in 2002 to NACE Rev. 1.1.

A subsequent revision took place between 2000 and 2007, establishing NACE Rev. 2 by Regulation (EC) no 1893/2006 in December 2006. As of January 2008, NACE is the standard classification of economic activity in Europe (applied in Ireland by the Central Statistics Office from January 2009). An economic activity takes place when resources such as capital goods, labour, manufacturing techniques or intermediary products are combined to produce specific goods or services (Eurostat, 2018).

NACE is part of an integrated system of statistical classifications and is derived from the United Nations' International Standard Industrial Classification (ISIC) of economic activities. Analogous systems are the North American Industry Classification System (NAICS) in the U.S. and the Standard Industrial Classification (SIC) system in the U.K. Under the NACE Rev. 2 system Eurostat provides a classification of sectors aggregated into technology-based manufacturing and knowledge-intensive service industries by NACE Rev. 2 codes at two-digit level. A reproduction is provided in Table 3.1. Within this classification, manufacturing sectors are categorised as high, medium or low technology-based on their R&D expenditure/value added whilst knowledge intensive activities are classified based on the share of tertiary-educated persons in the sector relative to the total employed (Eurostat, 2016b).

Table 3.1. Aggregations of Technology-based Sectors based on Technological-Intensity

Manufacturing Industries by NACE Rev. 2 Code:	
High-technology:	
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
26	Manufacture of computer, electronic and optical products
Medium-high-technology:	
20	Manufacture of chemicals and chemical products
27-30	Manufacture of electrical equipment; Manufacture of machinery and equipment n.e.c; Manufacture of motor vehicles, trailers and semi-trailers; Manufacture of other transport equipment
Medium-low-technology:	
19	Manufacture of coke and refined petroleum products
22-25	Manufacture of rubber and plastic products; Manufacture of other non-metallic mineral products; Manufacture of basic metals; Manufacture of fabricated metal products, except machinery and equipment;
33	Repair and installation of machinery and equipment
Low-technology:	
10-18	Manufacture of food products, beverages, tobacco products, textile, wearing apparel, leather and related products, wood and off products of wood, paper and paper products, printing and reproduction of recorded media
31/32	Manufacture of furniture; Other manufacturing
Services Industries by NACE Rev. 2 Code:	
Knowledge-intensive Market Services:	
50/51	Water transport; Air transport
69-71	Legal and accounting activities; Activities of head offices, management consultancy activities; Architectural and engineering activities, technical testing and analysis
73-74	Advertising and market research; Other professional, scientific and technical activities
78	Employment activities
80	Security and investigation activities
High-tech Knowledge-intensive Services:	
59-63	Motion picture, video and television programme production, sound recording and music publishing activities; Programming and broadcasting activities; Telecommunications; Computer programming, consultancy and related activities; Information service activities
72	Scientific research and development
Knowledge-intensive Financial Services:	
64-66	Financial and insurance activities
Other Knowledge-intensive Services:	
58	Publishing activities
75	Veterinary activities
84-93	Public administration and defence, compulsory social security; Education; Human health and social work activities; Arts, entertainment and recreation
Less Knowledge-intensive Market Services:	
79	Travel agency, tour operator reservation service and related activities
82	Office administrative, office support and other business support activities
95	Repair of computers and personal and household goods

Source: http://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an3.pdf

This target population is further stratified into two groups: equity and non-equity financed firms. The sampling procedures for each are discussed below.

Equity Financed

In building a sample frame of equity financed technology-based firms, two aspects had to be considered. First, there is no publicly accessible complete register of indigenous firms that have obtained equity finance. Second, the time of sampling (2010) was characterised by challenging market conditions coming out of the downturn., with low investment activity seeing seed and first round funding being particularly hard hit (Pierrakis, 2010). As such, random or probability sampling methods could not feasibly guarantee enough respondents to provide necessary data. Thus, firms were identified through non-probability sampling, the aim of which was to identify as many firms as possible, rather than a target number, which fit the following: (1) had obtained equity (independent, corporate and government-sponsored venture capital, or business angel) funding (see Chapter 1, Section 1.2 for definitions); (2) operate in an applicable technology-based sector; and (3) are indigenous enterprises. Consequently, purposeful sampling was deemed the most advantageous procedure as, although perhaps not ideal from the standpoint of statistical theory, it would allow for the identification of as many Irish equity-financed technology-based firms as possible. Purposeful sampling is a technique utilised for the identification and selection of information-rich cases upon which one can learn a great deal about the issue of central importance to the enquiry (Patton, 2014). This procedure involves identifying and selecting units that are especially knowledgeable about or experienced with the phenomenon of interest (Cresswell and Plano Clark, 2011).

The main sources used in identifying firms were reports of the Irish Venture Capital Association (IVCA) and Enterprise Ireland – particularly the IVCA Venture Pulse Survey and Enterprise Ireland’s Annual Seed and Venture Capital report. These publications, although being the main (publicly available) listings of deal activity for Irish businesses, suffer limitations. Specifically, Enterprise Ireland provides only a list of firms financed through their government-sponsored equity funding scheme. The IVCA, on the other hand, produces a more complete listing based on investments made by members and Enterprise Ireland, supplementing this data with published information (where available) on investments made by non-members. Data mostly comes from investments made by domestic venture capital funds (for example, Kernel Capital, Seroba Lifesciences, ACT, Atlantic Bridge, Fountain Healthcare) and, where available, international investors (for example, Balderton Capital, Draper Espirit and Amadeus Capital in the UK; Celtic House in Canada; Cross Atlantic, SOS Ventures and Polaris Partners in the US; Capital E in Belgium). However, their reports are predominantly based on information supplied internally by members. Overall, both sources suffer from opaqueness regarding the invisible equity market (i.e. capture only deals that are publicly announced or initiated by members while missing deals made by private (angel) investors) and, as a result, their listings may suffer from incomplete or missing data.[44] Nonetheless, taking these sources together could reasonably be assumed to be a good representation of equity activity in Ireland.

Although most of the sample frame was compiled from these publications, a closer examination proved that the lists were incomplete. Specifically, additional firms were identified using several secondary sources, namely newspaper articles and websites of Irish fund providers (e.g. Kernel Capital, Enterprise Equity, Delta Partners) along with information published by the Halo Business Angel Network (HBAN). A detailed list of all sources and the number of cases obtained from each is presented in Table 3.2. These provide a comprehensive (publicly available) record of indigenous equity-financed technology-based firms, totalling a

[44] A notable issue regarding research into equity financing is the existence of the invisible, or hidden, side of the equity market that is the angel investor (Mason *et al*., 2016).

sample frame of 445 eligible respondents. While every effort was made to identify as many firms as possible that fit the criteria, this is a sample frame rather than a complete listing of the target population. Given the private and invisible nature of business angel investing (Mason *et al.*, 2016), and the absence of a single access point on angel deal activity, difficulties in identifying firms with angel finance during sampling meant that all angel financed firms could not be identified. Moreover, investments by international venture capital funds may not be recorded in accessible sources unless a co-investment was also made by an Irish fund or information regarding the investment was made publicly available. The total of 445 firms is thus as comprehensive a sample frame as possible given the resources available.

Once these firms had been identified, the FAME and Companies Registration Office (CRO) databases, along with Google and the Golden Pages were used to verify their name and status, obtain contact details and, where available, get the name of the founder. These searches also allowed for the identification of firms which had pursued divestment or exited.[45] In corroborating that firms were (or were not) equity financed, the FAME database was used to verify shareholder listings.[46] In total, 144 of the initial 445 were identified as either non-survivor or exited (merger or acquisition), bringing the sample to 301 firms. Additionally, 12 firms contacted as part of the non-equity-financed group had obtained equity finance (from business angels in all cases) and were thus transferred to the equity financed group.[47]

[45] Those which had been acquired were identified through searches of newspaper articles and industry websites; those which had been dissolved or liquidated were more difficult to identify but were mostly found using the FAME, CRO and Solocheck (www.solocheck.ie) databases.
[46] While it is not always possible to identify angels from this listing, any reference to venture capitalists or government-sponsored equity funds is observable.
[47] Although the IVCA publications do include investments made by private investors, the firms identified here were not included in any IVCA report. This discrepancy could simply be symptomatic of angel financing, where investors outside of formal syndicates/groups are a largely invisible population (Mason *et al.*, 2016).

Table 3.2. Sources Utilised in Compilation of Sample of Equity Financed Firms

Source	Total Cases
Irish Venture Capital Association, VenturePulse Surveys, 2007 – 2009	177
Enterprise Ireland, Seed & Venture Capital Reports, 2000 – 2008	152
Enterprise Ireland, International Investor Forum, 2009	12
AIB Seed Capital Fund Portfolio	4
ACT Capital Portfolio	23
Bank of Scotland Portfolio	2
Delta Portfolio	18
Enterprise Equity Portfolio	6
ETV Capital Portfolio	5
Growcorp Group Limited Portfolio	1
TVC Holdings Portfolio	5
Western Development Commission Portfolio	24
4th Level Ventures Portfolio	2
Halo Business Angel Network	8
Newspaper Articles	6
Total – Eligible Sample Frame	**445**
Non-Survivor/Exited	(144)
Moved from non-equity financed sample*	12
Total – Cleaned Sample Frame	**313**

Source: Author's Own

Notes: * See Table 3.3 for details of non-equity financed sample composition

Non-Equity Financed Firms

A similar sampling process was employed to compile a sample frame of non-equity financed technology-based firms. The target population were indigenous companies identified, in so far as possible, as not having received external equity financing and operating within the technology-based sectors of interest. The overall aim was to provide a comparison base for data gathered from equity financed firms.

Various sources, detailed in Table 3.3, were utilised. These included business listings in the Golden Pages, at www.business.ie, and occupancy published for various technology and enterprise centres, including any businesses listed for incubation centres which had not been identified for inclusion in the equity financed group. Member lists provided by the Irish Software Association along with the Irish Times "Top 1000 Companies" were also utilised. Publications of EI (for example, High-Potential Start-up Directories), Údarás na Gaeltachta (for example, case studies, news and media publications) and County Enterprise Boards were also accessed (this did not comprise official client listings – this information is not publicly available, and the agencies maintain confidentiality so do not release official client lists). These agencies do, however, provide information regarding companies they have been involved with through, for example, advertisements or news articles published on their websites. Another source of information was the Irish Small and Medium Sized Enterprises (ISME) organisation, who provide a list of members on their webpage, which allows for searches to be carried out by sector or business type. In total, a sample frame of 497 firms was identified. This is slightly higher than the initial sample frame of eligible equity-financed firms (N = 445) simply to guarantee a sufficient number of responses given that data collection with these firms was intended to be via self-administered online (or telephone) survey (see Section 3.2.3 next).

Table 3.3. Sources Utilised in Compilation of Sample of Non-Equity Financed Firms

Source	**Total Cases**
Golden Pages	115
www.business.ie	58
Occupancy Lists Enterprise Parks/Incubation Centres etc.	78
Irish Software Association Portfolio	15
ISME Portfolio	54
Enterprise Ireland	63
Údarás na Gaeltachta	19
County Enterprise Boards	42
Irish Times "Top 1000 Companies"	16
Various Newspaper Articles	37
Total – Eligible Sample Frame	**497**
Non-Survivor/Exited	(113)
Moved to equity financed sample*	(12)
Total – Cleaned Sample Frame	**372**

Source: Author's Own

Notes: * See Table 3.1 for details of equity financed sample composition

In cleaning this eligible sample frame, 96 of the initial 497 were identified as non-survivors with a further 17 acquired/merged. This brought the total to 384 firms. As mentioned above, 12 were removed as they had angel financing. The eventual sample frame for non-equity financed firms totalled 372 firms.

In total, 685 (313 equity and 372 non-equity) indigenous technology-based firms were identified for inclusion in the sample frame for this study.

3.2.2 Design of Survey Instruments

In approaching any field of enquiry, one utilises instrumentation to measure features and characteristics of the universe explored (Reid, 1998). It is with the design of instrumentation that this subsection is concerned. Two structured survey instruments were designed for data collection, one for administration to equity financed firms and the other, a self-administered condensed version, to non-equity. Below, these will be considered by reference to their design and intentions, in terms of the issues they aim to explore, how these issues were addressed and why they were examined in the fashion adopted. Each survey section will be dealt with, in turn, with an emphasis on question formulation and the information the question was designed to elicit. A copy of all instrumentation is provided in Appendix 1. It should be noted that the instruments, while almost identical, have two main differences, namely: (1) the instrument for equity financed respondents contains an additional part (Section 3) devoted purely to equity financing; and (2) in the final part of each instrument (Section 4 for non-equity; 5 for equity) regarding exit, the equity financed version contains additional questions relating to exit intentions of equity investors.

3.2.2.1 General Characteristics of the Firm

To begin, Section 1 focused on general characteristics of the firm and the founder-CEO. This set of questions was identical in both instruments and serves two main purposes. First, apart from work by Hogan and Hutson (2005a, b; 2006), there has been scant attention paid to building an in-depth profile of the characteristics of Irish technology-based firms and those individuals running these businesses. Second, data regarding firm-specific and human capital factors gathered is key for empirical analysis (Chapters 5, 6 and 7).

The section began by confirming the respondent's role (i.e. founder, founder/CEO, non-founder/CEO), the firm's year of establishment, current legal status (public or private company) and main line of business.

Next, a series of three questions were included to gather information regarding the firm's market environment, focusing on competition, product differentiation[48] and exporting activity. As discussed in Chapter 2 (Section 2.4), evidence suggests that product attributes such as uniqueness or differentiation play a role in attracting equity (see Hindle and Lee, 2002; Petty and Gruber, 2011). The respondent was asked to compare products in their main product group with those of their rivals and to appraise whether they were: identical; very similar; similar; different; or very different. The variable is a self-appraised measure of differentiation, designed based on Power and Reid (2013, 2015). The nature of the target market and competition within that market are also said to be important criterion for equity investors (see MacMillan *et al*., 1985; Zacharakis and Meyer, 2000; Shepherd *et al*., 2003; Petty and Gruber, 2011). Respondents were simply asked to state the number of main rivals in their main market, to provide a quantitative measure of rivalry. In selecting a measure for export activity, the survey followed existing work which uses foreign sales as a percentage of turnover (see Coeurderoy *et al*., 2012; Riding *et al*., 2012b). In line with this, but to gain a more in-depth profile, respondents were asked to indicate the percentage of turnover generated in local, regional, national, European and international markets.

It is commonly agreed that the assets of technology-based firms are predominantly intangible, typically knowledge assets partly embedded in the human capital of the firm and ordinarily specialised to the firm in which they reside (see Kortum and Lerner, 2000; Hall, 2002; Revest and Sapio, 2012). As such, asset intangibility is generally more pronounced

[48] Everywhere the word 'product' is mentioned in the survey instrument the word 'service' was also included. The same convention is adopted in the text here, so the term product encapsulates tangible (physical products) and intangible (services) goods.

among technology-based firms (Gompers, 1999). A question was thus included, not only in the interest of examining this specific characteristic of technology-based firms, but to build a unique profile of the types of intangible assets held by these firms. Respondents were presented with a list of possible intangible assets and asked to select all that apply to their firm. An '*Other*' option was also included, to capture any possible intangibles not included in the list specified.

Following this, attention turned to the entrepreneur, with a series of questions designed to collect data relating to the human capital of the founder-CEO. First, to measure education, commonly used as a proxy for general human capital (see Gimmon and Levie, 2010; Teixeira and Travares-Lehmann, 2014), respondents were asked to indicate the highest level of formal education attained. Next, specific human capital of the founder-CEO is measured by years of industry-specific experience, commonly used in prior studies (see Sudek *et al.*, 2006; Clark, 2008; Colombo and Grilli, 2010). Finally, respondents were asked to indicate if they had experience of working overseas and, where they answered in the affirmative, to specify number of years. Patzelt (2010) reports evidence of a positive relationship between international experience and venture capital.

The data obtained in this section of the instrumentation is used to build a unique and novel profile of Irish technology-based firms, their market, intangible assets and to characterise the entrepreneurs behind these firms (Chapter 4). Moreover, these measures are used in all econometric models (Chapters 5, 6, and 7).

3.2.2.2 Entrepreneurial Financing

The second section, identical in both surveys, was devoted to the entrepreneurial financing of technology-based firms. A novel template was constructed, the aim of which was to collect data retrospectively for all sources of financing used over the stages in the firm's lifecycle to date. A reproduction is provided in Figure 3.1. Within this template, four stages (seed, early-growth, expansion and later) were displayed in a row, with the first column of the matrix containing 18 possible sources of financing. This list was compiled following extant literature (see Roberts, 1991; Berger and Udell, 1998; Bozkaya and Van Pottelsberghe de la Potterie, 2008) and to capture the sources of equity of interest in this study (independent venture capital, corporate and government-sponsored venture capital, and business angel funding). Every new source of finance obtained during each stage was recorded. Additional notes (for example, number of investors, year of investment, etc.) were also recorded during interviews with equity financed respondents.

To illustrate the use of this template, let us briefly consider the sample response below. This equity financed firm was established in 2003 and therefore in the expansion stage at the time of data collection (2011). Over the lifecycle, the firm used a variety of sources of financing. This firm began, at the seed stage, with personal funds of founders and investment from f-connections (i.e. family and friends). Moving into the early growth stage, the founders committed additional funds, obtained a small overdraft, began utilising trade credit, and received government funding in the form of an Innovation Voucher. In their third year of operation (2006), the firm obtained equity investment from two business angels along with matched funding through Enterprise Ireland. During the expansion stage, retained profits become a source of funding. It should be noted that, although the bank overdraft and trade credit were still in place, they are not selected as the template only focuses on new sources of funds utilised during each stage. During the 2008/2009 period the firm finalised a round of investment with a venture capital fund. One angel and Enterprise Ireland also participated in this round, although these were not marked as they were repeat investors. The firm had not reached the later stage at the time of data collection and so this column in left blank.

Figure 3-1. Response Format for Calibration of Financing over the Lifecycle: Case of an Equity Financed Technology-Based Firm

2.1 Please indicate each source of financing obtained during the following stages in your firm's lifecycle:
(Tick all new sources of financing utilised during each specific stage)

	Seed Stage (first year of trading) (2003)	**Early Growth Stage** (2-5 years) (2004 - 2007)	**Expansion Stage** (6-9 years) (2008 - 2011)	**Later Stage** (10+ years) n/a
Personal funds of founders (e.g. personal savings)	☑	☑	☐	☐
Retained profits/earnings	☐	☐	☑	☐
Business overdraft	☐	☑	☐	☐
Business mortgage	☐	☐	☐	☐
Short-term business loan (term of less than 5 years)	☐	☐	☐	☐
Medium-term business loan (term of 6 to 10 years)	☐	☐	☐	☐
Long-term business loan (term of more than 10 years)	☐	☐	☐	☐
Trade credit	☐	☑	☐	☐
Invoice discounting	☐	☐	☐	☐
Leasing or Hire Purchase	☐	☐	☐	☐
Funds from family/friends	☑	☐	☐	☐
Director's loan	☐	☐	☐	☐
Share capital	☐	☐	☐	☐
Private venture capitalist(s)	☐	☐	(08/09) ☑ ⇒ with	☐
Corporate venture capitalist(s)	☐	☐	☐ 1 angel	☐
Angel investor(s)	☐	(2006) ☑ x 2	☐ 3 E.I	☐
Government-sponsored equity finance – please specify source (e.g. Enterprise Ireland)	☐	☑ E.I. (matched)	☐ (2nd round)	☐
Government funding – please specify source (e.g. County Enterprise Board)	☐	☑ Inno. Voucher	☐	☐
Others (please specify sources)	☐	☐	☐	☐
	☐	☐	☐	☐
	☐	☐	☐	☐
	☐	☐	☐	☐

This template is a unique and novel feature of the survey, gathering details on financing across the lifecycle. It is designed to build on work by Bozkaya and Van Pottelsberghe De La Potterie (2008) and Hogan and Hutson (2010) in two important ways. First, data gathered is retrospective, collected over distinct stages in the lifecycle, while Bozkaya and Van Pottelsberghe De La Potterie (2008) and Hogan and Hutson (2010) gather data for one specific stage for each firm surveyed. In the former, examining the financing of small technology-based firms in Belgium over four stages of the lifecycle (i.e. seed, start-up, early-growth and development/expansion), the authors presented respondents with a description of each stage (based on Mayer, 2002) and asked them to self-select the stage which best described their current position. In the latter, using data from Irish software firms, the authors categorise firms into four age groups based on age at the time of survey as follows: start-up (< 2years); commercialisation (2-4 years); growth (5-9 years); and maturity (> 10years). Second, the list of sources of financing compiled is more detailed. Bozkaya and Van Pottelsberghe De La Potterie (2008) examine 10 sources (personal funds, family and friends, retained earnings, commercial bank loans, government subsidies, non-financial institutional funds, other debt-finance funds, business angels, venture capital and other equity-finance funds). Hogan and Hutson (2010) include 3 sources of internal (i.e. savings, consultancy revenues; retained profits) and 4 sources of external (i.e. bank loans, venture capital, private investors, and government grants). The list compiled for this study included a total of 18 sources of funding, both internal (personal funds, retained profits, director's loan) and external (family/friends, debt, share capital, government funding, and equity funding). Moreover, respondents were not limited to those listed (i.e. ample space was provided for any '*Other*' sources obtained). This unique template thus provides novel data pertaining to the financing patterns of indigenous technology-based firms over their lifecycle.

The next question examined preferences in relation to financing (i.e. internal or external sources), developed based on the pecking order hypothesis (POH). As discussed in Chapter 2 (Section 2.2), the POH, developed by Myers (1984) and Myers and Majluf (1984), posits that, due to information asymmetries between firms and providers of finance, internal sources of finance are preferred over external. Respondents were simply asked: *"When your business requires additional financing, do you prefer to utilise internal sources of capital (e.g., retained profits), where possible, before resorting to external financing (e.g., debt or equity funding)?"* Although producing a binary (*yes/no*) response, the question also included an open-ended follow-on asking respondents to explain the reasoning behind their preference. This question is modelled on Mac an Bhaird (2010), where respondents rated the statement '*I prefer to use retained profits as much as possible'* on a scale from strongly agree to strongly disagree. A similar format is utilised by Hogan and Hutson (2005b).

It is generally accepted that financing for entrepreneurial start-ups begins with founders investing personal funds (see Berger and Udell, 1998; Coleman and Robb, 2012). Furthermore, personal investment signals the quality and potential of the project, as the extent of inside equity can be interpreted as a measure of the entrepreneur's confidence in and commitment to the firm (Prasad, 2000). Respondents were asked to provide an estimate of the percentage of total seed stage finance which came from founders' personal funds.

Following this, several questions were included to build a profile of debt financing. First, a filter question assessed whether the respondent had utilised debt. Those who answered '*No*' were asked to skip to the end of the section. Those answering affirmatively were asked to provide details of the following: the number of banks they bank with; the number of years spent banking with the primary financial institution; and the collateral (if any) required to guarantee debt financing (i.e. personal assets and/or business assets). Respondents were also asked to rate the importance (on a five-point scale from 'very important' to 'not important at all') of various considerations on their decision to utilise debt finance (e.g. interest rates, collateral requirements, debt-tax shield, etc.). Other researchers have utilised a similar design (see Hogan and Hutson, 2005b; Mac an Bhaird, 2010).

Next, respondents were asked to assess the extent to which they agree (on a scale from 'strongly agree' to 'strongly disagree') with statements pertaining to the availability of various sources of finance, requirements of financiers and availability of funding. Finally, respondents were asked to indicate from a list provided (for example, retained profits, business overdraft, business loan, f-connections, venture capital, business angel, etc.) the sources of financing that they would consider seeking and utilising in the future. An '*Other, please specify*' space was also provided for any sources not listed.

3.2.2.3 Characteristics of Equity Financing

In the instrument designed for equity financed firms, Section 3 was devoted to equity financing. Specifically, micro-micro data was collected on the characteristics of each individual source (e.g. location, control, ownership, interaction, etc.)[49], with a view to developing an in-depth understanding of the equity financing of technology-based firms by gathering data concerning a wide variety of elements, including not only these implicit factors but also entrepreneurs' judgments and perceptions.

Briefly, equity investment is characterised by significant information asymmetry and uncertainty (see Sahlman, 1990; Amit *et al*., 1998; Cumming, 2006). As discussed in Chapter 2 (Subsection 2.2.2), private equity investors commonly utilise various control mechanisms to mitigate agency problems (see Gompers and Lerner, 2001; Cumming and Johan, 2013). Investing locally is one method by which equity investors can reduce uncertainty and thereby

[49] The layout of this section included space for details pertaining to six equity investors. Where respondents indicated that their firm had received funding from more than six sources of equity financed, they were asked to provide information pertaining to their six main investors.

minimise risk (see Florida and Kenney, 1988a, b; Mason, 2007). Extant evidence highlights the role of geographical proximity in equity investment (see Sapienza, 1992; Lerner, 1995; Davila *et al*., 2003; Manigart *et al*., 2006; Cumming and Dai, 2010). To test for the presence of local bias in equity financing in Ireland, respondents were asked to indicate the location of each equity investor among the following: local (< 1hour drive); within region; rest of Ireland; UK/Europe; or international.

Given that contracts are inherently incomplete, equity investors commonly choose to closely monitor their portfolio companies formally by taking a seat on the board of directors (see Rosenstein *et al*., 1993; Kaplan and Strömberg, 2001). By having a seat on the board of directors, equity investors not only have the ability to influence business decisions but can also obtain valuable information regarding the firm's performance and can monitor the entrepreneur (see Lerner, 1995; Hellmann and Puri, 2002). Respondents were asked to identify all those investors holding seats on their board.

The next aspect considered was stock ownership. Equity investors utilise common or preferred stock, or a combination of these securities (Kaplan and Strömberg, 2003). Preferred equity holders have the rights to a stream of prespecified dividend payments and rank behind debt holders (but ahead of common equity holders) in bankruptcy proceedings (Cumming and Johan, 2013). As such, respondents were asked to indicate, for each equity investor, the type of shareholding (i.e. common stock, preferred stock, or a combination of both).

Sociologists have long argued that referrals from people in whose judgement the decision maker has confidence make them more favourably disposed to the person referred (Blau, 1964). For equity financing, third party referrals can play an important role. From the entrepreneur's perspective, referrals can be useful in identifying potential investors, particularly individual angel investors (Paul *et al*., 2003). From the investor's perspective, referrals provide information regarding qualities which may be difficult to observe, such as entrepreneurial competence (Shane and Cable, 2002). In examining the role of referrals, respondents were asked to indicate which, if any, of their investors they were referred to and to provide details of their reference. For those without a referral an open-ended question was including, asking the respondent to briefly explain how they found their equity investor.

Next, respondents were asked to specify whether they received investment in funding rounds or in one lump sum. The aim was to examine the use of staged financing, which involves contributing financial investment in stages over time. Instead of investing all funding up front, equity investors stage investment based on the receipt of new information about the project and achievement of certain milestones (Gompers and Lerner, 2001). Staging capital infusions not only reduces the risks inherent in an investment but allows the investor to gather additional information and monitor progress (Wang and Zhou, 2004). Hence, it is a useful tool in reducing the information asymmetries and agency costs associated with investment.

Typically, equity investors are actively involved in portfolio firms (see Lerner, 1995; Hellmann and Puri, 2002). Although investors can monitor investees formally by taking a seat on the board of directors (Kaplan and Strömberg, 2001), they also rely on informal involvement, such as telephone calls, emails or informal meetings (Ortgiese, 2007). In examining the frequency of such interaction, Bottazzi *et al*. (2004) use a scale (weekly, monthly, quarterly, annually) to measure site visits among European venture capitalists. A similar design was used here, with respondents asked to indicate how often, outside of formal board meetings, they interact with each equity investor from the following reply categories: daily; weekly; monthly; less than once a quarter; quarterly; twice yearly; and yearly.

The prospect of sharing risk with equity investors can impact on the financing decisions of entrepreneurs (see Amit *et al*., 1990; Reid, 1998). These investors take a stake in the business, sharing both the upside and downside risks (Pfirrmann *et al*., 2012). The sharing rule implied by equity financing is such that both the equity investor and the entrepreneur cannot, at the same time, have a claim of 100% in the firm (de Bettignies and Brander, 2007). In examining the relevance of risk-sharing in the entrepreneur's decision to utilise equity financing, a scale was thought to be the best option. This produces a rating of the importance of risk-sharing and is thus more effective than a simple binary measure or a qualitative answer which may be difficult to code for empirical analysis. Respondents were therefore asked to rate the importance of risk sharing with each equity investor on a four-point scale as follows: unimportant; moderately important; important; and very important.

As discussed in Chapter 2 (Subsection 2.4.2), it is generally agreed that equity investors contribute not only financially but non-financially through activities including monitoring, strategic advice and networking (see Sapienza *et al*., 1996; Colombo and Grilli, 2010). Briefly, equity investors add value by coaching, that is, providing financial, administrative, marketing, strategy and management support (Luukkonen *et al*., 2013. Equity investors also support the professionalisation of young firms (Bottazzi *et al*., 2008), along with facilitating access to specialised professional services and alliances with third parties (see Colombo *et al*., 2006; Hsu, 2006). Based on a review of the literature, a list was compiled of twelve possible non-financial benefits, ranging from various forms of advice to referrals to networking.[50] The objective of this question was to examine the extent to which investors provide such benefits, from the entrepreneur's point of view. Ample space was also left, marked '*Other*', for the respondent to detail any non-financial benefits not listed.

Next, respondents were asked to detail information requested as part of the application (due diligence) process with each investor. Due to adverse selection and information asymmetry problems (Amit *et al*., 1993), gathering information is one of the most crucial phases in the equity investment process (Manigart *et al*., 1997). This question was intended to

[50] Specifically, this list included: technical advice; managerial advice; market advice; financial advice; legal advice; financial contacts; industry contacts; customer/client contacts; government agency contacts; help with hiring/recruiting staff; provision of business services; and mentoring.

assess the extent of the screening process and compare this process among the different investor types. The choice set included: formal application for financing; business financial statement; business plan; personal financial statement; appraisal of assets to be financed; cash flow projections; presentation to investors; and letters of interest. An "*Other*" option was included.

Finally, respondents were asked to indicate the importance of various considerations relating to their decision to seek equity. These considerations include: loss of control; loss of management freedom or independence; pressure to change the management team or bring a new management team onboard; pressure to meet the targets set by investors; increased burden of monitoring costs; pressure to appoint non-executive directors; and search costs. Response categories ranged from very important through to not important at all. Considerations were selected for inclusion based on issues identified in the related literature (see Gompers, 1997; Hogan and Hutson, 2005b; Cumming and Johan, 2007; Turcan, 2008).

Finally, two open-ended questions were included, asking respondents to give their opinion of the process of raising equity finance and to outline the main uses of equity. The aim of these questions was to gather qualitative data pertaining to experience in accessing and raising equity along with gaining an insight into the activity equity is funding within technology-based firms.

3.2.2.4 Innovation Activity

Two streams of literature link equity financing and innovation activity. First, evidence suggests that innovative firms are more likely to receive equity funding (see Hellmann and Puri, 2000; Peneder, 2010). Second, evidence shows that equity helps spur innovation (see Kortum and Lerner, 2000; Gompers and Lerner, 2004; Da Rin *et al*., 2006). A positive relationship between innovation and firm performance and survival has also been documented (see Cefis and Marsili, 2005, 2006; Thornhill, 2006; Fontana and Nesta, 2009; Cohen, 2010).

A notable obstacle in assessing innovation activity, however, is difficulty measuring the numerous dimensions of innovation (Buddelmeyer *et al*., 2010). Common gauges include: innovation orientation (i.e. product/process) (see Cefis and Marsili, 2005, 2006; Fontana and Nesta, 2009; Peneder, 2010; Børing, 2015); R&D (see Ortega-Argiles and Moreno, 2007; Esteve-Perez and Manez-Castillejo, 2008); and intellectual property (see Wagner and Cockburn, 2010; Buddelmeyer *et al*., 2010).

As such, Section 3 in the survey for non-equity financed respondents and Section 4 for equity financed consider innovation activity. These Sections are identical in both surveys and begin with a question designed to evaluate the level of product and process innovation over stages of the lifecycle. A definition of each type of innovation was provided for clarification and respondents were asked to self-assess the frequency of product and process innovation at each stage of their firm's lifecycle with one of the following options: continuously; regularly; rarely; never.

Next, attention turned to intellectual property (IP). Respondents were asked to indicate all IP protection mechanisms, both formal and informal, from the following: secrecy; complexity of design; confidentiality agreements; lead-time advantage; registration of design; trademarks; copyrights; and patents. Those with patents were also asked to state the number of patents issued in Ireland, Europe and the United States.

To end, three questions pertaining to research and development (R&D) were included. First, respondents were asked to indicate the frequency of R&D activity, with the following response categories: daily, weekly, monthly, once a quarter, twice yearly, and yearly. Following this, respondents were asked to indicate if their firm had, to date, availed of R&D tax credits. Some countries, including Ireland, offer a tax credit or subsidy for R&D spending, to reduce the costs of R&D investment. Such a policy observes that the cost of capital is relatively high for R&D and hence attempts to close the gap via a tax subsidy (Hall, 2002).

Finally, for those firms utilising the R&D tax credit scheme, respondents were asked whether this acted as an incentive to increase the level of R&D activity undertaken by their business.

3.2.2.5 Performance

The next part (Section 4 for non-equity; Section 5 for equity) was designed to collect quantitative measures of performance and scale. In line with existing research, the following measures were chosen to examine whether equity financed firms perform better in terms of: employment growth (see Engel and Keilbach, 2007; Bertoni *et al*., 2011); asset growth (see Manigart and Van Hyfte, 1999; Alemany and Marti, 2005); and turnover or sales growth (see Peneder, 2010; Grilli and Murtinu, 2014a, b). To allow for the calculation of these measures, respondents were asked to provide an estimate of the following for the end of the first year of trading and current trading year: employee numbers (part- and full-time); turnover; total assets; and operating income. These figures provide the basis for empirical analysis (Chapter 7) relating to the performance of technology-based firms, given that such information is generally not publicly available for small, privately-held firms. The only other question asked the respondent to indicate, for an average trading year, the percentage of total expenditure devoted to: R&D activities; personnel training; and technology acquisition/licensing.

3.2.2.6 Exit

Finally (Section 5 for non-equity; Section 6 for equity), we turn to exit. The layout is different in each instrument, as detailed below. Overall, data provides unique evidence on entrepreneurial and equity investor exit.

For non-equity financed firms, Section 5 examines entrepreneurial exit. An entrepreneurial exit is defined as the process through which the founder of a business leaves that business, thereby removing themselves, in varying degrees, from the primary ownership and decision-making structure of their business (DeTienne, 2010). Entrepreneurs can exit in many ways, including family succession, sale to a third party (e.g. management/employees, another company, or via an initial public offering (IPO)), or they can windup the business through bankruptcy or closure (Wennberg and DeTienne, 2014). For the purposes of this research, respondents were presented with the following list of possible exit routes: IPO, trade sale, management/employee buyout, family transfer, liquidation, voluntary cessation, or other. This provides an indication of whether the respondent believes there is a market (public/private) for their firm, the likelihood of family succession and whether management or employees were equipped to buyout the entrepreneur.

The Section began with a filter question, which asked the respondent "*Do you have an exit or transfer strategy in place for your own exit*?". Those who responded affirmatively were asked to indicate their planned exit route. This was followed by an open-ended question asking the respondent to explain why this is the chosen exit strategy. Those who answered "*No*" were asked to indicate the most likely route for their eventual exit. Again, an open-ended question asked them to explain their choice. The focus then turned to perceived barriers to exit, with respondents asked to indicate, from a list of possible barriers, those most pertinent in their exit. Finally, respondents were asked, if they do not plan on pursuing an IPO, why this is the case. A list of possible reasons is provided along with an *"Other"* option.

In the version for equity financed firms, Section 6 began by examining exit for equity investors. Exit routes listed include: IPO; trade sale or acquisition; buyback or buyout; secondary sale; family transfer; and liquidation. The most important exits for equity investors are IPOs and acquisitions (see Black and Gilson, 1998; Cumming, 2008).[51] A filter question assessed initially whether there had been a divestment, asking: "*Have any of your equity*

[51] Empirical evidence suggests that there is a pecking order of exit mechanisms – IPOs normally yield higher returns than trade sales and so are preferred (Bienz and Leite, 2008).

investors exited to date?" Those answering affirmatively were asked to indicate the exit route the equity investor(s) pursued and, through a follow-on open-ended question, why this was the chosen method. The aim was to gather data regarding the respondent's experience of the divestment process. The next question asked how many equity investors remained after this divestment. Finally, respondents were asked to indicate who had chosen the exit route for the divestment, with the following options: you, equity investor, and joint decision. Those who answered "*No*" were instructed to skip these four questions.

Following this, attention turned to divestment strategies of active equity investors. Respondents were asked to indicate, from the same list, the planned or expected exit route for existing equity investors. Again an "*Other*" option was provided to capture different choices. This was followed by an open-ended question asking respondents to explain why this exit route was chosen. The objective was to investigate exit options pursued by equity investors investing in Irish technology-based firms.

Finally, attention turned to entrepreneurial exit. Three straightforward questions were asked, beginning with the filter question "*Do you have an exit or transfer strategy in place for your own exit*?". Those who responded affirmatively were asked to indicate their planned exit route. Those who answered "*No*" were asked to indicate the most likely exit route for their eventual exit. Finally, respondents were asked to reflect, through an open-ended question, on their experience in planning for exit and the main challenges they faced in choosing an exit strategy, providing qualitative data on the task and exit environment facing entrepreneurs.

3.2.2.7 Conclusion

This aim of the preceding discussion was to described the unique features of the design of the survey instrumentation for this study. Overall, the instrumentation has three main contributions. First, data pertaining to sources of financing is collected retrospectively across four stages in the firm's lifecycle. Second, detailed data on the characteristics of equity investors, and the various control mechanisms employed, is gathered by equity investor type (private venture capitalist, corporate venture capitalist, business angel, and government-sponsored equity fund). Finally, novel data is gathered pertaining to both entrepreneurial and equity investor exit. Overall, this data not only permits empirical examination using new measures but allows for a unique profile of technology-based firms, their financing and end-game intentions.

The measures developed in survey instrument enable: a characterisation of technology-based firms (see Chapter 4); an examination of the determinants of equity financing (Chapter 5); a unique analysis not only of the determinants of each source of equity financing at distinct stages of the lifecycle but also given the relationship (i.e. complements or substitutes) between the sources of equity (Chapter 6); and an examination of the impact of equity financing on the performance of funded firms and in influencing entrepreneurial exit intentions (Chapter 7).

3.2.3 Fieldwork Methods

Fieldwork methods enable the researcher to seek an understanding of the universe which they are exploring, in a way which takes account of the context of the situation (Reid, 1998). The fieldwork involved in this study is detailed herein.

3.2.3.1 Pilot Testing

The term 'piloting' has various meanings in social science research. A pilot can be the pre-testing, or trying out, of a research instrument (Baker, 1994). It may also refer to feasibility studies which are "*small scale version[s], or trial run[s], done in preparation for the major study*" (Polit *et al*., 2001; page 467). According to Converse and Presser (1986; page 74) a pilot is a "*dress rehearsal*"; a test of the entire data collection process, not only a test of the survey instrument. For the purposes of piloting the survey instruments designed for this study, preliminary versions of questionnaires were circulated among six technology-based firms. Feedback was requested from each on every element of the survey, specifically focusing on: layout and design; data requested; instructions given; length of the survey; the order and content of questions; and ease of understanding. All questions were tested to examine the level of variation in responses, to see if respondents understood what was being asked of them, to examine the difficulty of the task facing respondents in completing the survey, and to assess the interest and attention of respondents in the content of the survey. The flow of the sections, sequencing of questions, skip patterns, explanations and time it took to complete the survey were also considered. The results from piloting and main lessons learnt are discussed herein.

Pilot Sample

Six firms were selected for the pilot study. A brief description of these firms is presented in Table 3.4. These were chosen from different locations, although mainly concentrated in the counties most represented in the sample. The average age was just over eight years at the time of the pilot. They vary in size, from a sole trader to a firm with eighty employees. This diversity facilitated rigorous testing of the survey instruments.

Table 3.4. Description of Firms in Pilot Study

Line of Business	Financing	Location	Age	Size (FTEs) [a]
Medical Devices	Equity	Galway	5	8
Internet Service Providers	Equity	Dublin	6	75
Software Development	Equity	Limerick	5	12
Online Mobile Services	Non-Equity	Dublin	15	80
Software Retailer	Non-Equity	Cork	10	2
IT services	Non-Equity	Cork	10	1

Source: Author’s Own

Notes: [a] FTE is an abbreviation for full-time equivalent employees

Equity-financed firms were all interviewed as part of the pilot to fully test and practice the data collection process. It was important to rigorously test administration, to ensure interviews flowed smoothly and to give the author practice in conducting and leading meetings. During the pilot interview, the questionnaire was first completed in its entirety. Following this, the respondent was asked to provide feedback on the interview process and survey instrument. Each pilot interview took one to two hours to complete.

For the non-equity financed pilot the candidates completed the questionnaire through alternative methods: one received a postal survey, the next completed the survey online (through the online survey provider at www.esurveyspro.com), and the third through telephone interview. Once the postal and online responses had been received, respondents were telephoned to elicit feedback on how the survey instrument could be improved, the data collection process, how long it took them to complete the survey (approximately half an hour) and ease of the task. This feedback information was gathered once the survey had been completed with the respondent completing the telephone version.

Overall, respondents were enthusiastic about the research project, particularly the three entrepreneurs from the equity-financed firms. Each respondent selected for the pilot study was frank and forthcoming with their feedback, providing insightful comments and suggestions. The overall findings from the pilot study are outlined next.

Findings of the Pilot Study

Some notable points emerged during piloting and, subsequently, alterations were made to the survey instruments. These changes enhanced the questionnaires, while also easing the difficulty of the response task. The focus of the ensuing discussion is on the most significant findings of pilot testing.

In general, it was found that the time taken to complete the first section of the survey, concerning the general characteristics of the business, was too long. It took approximately ten minutes to complete. Given that this is only the introductory portion and it is vital that respondents continue long enough to answer questions further on in the survey, this section was reduced in length. A question regarding the barriers to entry the firm faces in their main market was generally found to be the most time consuming. This question was originally part of three, included to build a profile of the technology-based firm's market environment (the other two questions focused on the extent of market rivalry and product differentiation). Respondents were presented with a list of possible barriers to entry and asked to rate the importance of each. While this data was intended to be utilised for purely descriptive purposes, the other two measures (i.e. rivalry and product differentiation) were vital to empirical analysis. Briefly, extant evidence suggests that the firm's product offering and competition within its target market can impact on the ability to attract equity investors (see Van Osnabrugge and Robinson, 2000; Mason and Stark, 2004; Hsu *et al*., 2014). Thus, it was imperative that respondents provided this data in the survey. The question pertaining to barrier to entry was therefore omitted, which both reduced the section to one page and increased the speed at which it could be completed, given that the other questions requested demographic information which was relatively easy to recall.

Turning to Section 2, respondents reacted positively to the design and format of the chart requesting sources of financing per lifecycle stage, finding it easy to complete and interpret. Moving through the section, the only notable change was to Question 2.9, which elicited information associated with debt financing – here, testers requested an explanation for the selection choice "*debt limitations applicable*". This option was duly changed to "*debt* *covenants imposed by lenders*".[52] Based on definitions provided in Smith (1993) and Chava and Roberts (2008) a description was also included, reproduced in Figure 3.2.

Figure 3-2. Question 2.9 After Piloting

2.9 When deciding to raise/utilise debt finance, how important are the following considerations in your decision?

	Very Important	Important	Moderately Important	Slightly Important	Not Important at all
Interest rates payable					
Collateral requirements of lenders					
Tax deductibility of interest					
Desire for unused borrowing capacity					
Recent profits insufficient to fund activities					
Desire to maintain control of the business (i.e., by not issuing shares through equity finance**)**					
Debt covenants imposed by lenders (e.g. restrictions on dividend payments/new debt issuances; financial covenants requiring maintenance of minimum net worth/current ratio, etc.**)**					
Other (please specify**)** ______________________________ ______________________________ __					

In the equity-financed survey a few alterations were made in Section 3. First, additional instructions were included in Question 3.9, regarding interaction with investors, where there was some uncertainty concerning the type of interaction. An explanation was duly included. Second, respondents suggested additional non-financial benefits for the list provided in Question 3.12, namely the provision of business services and mentoring. Furthermore, it was generally felt that the process of applying for and obtaining equity was not given enough consideration in the questionnaire. Therefore, an open-ended question was included (Question 3.10), allowing the respondent room to freely express their experience of the process of raising

[52] Because most debt contracts include covenants that involve restrictions placed on firms in conjunction with the debt issue (Gârleanu and Zwiebel, 2009) it was felt that using the exact terminology would make this option easier to understand.

equity financing for their venture. To show how careful piloting can enhance and simplify the design of questions, Figure 3.3 compares the original Question 3.9 to the newer version.

Figure 3-3. Question 3.9 Before and After Piloting

Before Piloting:

3.9 Please indicate the frequency of interaction with equity investors.
(Tick one for each investor)

	Investor 1	Investor 2	Investor 3	Investor 4	Investor 5	Investor 6
Daily						
Weekly						
Monthly						
Less than once a quarter						
Once a quarter						
Twice yearly						
Yearly						

After Piloting:

3.9 Outside of formal board meetings, how often do you interact with equity investors (include informal face-to-face meetings, telephone and written correspondence.
(Tick one for each investor)

	Investor 1	Investor 2	Investor 3	Investor 4	Investor 5	Investor 6
Daily						
Weekly						
Monthly						
Less than once a quarter						
Once a quarter						
Twice yearly						
Yearly						

The next set of questions focused on innovation. Respondents were initially asked to provide the number of new innovations introduced, both product and process, per stage. This process, however, proved onerous, with some having difficulty remembering the trajectory of new products/processes over time. Also, some felt they were innovating by constantly updating and improving existing products, which was not accurately conveyed through the question format. The question was simplified by asking respondents to self-assess their firm's frequency of innovation for each stage of the lifecycle shown in Figure 3.4. This alteration significantly improved the speed and ease with which the question could be answered.

Figure 3-4. Question 4.1 Before and After Piloting

Before Piloting:

4.1 For each applicable stage in your firm's lifecycle, please indicate the total number of new or significantly improved products and processes introduced:

	Seed Stage (first year of operation)	Early Growth Stage (2-5 years)	Expansion Stage (6-10 years)	Later Stage (10+ years)
Product Innovation				
Process Innovation				

After Piloting:

4.1 For each applicable stage in your firm's lifecycle, please specify how you would rate the frequency of product and process innovation undertaken on a scale of:

Continuously; Regularly; Rarely; Never

	Seed Stage (first year of operation)	Early Growth Stage (2-5 years)	Expansion Stage (6-10 years)	Later Stage (10+ years)
Product Innovation				
Process Innovation				

In the next Section (4 for non-equity financed and 5 for equity financed), the only alteration made was to clarify the meaning of part-time and full-time employees. An explanation was included. An illustration of the updated question is reproduced in Figure 3.5.

Figure 3-5. Updated Question 5.1

5.1 We would appreciate if you could provide estimates of the following measures:
Note: Here an estimate or rough figure will suffice.

	Last trading year (i.e., at present)	**End of first year of trading (i.e., at start-up)**
Number of part-time employees (i.e. those who work less than 30 hours a week)		
Number of full-time employees (i.e. those who work a regular week of at least 30 hours)		
Turnover		
Total Assets (i.e. fixed plus current assets)		
Current Liabilities		
Operating Income (i.e. earnings before deduction of interest payments and taxes)		

The last part in both survey instruments focused on exit strategies. No changes were made to the version of the survey for non-equity financed respondents (Section 5). In the survey for equity financed respondents (Section 6), it was suggested that a question regarding challenges faced in choosing an exit strategy would be easier to answer if it was open-ended. Initially, the question listed various possible challenges and respondents were asked to select all those applicable to their experience. During the piloting, two respondents felt that an open-ended question would be more beneficial in capturing the nuances of entrepreneurial exit when equity investors are involved. Thus, the question was redesigned.

Once the survey had been edited based on these recommendations, opinion was obtained from several professionals, including: Head of Corporate Banking at AIB; Business Banking Manager at a local branch of AIB; Partner at Kernel Capital; and Investment Executive at Enterprise Equity. In addition, the author spoke with the Chief Executive of the Irish Small and Medium Business Enterprise Organisation (ISME), who has vast experience in conducting survey-based research in the SME sector.

Overall, the piloting was extremely useful in simplifying the design of the questionnaires. Most importantly, conducting the pilot testing provided the author with experience of data collection and survey administration, which was particularly useful for conducting interviews with equity financed respondents.

3.2.3.2 Data Collection Process

As indicated previously, structured questionnaire instruments were designed to gather primary source data from a sample of equity and non-equity financed technology-based firms throughout Ireland. The major benefit of using a survey-based approach for data collection in financing research is that a survey may be used to: (1) test the qualitative assumptions and conclusions in the capital structure literature; and (2) indicate practitioners' perceptions when making capital structure choices (Norton, 1991). The next step involved the data-acquisition process itself, details of which are the focus of the proceeding discussion. Ethical approval was sought and obtained prior to beginning.

Primary source data collection can take a variety of forms. Some use indirect methods, disseminating postal, as in Hogan and Hutson's (2005b) analysis of the capital structure of Irish software firms, or email, as in Ullah *et al.*'*s* (2010) investigation of the financing of UK technology-based firms, questionnaires or surveys. Alternatively, some choose direct methods, including face-to-face, as in Deakins *et al.'s* (2015) investigation of the financing of small technology-based firms in New Zealand, or telephone, like North *et al.'s* (2013) examination of the impact of the financial crisis on the funding of UK technology-based firms, interviews. Others employ a combination of methods, such as Bozkaya and Van Pottelsberghe De La Potterie (2008) who collect data pertaining to the financing of Belgian technology-based firms through interviews and mail questionnaires. Regardless of the choice, the investigator must bear in mind resource constraints, access to the field, participant consent, and data complexity in choosing a technique (Reid, 1998). Within the context of this study, two fieldwork techniques were chosen. Specifically, evidence on which empirical analysis is based derives from face-to-face interviews with equity financed respondents and self-administered questionnaires for non-equity financed respondents. A profile of fieldwork methods is provided in Table 3.5. The data collection process took place over the period November 2010 to May 2011.

Table 3.5. Fieldwork Methods

Equity Financed:			
Total Eligible Cases:	**Data Collection Method:**		**Response Rate:**
313	Face-to-Face Interview - 153		48.9%
Non-Equity Financed:			
Total Eligible Cases:	**Data Collection Methods:**		**Response Rate:**
372	Online Survey - 129 Postal Survey - 9 Telephone Survey – 3	141	37.9%

Source: Author's Own

Initial contact with all firms was via a pre-letter and information flyer, which identified the researcher, explained the nature of the study, the process by which data was to be collected and time required for completion. These documents were designed to meet standard criteria in terms of explaining to each respondent: (1) what the research aimed to do; (2) why it would be of interest to them and why they should participate; (3) how long the process would take; (4) who was involved in the project, including contact details; and (5) how considerations of anonymity would be respected. Letters were printed on headed paper from the School of Economics, University College Cork, and contained contact details for all researchers involved, to establish that the research was the subject of a legitimate academic need. Respondents were given assurances on confidentiality throughout all correspondence. Full copies of correspondence are provided in Appendix 2.

In total, firms were contacted on four separate occasions. The first was via the pre-letter and flyer, addressed to the named Chief Executive Officer (CEO) (where it was not possible to identify the current CEO the pre-letter was sent to the founding entrepreneur). Approximately one week after, firms were contacted by telephone and/or email[53]. Non-responders were sent a reminder approximately three weeks after, followed by a final email reminder another three weeks after that. For those who declined, contact was valuable in ascertaining reasons for reluctance in responding. Commonly cited reasons included: reluctance to supply financial information; survey fatigue; lack of time; and company policy.

Data collection began with equity financed firms. In carrying out this fieldwork, the founder-CEOs of all responding technology-based firms were interviewed by the author. Face-to-face interviews using an administered survey instrument were considered to have considerable advantages over self-administered methods. Briefly, in view of the complexity

[53] For email follow-ups, personal email addresses were sourced were available and a standard email sent to the recipient of the pre-letter.

of the survey instrument it was felt that the use of online or postal questionnaires would potentially result in a low response rate and, furthermore, a poor quality of return. Essentially, given the amount of micro-micro data required by equity investor type, interview was deemed the most appropriate and efficient method for data collection, as respondents could be guided through the survey instrument. Moreover, interviewing respondents personally allowed the author to gain a more insightful understanding of the equity financing process, from the entrepreneur's perspective. Gathering data by speaking to people has the greatest potential to generate insight into the object of analysis (Reid, 1998). Interviews offer enough flexibility to respond to what the interviewee says while also maintaining systematic direction in the interview process (Cohen *et al*., 2007). It was decided, therefore, that the questionnaire should be administered personally, with the author personally conducting semi-structured interviews.

In terms of data collection within the field, the structured questionnaire instrument included several open-ended questions, to allow the interviewee the freedom to express their own experiences, feelings and opinions (Merriam, 2009). Fieldwork necessitated travel throughout Ireland, meeting personally with the founder-CEOs of 153 technology-based firms. Interviews were held at the convenience of the interviewee and the time averaged 1–2 hours, very much influenced by the personal style of the respondent. Time was spent not only addressing the questions delineated in the questionnaire but also discussing experiences, challenges and general opinions of the financing environment, both in Ireland and abroad, although the overall pattern of the discussion adhered to the administered survey instrument. Based on this, a great deal of unique and novel data was gathered. A deliberate aspect of this approach was that respondents could digress in areas of potential interest to this study, although every effort was made during the interview to curtail irrelevances.

Data collected was of diverse forms, including: qualitative, textual evidence, based on respondents' responses to open-ended enquires, structured around issues relating to equity financing; and quantitative evidence (binary and categorical) obtained from completed questionnaires. It would be very difficult to gather this amount of data from any other method of data collection. In total, 153 (response rate 48.9%) face-to-face interviews were conducted, with all returns being completed to a high level of accuracy and detail.

Following this, fieldwork turned to non-equity financed technology-based firms. A self-administered questionnaire instrument was chosen, disseminated via an online provider (postal or telephone upon request). Keeping in mind the nature and amount of data required from this sample, along with the industrial sectors targeted, an online questionnaire was felt to be the most appropriate and efficient technique for data collection.[54] Initial contact was again by pre-letter, this time containing details of the hyperlink to the survey (also included in each email reminder). Once completed, respondents would click on the submit button which would save the information and send it to the author through email. The survey took respondents, on average, thirty minutes to complete. As can be seen from Table 3.5, the majority (91.5%) completed the questionnaire online. In total, 141 (response rate 37.9%) useable completed surveys were collected.

3.2.3.3 Response Rates

At the outset, various elements were incorporated to aid and enhance response rates. First, confidentiality was emphasised in all correspondence and anonymity guaranteed. It is a long-held view that such assurances encourage response (see Fuller, 1974; Pressley and Dunn, 1985; Tyagi, 1989). Second, a non-monetary incentive was offered in the form of a charitable donation.[55] Previous survey-based studies indicate that monetary (Duncan, 1979; Jobber *et al*., 2004) and non-monetary (Willimack *et al*., 1995) incentives can increase response rates and

[54] Specifically, because respondents were required to complete a significantly condensed version of the survey instrument (see Subsection 3.2.2) and given that these respondents were operating in technology-based fields, it was considered more efficient to utilise an online self-administered questionnaire.
[55] A donation of €1 per completed survey received was distributed among various cancer support groups in the Cork area and a note to this effect was included in the pre-letter (see Appendix for a copy).

speed of return (see Nederhof, 1983; Faria and Dickinson, 1992). Third, researchers have reported higher response rates for studies which have some form of sponsorship, from a university, government or commercial entity (see Peterson, 1975; Albaum, 1987; Faria and Dickinson, 1992). All correspondence included the ideogram of University College Cork and logo of the Irish Research Council for the Humanities and Social Sciences (IRCHSS). Lastly, pre-notification can have a positive impact on response rates, speed of response and data quality (Murphy *et al*., 1990). Additionally, follow-up contact can improve response rates (see Kanuk and Benson, 1975; Furse *et al*., 1981; Yammarino *et al*., 1991), with multiple follow-up strategies resulting in even higher response rates than one-time reminders (Heberlein and Baumgartner, 1978; Dillman 2007). Thus, a pre-letter and follow-up reminders were sent to all firms.

Overall, 294 technology-based firms participated in this study, out of a total sample frame of 685 firms. This corresponds to an overall response rate of approximately 43%. The level of response was slightly lower among non-equity, as can be seen in Table 3.6. Almost half (48.9%) of the eligible firms from the equity financed sample responded, while just over two-thirds (37.9%) of non-equity financed completed the questionnaire. Overall, this is felt to be an impressive response rate given previous research has reported response rates as low as 10% in small-business mail surveys (Curran and Blackburn, 2001). Additionally, these response rates are in line with those recorded for similar studies based on the Irish business population. Mac an Bhaird and Lucey (2009) report a response rate of 42.6% to their study of the financing of Irish SMEs while Hogan and Hutson (2005a), in their survey of Irish software firms, record a response rate of just under 46%.

The composition of the sample of eligible responses is as follows: 153 (52%) of those interviewed are equity financed technology-based firms; the remaining 141 (48%) completing the administered questionnaire are non-equity financed technology-based firms.

Table 3.6. Response Rates

Sample	Eligible Cases	Eligible Responses	Response Rate
Equity Financed	313	153	48.9%
Non-Equity Financed	372	141	37.9%
Total	685	294	42.9%

Source: Author's Own

3.2.3.4 Database Design

Data collected was qualitative and quantitative in nature, gathered from a unique sample of technology-based firms. Subsequently, a number of databases were generated using Statistical Package for Social Science (SPSS). The primary sorting key in each database was the assigned '*Firm ID'* number.[56] First, a database containing data from all firms (i.e. equity and non-equity financed) was created and this was used to build the profile of technology-based firms presented in Chapter 4, along with empirical analysis in Chapters 5 and 7. Second, a slightly reduced database was created for all identifiable firms for survival analysis in Chapter 7. A feature of data collection was that non-equity financed respondents could, if they so wished, remain anonymous. In total, 61 respondents chose not to disclose their identity and, as a result, the status of their firm as of December 2018 could not be confirmed. As such, the database reduces to 233 firms for survival analysis. Third, a database containing data solely on the 153 equity financed firms interviewed was created, for analysis in Chapters 6 and 7. From this database, a further three datasets were created according to stage in the lifecycle. Briefly, as analysis in Chapter 6 is conducted by stage in which equity financing was obtained, three databases were created, one each for the seed, early-growth and expansion stages. These will be discussed in greater detail in Chapter 6 (Section 6.3). Although this study uses

[56] Where possible, the firm's registered number was sourced from the CRO database as a secondary sorting key.

numerous databases this discussion will give a summary of the design of the two main ones (i.e. all firms and equity financed firms).

A dummy variable was created, coded *'1'* if the respondent is equity financed and *'0'* otherwise. In total, the equity financed database contains 502 variables with 153 data points; 261 variables for non-equity firms with 141 data points. A similar coding system is utilised in all databases. Answers to questions containing numbers (e.g. age, number of rivals, firm size) were entered without coding. Qualitative data (for example, regarding judgements or opinions) were inserted as a string variable. All qualitative data was entered verbatim. Any open-ended questions which gathered qualitative evidence were entered row by row into the database for each respondent. An additional row was entered for comments made by respondents at the end of the interview or self-administered survey. All quantitative data was coded in a format which facilitated flexible analysis. Questions producing binary responses are coded '1' for *'Yes'* and '0' for *'No'*. Those producing a scale were coded from lowest to highest. For example, the variable *ProdDiff* is a self-appraised measure of product differentiation. Respondents were asked how they would compare products in their main product group with those of competitors and were given descriptions ranging from 'identical' to 'very different'. The variable was coded such that lower values denote less differentiation and higher values denote uniqueness, as follows: =1 "identical"; =2 "very similar"; =3 "similar"; ='4" different; =5 "very different".

Certain questions produce several individual dummy variables. For example, the survey included a question pertaining to stock of intangible assets. A total of eight options were listed for respondents to choose from, with space provided for additional assets not listed. Under the *'Other'* option, responses invariably centred around people (i.e. employees) and knowledge and so two additional categories were included in the original list. For the purposes of coding, ten dummy variables were created to represent each form of intangible assets – one for each asset listed on the survey and two for additional assets stated for '*Other*'.

3.3 Secondary Data

Primary data is supplemented with secondary data, used to clarify data gathered in the field, thus improving accuracy for empirical analysis. The FAME databased and patent filings were the wo main sources accessed in gathering this secondary data.

FAME

The Financial Analysis Made Easy (*FAME*) database, maintained by Bureau van Dijk, provides detailed information for over 9 million companies in the UK and Ireland. A typical company report contains basic information, such as name, registered address, firm type, and industry code, details of the firm's status (active, dormant, in liquidation, in receivership, etc.) and date of incorporation. FAME also lists seventy-four balance sheet items, sixty-three profit and loss items and ten cashflow items along with twenty-eight financial and profitability ratios. The database includes information on the individuals involved in the company, listing current and previous directors.[57] All data is provided, where available, over a ten-year period (from the date accounts are first filed for new companies).

One issue with FAME, however, is that the availability of financial information varies substantially across firms. In compiling financial data, FAME relies on accounts filed with the Companies House in the UK or the Companies Registration Office in Ireland. Because only large companies are required to submit detailed accounts and financial statements, the database is often incomplete, either containing information on some but not all financial indicators or not containing any, when companies are classified within the small category.[58] As a result, full financial information is mostly unavailable for the firms in the sample for this study.

[57] Other information includes mortgage data, company news and any merger or acquisition deals.

[58] According to the Companies Act 2014 (Section 350), small companies are exempted from the full extent of the requirements relating to annual financial statements when the company satisfies two of the three following conditions: balance sheet not exceeding €4.4 million; turnover not exceeding €8.8 million; or employees not exceeding 50. Thus, the smallest firms are legally required to submit only very basic balance sheet information, such as shareholders' funds and total asset.

Nonetheless, FAME provides valuable supplementary information. FAME was used to track all respondents in the sample, where identifiable, verifying firm age, ownership structure (i.e. equity or non-equity financed) and industry code. For equity financed respondents, details of investors (for example, source, number of investors, year of investment) were clarified using shareholder information. Moreover, respondents were traced to confirm status as of 31st December 2018 (for empirical analysis Chapter 7).[59] Exits were traced and confirmed, where possible, using the Companies Registration Office (CRO) database.

Patent Data

While primary data collection provided details of the number of European and International patents granted it was decided at the time of data analysis that it would be more appropriate to operationalise the patent variable so that it is stage-specific.[60] During data collection respondents were asked to indicate the sources of intellectual property utilised and, where applicable, the total number of European and International patents granted to date (see Appendix 1). Secondary data was used to obtain further details of patenting. Specifically, three sources were used: Irish Patents Office (IPO), Patent Database; European Patent Office (EPO), European Patent Register; and United States Patent and Trademark Office (USPTO), Patent Full-Text and Image Database. Patent data was collected manually for each firm, searching for every patent granted where the focal firm or founder was listed as the applicant/assignee. It should be noted that, due to the anonymity of respondents among non-equity financed firms (i.e. 61 participants chose not to include their name or details on

[59] FAME includes details of 5 million companies which are no longer active, classified as being in liquidation (or liquidated), dormant or in receivership. Firms were also traced through changes in name to identify any mergers or acquisitions which had taken place within the observation time frame. FAME provides details of all companies in the same corporate family, including domestic and international ownership information, thus allowing for the identification of respondents who have exited through merger or acquisition since the date of data collection.
[60] The patent dummy indicator switches from 0 to 1 from the stage in which the first patent was granted. For example, an eleven-year-old firm got their first patent in their seventh year of operation with associated patent variables coded as follows: seed = 0; early = 1; expansion = 1; later = 1.

completed survey), patent data could only be confirmed for 233 firms. The process began with the Irish patent database, checking each identifiable firm, regardless of whether they indicated that they held a patent at the time of fieldwork. This improved the accuracy of the data and helped to clarify and update the information gathered. The IPO provides application number, dates of patent filing and granting, the title of the invention and inventors, along with details for the priority country and the application number. For each patent identified the name of the applicant and address were checked to ensure that the patent matched the focal firm. Once this was confirmed, the date of the earliest patent granted was noted along with a count of patents.

Attention then turned to the EPO European Patent Register. Again, data was collected by manually searching each firm by name. Each patent application number was noted and, where necessary, the application number obtained from the IPO database was entered. Only patents granted were included in the count for patent stock.[61] The EPO database provides a detailed description of each patent submission, including title, status, applicant and inventor details, publication, designated states and examination process. A patent was considered granted from the date of communication of intent to grant. Lastly, a count of US patents was compiled using the USPTO Patent Full-Text and Image Database, where each firm was manually entered first by name and, where necessary, either the title of the invention or the application number as per the IPO database.[62] Again, for each patent identified the name of the applicant/inventor and address of the firm was checked to ensure that the patent being counted matched the focal firm.[63] Overall, these three databases enabled the compilation of data pertaining to total patent stocks (in Europe and the US) while also providing a timeline for patenting activity over the lifecycle.

[61] Patents withdrawn, having examination in process, or application published were excluded from the count.
[62] In a small number of cases, the name of the firm or the applicant differed slightly across patent databases. To ensure the validity of the measures for patent count, all patent application numbers and invention titles were cross checked and, where necessary, searches were performed using a combination of variations of the firm name.
[63] The USPTO provides detailed patenting information, including an abstract, inventor and assignee details.

3.4 General Conclusions

This Chapter set out to detail the research process behind this thesis. The central focus was on procedures surrounding fieldwork activities, with discussion predominantly emphasising three elements: identification of the sample frame of Irish technology-based firms; design of survey instrumentation employed in fieldwork; and the processes involved in primary-source data collection. The main contributions are, consequently, in these three areas.

The starting point in the fieldwork process was the identification of a sample frame. The target population was the indigenous technology-based firm, categorised using a sectoral approach based on the NACE classification system (Eurostat, 2013) which covers both technology-based manufacturing and knowledge-intensive service industries. Two sampling procedures were employed – sampling of equity financed technology-based firms using a purposeful sampling technique and sampling of non-equity financed firms. Overall, a sample frame totalling 685 technology-based firms was compiled (313 equity and 372 non-equity financed firms). The comprehensive sample of firms compiled for fieldwork is a notable contribution of this study.

Attention then turned to the design of survey instrumentation. Two surveys were created (one version for equity financed and one condensed version for non-equity financed). A common feature of both instruments was that questions were set out within distinct sections, under the headings of general characteristics, financing, equity finance, performance and exit. Overall, this instrumentation offers several contributions to this research. First, a novel question was designed to collect retrospective data for an extensive set of sources of financing over four consecutive stages in the lifecycle of technology-based firms. Such detailed descriptive data does not currently exist. Second, the instrumentation created for equity financed firms contained questions designed to extract comprehensive micro-micro data characterising different sources of equity. Detailed data of this kind, to the best of the author's knowledge, does not currently exist and allows for a unique comparison of four distinct sources of equity financing. Third, novel questions were designed to examine perspectives on asymmetric information regarding the use of debt and equity financing, along with experiences in raising external finance. This provides unique and original demand-side evidence regarding perceptions of entrepreneurial financing. Lastly, questions pertaining to exit gather data which makes an important contribution to existing knowledge. After having been largely neglected in the entrepreneurship literature, a burgeoning literature increasingly acknowledges entrepreneurial exit as a vital part of the entrepreneurial process (see DeTienne, 2010; Ryan and Power, 2012). Overall, however, our understanding of entrepreneurial exit intentions, or even the choice of whether to have an exit strategy, is very limited (DeTienne and Cardon, 2012). This study addresses the dearth in the literature by including questions designed to probe the end-game strategies of entrepreneurs and, where applicable, their equity investors.

Having described sampling procedures and design of instrumentation, the final task was to detail the data gathering process. Two fieldwork methods were adopted. First, interviews were conducted personally by the author with equity financed respondents. This method is a highly beneficial mechanism within which to conduct fieldwork, allowing the researcher to be immediately responsive and adaptive, while also allowing the research to improve understanding of the topic through non-verbal as well as verbal communication, process information immediately, clarify material, check with respondents for accuracy of interpretation, and explore any unexpected or unanticipated responses (Merriam and Tisdell, 2015). Moreover, these face-to-face interviews were particularly beneficial in gathering the micro-micro data desired and allowed for the collection of exhaustive information regarding individual equity investors. Interviews provided the author a unique insight into the financing process and perceptions of entrepreneurs. The time and effort spent travelling to each technology-based firm and lengthy discussions with founder-CEOs regarding measures in the survey and their experiences in obtaining financing ensures that the quality of the data obtained is high. In addition, the qualitative evidence obtained could not have been gathered by any other method. Second, a self-administered method was used with non-equity financed respondents, with the use of an online survey provider. Evidence gathered is based on the entrepreneur's perspective (i.e. demand-side), responding to Rasmussen and Sørheim's (2012) call for more studies on the financing process of technology-based firms which focus on how the entrepreneur makes financing decisions.

The novel primary-source data gathered through the fieldwork outlined herein is used to build a distinctive profile of Irish technology-based firms and the entrepreneurs behind these firms (Chapter 4). Measures obtained are also employed in quantitative analysis to present unique empirical evidence. First, data from the full sample of 294 firms is used to examine the determinants of equity financing, and to compute a correction term to correct for selectivity bias going forward (Chapter 5). Second, data from equity financed firms is used to undertake a novel analysis of whether the determinants of equity financing differ when examined according to source of equity (angel, venture capital, government-sponsored), stage of the lifecycle (seed, early-growth, expansion), and given the relationship between the sources (complements or substitutes) (Chapter 6). Finally, data enables an in-depth analysis of the impact of equity financing, and the sources of equity, on funded firm performance (innovative output, growth, survival) and in influencing entrepreneurial exit strategies (Chapter 7).

CHAPTER 4 : A PROFILE OF TECHNOLOGY-BASED FIRMS IN IRELAND

4.1 Introduction

Ireland's indigenous technology sector employs approximately 12,000 people and has a total sales revenue of over €2 billion per annum (IBEC, 2016). It is these homegrown firms that are at the centre of this study. Before turning to empirical investigation, this Chapter provides a comprehensive description of the firms upon which analysis reports and introduces the key variables to be employed in that analysis. The database is comprised of 294 technology-based firms, across technology-based manufacturing and knowledge-intensive service sectors, divided into two groups – equity (N=153) and non-equity (N=141) financed. The ensuing discussion profiles these firms.

To begin with, general characteristics are detailed. Initially, Section 4.2 describes the sectorial and geographic scope of the firms, with relevant distributions compared to those in the Irish population where appropriate. Most (84%) firms operate in knowledge-intensive service sectors. Data provided by the Central Statistics Office (Business Demography, 2013) for enterprises operating within the technology-based sectors covered in this study in 2011 shows that technology-based manufacturers represented 7.8% of active businesses, with knowledge-intensive services accounting for 92.2%. The sectorial composition is thus considered representative. Following this, firm age and size are summarised. Firms were, on average 8 (mean=7.7) years in operation at the time of data collection. The predominant size class is micro (52%), followed by small (37.1%) enterprises. The clear majority (90.8%) of businesses in Ireland are micro-enterprises (CSO, Business Demography 2011).

Having examined these general characteristics, Section 4.5 provides an in-depth description of the financing of technology-based firms. Specifically, the aim is to profile the financing of these firms through the organisational lifecycle (see Chapter 2, Section 2.3) by considering the sources of finance used across four distinct stages. Overall, data suggests support for the financial lifecycle (see Roberts, 1991; Berger and Udell, 1998), with personal funding dominating nascent and younger years, while use of retained profits becomes prevalent during expansion and later stages.

Next, Section 4.6 provides a comprehensive description of the characteristics of technology-based firms, including organisational form, human capital, market extent, competitive environment, intangible activity, incubation, innovation and financing preferences. Essentially, the aim is to introduce those attributes which may, potentially, act as drivers of equity financing before testing their impact in empirical analysis (Chapters 5 and 6). Such factors may be considered antecedents of equity investors' decisions or signals of quality (see Audretsch *et al*., 2012; Lahr and Mina, 2016).

Lastly, attention turns to equity finance. The first part of Section 4.7 explores facets of equity investment. Briefly, the equity market has developed various mitigation tactics to alleviate agency problems (Gompers and Lerner, 2001) and those of interest herein include information gathering prior to investment, spatial proximity, co-investment, staging of capital infusions, security selection, board representation and monitoring (see Sahlman, 1990; Kaplan and Strömberg, 2001). The second part focuses on the entrepreneur's perspectives on equity financing, looking at issues such as considerations in deciding to seek equity, risk sharing, perceptions of non-financial value added and opinions on and attitudes towards equity investors. Taken together, this Section sheds light on the numerous aspects surrounding the equity financing of technology-based firms.

Overall, this Chapter offers three important contributions. First, a unique profile of Irish technology-based firms is presented. Similar data does not currently exist. Hogan and Hutson (2005, 2006) provide a brief description of the general characteristics of 117 Irish software product firms (firm size and age, founder education and experience). The data presented herein extends this, providing a profile across both technology-based manufacturing and knowledge-intensive service sectors and considering a more comprehensive array of attributes. This also builds on research providing assorted descriptive statistics for technology-based firms in Europe (see Storey and Tether, 1998; Grilli and Murtinu, 2014a,b), the UK (see Ullah and Taylor, 2007; North *et al.*, 2013), US (Coleman and Robb, 2012) and Belgium (Bozkaya and Van Pottelsberghe de la Potterie, 2008). This Chapter uses novel micro-micro data to build a unique profile of technology-based firms and the entrepreneurs behind them.

Second, this Chapter offers an exclusive portrayal of the financing of Irish technology-based firms. The unique question designed for survey instrumentation (Chapter 3, Subsection 3.2.2) allowed for the collection of detailed retrospective data on a multitude of internal and external sources of financing utilised over the lifecycle. To the best of the author's knowledge, similar information does not exist. In the studies closet to this, Bozkaya and Van Pottelsberghe De La Potterie, (2008) and Hogan and Hutson (2006, 2010) gather present-day data and use that to compare firms at different stages of the lifecycle. The former examines Belgian technology-based firms, asking respondents to self-select the stage which fits their position and indicate financing utilised. Using data on current sources of financing employed by 96 Irish software firms, Hogan and Hutson (2006) categorise firms into four age groups to assess financing across stage categories. Uniquely, the profile provided herein follows firms from birth as they evolve through consecutive stages in their lifecycle, thus providing novel retrospective data on financing patterns.

Finally, a unique profile of the nuances of equity finance is provided, exploring not only the type of equity investors active in the financing of Irish technology-based firms but the structure of equity investment. Additionally, an original aspect of this discussion is the inclusion of details pertaining to entrepreneurs' attitudes towards equity financing. This provides novel demand-side evidence concerning entrepreneurs' perceptions and opinions of equity financing. To the best of our knowledge, this study is the first to provide such detailed demand-side data and, as such, this represents a key contribution.

4.2 Sectorial and Geographic Profile

In this study technology-based firms are categorised using the sectorial approach (Chapter 3, Section 3.2, Subsection 3.2.1), within the NACE Statistical Classification of Economic Activities system.[64] Under NACE Rev. 2, Eurostat provides a classification of sectors aggregated into technology-based manufacturing and knowledge-intensive service industries by NACE Rev. 2 code (Eurostat, 2016b). As such, firms in the sample for data analysis are categorised across five sectors, one technology-based manufacturing (Section C) and the remaining knowledge-intensive service (Sections J, K, M and N). Summary data is provided in Table 4.1.

Overall (Column I), the clear majority (84%) of the firms in the database are classified as knowledge-intensive service firms, with the remaining (16%) operating in technology-based manufacturing sectors. The main sectors (Column I) include: 62, computer programming, consultancy and related activities (29.2%); 58, publishing activities (22.1%); and 61, telecommunications (10.2%). These are all within Section J: Information and Communication.

Looking at equity financed firms (Column II), the overall split between manufacturing and service sectors is 15% and 85% respectively. A similar profile is observed among non-equity financed respondents (Column III) of 17% and 83% respectively. There is not a significant relationship between sector and equity financing (Pearson's Chi-square=1.108; d.f=4; p-value = 0.893).

[64] NACE is an acronym for the French title: '***N***_omenclature générale des_ ***A***_ctivités économiques dans les_ ***C***_ommunautés_ ***E***_uropéennes_'.

Table 4.1. Sectoral Composition by NACE Rev. 2 Code – 2 digit

NACE Rev. 2	Classification	I All Firms (%) (N = 294)	II Equity Financed (%) (N = 153)	III Non-Equity Financed (%) (N = 141)
	Section C: Manufacturing			
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	8 (2.7%)	4 (2.6%)	4 (2.8%)
26	Manufacture of computer, electronic and optical products	20 (6.8%)	9 (5.8%)	11 (7.8%)
27	Manufacture of electrical equipment	3 (1%)	2 (1.3%)	1 (0.7%)
28	Manufacture of machinery and equipment n.e.c.	7 (2.4%)	4 (2.6%)	3 (2.1%)
32	Other manufacturing	9 (3.1%)	4 (2.6%)	5 (3.6%)
	Section C (Manufacturing) Total	***47 (16%)***	***23 (15%)***	***24 (17%)***
	Section J: Information and Communication			
58	Publishing activities	65 (22.1%)	32 (21%)	33 (23.4%)
59	Motion picture, video and television programme production	1 (0.3%)	1 (0.7%)	0 (0%)
61	Telecommunications	30 (10.2%)	20 (13%)	10 (7.1%)
62	Computer programming, consultancy and related activities	86 (29.2%)	40 (26.1%)	46 (32.6%)
	Section J Total	***182 (61.9%)***	***93 (60.8%)***	***89 (63.1%)***
	Section K: Financial and Insurance Activities			
66	Activities auxiliary to financial services and insurance activities	3 (1%)	2 (1.3%)	1 (0.7%)
	Section K Total	***3 (1%)***	***2 (1.3%)***	***1 (0.7%)***
	Section M: Professional, Scientific and Technical Activities			
69	Legal and accounting activities	5 (1.7%)	1 (0.7%)	4 (2.8%)
71	Architectural and engineering activities; technical testing and analysis	6 (2%)	3 (2%)	3 (2.1%)
72	Scientific research and development	22 (7.5%)	16 (10.4%)	6 (4.3%)
74	Other professional, scientific and technical activities	3 (1%)	1 (0.7%)	2 (1.4%)
	Section M Total	***36 (12.2%)***	***21 (13.8%)***	***15 (10.6%)***
	Section N: Administrative and Support Service Activities			
78	Employment activities	2 (0.7%)	1 (0.7%)	1 (0.7%)
79	Travel agency, tour operator and other reservation service and related activities	2 (0.7%)	2 (1.3%)	0 (0%)
82	Office administrative, office support and other business support activities	22 (7.5%)	11 (7.2%)	11 (7.8%)
	Section N Total	***26 (8.8%)***	***14 (9.2%)***	***12 (8.5%)***
	Service Sector Total	**247 (84%)**	**130 (85%)**	**117 (83%)**
	Total	**294 (100%)**	**153 (100%)**	**141 (100%)**

Source: Survey data

Sectorial composition is compared to that of the Irish population in Table 4.2 using data provided by the Central Statistics Office (Business Demography, 2011) for active enterprises operating within the technology-based sectors covered in this study in 2011 in Ireland. Technology-based manufacturers represented 10.6% of businesses active in the technology sectors of interest in this study, with 89.4% operating in knowledge-intensive services. The sectorial composition of the sample for data analysis is similar, with 16% in manufacturing and 84% in knowledge-intensive service sectors. The sectoral composition is slightly broader within manufacturing sectors 26 and 27 and service sectors 58, 61 and 62.

Table 4.2. Representativeness of Sectorial Composition

Sector	Ireland (%)	All Firms (%)
Technology-Based Manufacturing:		
Chemicals and pharmaceuticals (20,21)	398 (1.3%)	8 (2.7%)
Computer, electronic, optical & electrical equipment (26,27)	562 (1.9%)	23 (7.8%)
Machinery and equipment (28)	560 (1.8%)	7 (2.4%)
Furniture and other manufacturing (31,32)	1644 (5.5%)	9 (3.1%)
Total	**3164 (10.6%)**	**47 (16%)**
Knowledge-intensive Services:		
Publishing activities (58)	1326 (4.5%)	65 (22.1%)
Picture, video and television programmes, sound recording and music publishing activities (59)	1450 (4.9%)	1 (0.3%)
Telecommunications (61)	586 (2%)	30 (10.2%)
Computer programming, consultancy & related activities (62)	6502 (21.9%)	86 (29.2%)
Activities auxiliary to financial services and insurance activities (66)	2674 (9%)	3 (1%)
Legal and accounting activities (69)	5218 (17.5%)	5 (1.7%)
Architectural & engineering activities; technical testing & analysis (71)	4574 (15.4%)	6 (2%)
Scientific research and development (72)	101 (0.3%)	22 (7.5%)
Other professional, scientific and technical activities (74)	2057 (6.9%)	3 (1%)
Employment activities (78)	866 (2.9%)	2 (0.7%)
Travel agency, tour operator and other reservation service and related activities (79)	162 (0.5%)	2 (0.7%)
Office administrative, office support and other business support activities (82)	1062 (3.6%)	22 (7.5%)
Total	**26578 (89.4%)**	**247 (84%)**
Total	**29742 (100%)**	**294 (100%)**

Source: Ireland - CSO, Business Demography, 2011; All Firms – Survey Data

Based on the NACE classification, Eurostat provides aggregations of the technological-intensity of these sectors (Eurostat, 2016b). The composition of firms according to technological-intensity is presented in Table 4.3. For the 294 firms surveyed (Column I), almost half (47.2%) are classified as '*High-tech knowledge-intensive services*', with over half (50.1%) of equity (Column II) and almost half (44%) of non-equity (Column III) financed respondents in this category. Turning to technology-based manufacturing, most (9.5%) operate in the '*High-technology*' category, with 13 (8.5%) and 15 (10.6%) equity and non-equity financed firms respectively. There is no significant relationship between equity financing and technological-intensity (Pearson's Chi-square=3.866, d.f=8, p-value=0.869).

Table 4.3. Technological-Intensity according to NACE Rev. 2 Classification

	I All Firms (%) (N = 294)	**II Equity Financed (%) (N = 153)**	**III Non-Equity Financed (%) (N = 141)**
Technology-based Manufacturing:			
High-technology	28 (9.5%)	13 (8.5%)	15 (10.6%)
Medium-technology	9 (3%)	5 (3.2%)	4 (2.8%)
Medium-Low technology	1 (0.3%)	1 (0.7%)	0
Low-technology	9 (3%)	4 (2.6%)	5 (3.5%)
Total	**47 (16%)**	**23 (15%)**	**24 (17%)**
Knowledge-intensive Services:			
Knowledge-intensive market services	17 (5.7%)	7 (4.6%)	10 (7.1%)
High-tech knowledge-intensive services	139 (47.2%)	77 (50.1%)	62 (44%)
Knowledge-intensive financial services	3 (1%)	2 (1.3%)	1 (0.7%)
Other knowledge-intensive services	63 (21.4%)	30 (19.6%)	33 (23.4%)
Less knowledge-intensive services	25 (8.5%)	14 (9.1%)	11 (7.8%)
Other less knowledge-intensive services	0	0	0
Total	**247 (84%)**	**130 (85%)**	**117 (83%)**
Total	**294 (100%)**	**153 (100%)**	**141 (100%)**

Source: Survey Data

Data pertaining to geographic scope, presented in Table 4.4, reveals clustering of respondents in Dublin, Cork and Galway. For the sample of 294 technology-based firms, almost half (48.3%) are in Dublin, followed by Cork (21.1%) and Galway (8.8%). This geographic scope is in line with data provided by the CSO (2011), also presented in Table 4.4, and consistent with reports of technology-based clusters in Ireland, concentrated largely in the Dublin area, with smaller agglomerations around Cork, Galway and Limerick/Shannon (see Green, 2000; Barry and Van Egeraat, 2008; and Leon *et al*., 2010).

Table 4.4. Geographic Profile

	Ireland (%)	**All Firms (%)**
Carlow	824 (1.1%)	2 (0.7%)
Cavan	715 (0.9%)	3 (1%)
Clare	2179 (2.7%)	10 (3.4%)
Cork	9750 (12.3%)	62 (21%)
Donegal	1868 (2.4%)	1 (0.3%)
Dublin	33788 (42.8%)	142 (48.3%)
Galway	4282 (5.4%)	26 (8.8%)
Kerry	2131 (2.7%)	6 (2%)
Kildare	3405 (4.3%)	4 (1.3%)
Kilkenny	1278 (1.6%)	2 (0.7%)
Leitrim	348 (0.4%)	1 (0.3%)
Limerick	3024 (3.8%)	13 (4.4%)
Louth	2241 (2.8%)	1 (0.3%)
Mayo	1428 (1.8%)	5 (1.7%)
Roscommon	795 (1%)	1 (0.3%)
Sligo	936 (1.2%)	3 (1%)
Tipperary	2104 (2.7%)	1 (0.3%)
Waterford	1718 (2.2%)	4 (1.3%)
Westmeath	1276 (1.6%)	2 (0.7%)
Wexford	1926 (2.4%)	4 (1.3%)
Wicklow	2960 (3.7%)	2 (0.7%)
Total	**78976 (100%)**	**294 (100%)**

Sources: Ireland - CSO, Business Demography, July 2013; All Firms – Survey Data

4.3 Age and Stage Profile

This Section presents an age[65] and stage profile of the firms in the database, with summary data provided in Table 4.5. Beginning with age, from Panel A we see that, for the sample cumulative, average age is approximately 8 years (mean=7.7; standard deviation=5.6), with a median and mode of 6 and 4 respectively. The maximum is 40 years (non-equity financed firm). Looking briefly at the profile for equity financed firms, data presented in Panel A reveals that average age is approximately 7 (mean=6.6; standard deviation=3.7) years. Moving to non-equity financed firms, the average age is approximately 9 years (mean=8.8; standard deviation=6.9). This is somewhat raised by the three oldest firms (30, 31 and 40 years) in this group. Non-equity financed firms are significantly older than equity-financed firms (T statistic = 3.446, d.f.=292, p-value=0.000).

Panel B delineates firms into stages, namely: seed (first year of operation); early-growth (years 2–5); expansion (years 6–9); and later (10 years and over). This classification is in line with the related literature (see Roberts, 1991; Mayer, 2002). Beginning with the data for all firms, of the 294 firms in the dataset, 12 (4.1%) were in their seed year at the time of data collection. With 109 (37.1%) firms, most respondents were classified as being in the early-growth stage. A total of 90 (30.6%) firms were classed within the expansion stage, while 83 (28.2%) were in the later stage. This is consistent with Hogan and Hutson (2006) who, based on a survey of Irish software firms, found the average age to be just under six years, with a median of just over four. Moving along, we see that 2 (1.3%) equity-financed respondents were in their seed year at the time of interview, while 65 (42.5%) were in the early-growth stage. A total of 53 (34.6%) firms were in the expansion stage, with 33 (21.6%) were in the later stage. As shown in Panel B, the non-equity financed group have a slightly older stage profile. With 50 (35.3%) respondents, we see that most were in the later stage at the time of

[65] Here, age refers to years elapsed from year of foundation to data collection (2011).

survey. A total of 10 (7.1%) firms were in their seed year, with 44 (31.2%) and 37 (26.2%) in early-growth and expansion respectively.

Table 4.5. Age and Lifecycle Stage Profile

Panel A:	**Age Profile (years)**		
	All Firms (N = 294)	**Equity Financed (N = 153)**	**Non-Equity Financed (N = 141)**
Mean	7.7	6.6	8.8
Median	6	6	7
Mode	4	4	5
Standard Deviation	5.6	3.70	6.9
Minimum	1	1	1
Maximum	40	18	40

Panel B:	**Lifecycle Stage Profile**		
	All Firms (%) (N = 294)	**Equity Financed (%) (N = 153)**	**Non-Equity Financed (%) (N = 141)**
Seed (1st year)	12 (4.1%)	2 (1.3%)	10 (7.1%)
Early (2–5years)	109 (37.1%)	65 (42.5%)	44 (31.2%)
Expansion (6–9years)	90 (30.6%)	53 (34.6%)	37 (26.2%)
Later (10 + years)	83 (28.2%)	33 (21.6%)	50 (35.5%)
Total	**294 (100%)**	**153 (100%)**	**141 (100%)**

Source: Survey Data

A Mann-Whitney U test showed that there was no a significant between the groups in terms of stage of development (U=9760, p-value<0.127).

4.4 Size Profile

Numerous measures can be adopted to approximate the scale of the firm (for example, assets, turnover, employment, output). In this study firm size is proxied by full-time equivalent (FTE) employee numbers and based on criterion defined by the European Commission (2003). Under this classification, small and medium-sized enterprises (SMEs) are defined as those which employ less than 250 persons (micro less than 10 persons employed; small between 10 and 49; and medium between 50 and 249) and large enterprises as those which employ over 250 persons (European Commission, 2005). Related data is presented in Table 4.6 below.

Table 4.6. Size Profile

	I All Firms (%) (N = 294)	II Equity Financed (%) (N = 153)	III Non-Equity Financed (%) (N = 141)
Micro (less than 10 employees)	153 (52%)	73 (47.7%)	80 (56.7%)
Small (10-49 employees)	109 (37.1%)	63 (41.2%)	46 (32.6%)
Medium (50-249 employees)	25 (8.5%)	12 (7.8%)	13 (9.2%)
Large (250 + employees)	7 (2.4%)	5 (3.3%)	2 (1.4%)
Total	**294 (100%)**	**153 (100%)**	**141 (100%)**

Source: Survey Data

Overall, the firms surveyed are mostly micro (52%) or small (37.1%) enterprises (Column I). Among equity financed (Column II), there is an almost equal split between micro and small (47.7% and 41.2% respectively). Firm size ranged from 1 (3.3%) to 512 (0.7%), with an average of 25 (mean=25.3; standard deviation=55.7) employees. The median and mode are 8.5 and 6 respectively. The proportion of micro enterprises is slightly higher among non-equity (Column III), with over half (56.7%) classified as micro. Almost a third (32.6%) were small-sized firms. These firms employ, on average, 22 (mean=21.6; standard deviation=41.9) FTEs. Overall, firms are predominantly micro-small enterprises, with a total of 136 (88.9%) equity and 126 (89.3%) non-equity financed firms employing between 1 and 49 FTEs. A Mann-Whitney U test showed that there was no significant difference (U=9760, p-value=0.163) between size category for the equity financed group compared to the non-equity financed. Moreover, an independent samples t-test confirms this, based on number of FTEs (T statistic = -1.084, d.f.=292, *p*= 0.279).

The concentration of micro-small firms is coherent with business demography statistics for Ireland. Data provided by the CSO (2011) shows that most enterprises in the Irish economy in 2011 were micro-enterprises (90.8%). In total, SMEs comprised 99.8% of all employer firms in Ireland in 2011, while large enterprises comprised 0.2% (CSO, 2011). Thus, the size profile for this study is unsurprising.

Moving on, Table 4.7 presents a profile of size class by stage. Briefly, for equity financed firms (Panel A), data indicates that the micro-enterprise category is dominated by younger firms (mostly early stage). Small enterprises are almost evenly split between early and expansion stages, while medium and large enterprises are predominantly in the expansion and later stages. Turning to non-equity financed (Panel B), most micro-enterprises are in the early stage, although this is closely followed by those in the later stage. Small enterprises are almost evenly split between expansion and later stages. There is an equal split between the expansion and later stages for medium-sized firms while both large firms are in the later stage.

A significant positive relationship is found between the size of the equity financed firm and its stage in the lifecycle (Kendalls Tau_b=0.344, p-value=0.000), along with size of the non-equity financed firm and stage (Kendalls Tau_b=0.183, p-value=0.005). Thus, it seems that these firms grow in size (measured here by employee numbers) as they progress through their lifecycle.

Table 4.7. Size Profile by Stage

Panel A:	**Equity Financed (N = 153)**				
			Business Size		
	Micro	Small	Medium	Large	**Total**
Business Stage					
Seed (First year)	2 (1.3%)	0	0	0	**2 (1.3%)**
Early (2-5 years)	42 (27.4%)	22 (14.4%)	1 (0.7%)	0	**65 (42.5%)**
Expansion (6-9 years)	21 (13.7%)	25 (16.3%)	5 (3.3%)	2 (1.4%)	**53 (34.6%)**
Later (10+ years)	8 (5.2%)	16 (10.5%)	6 (3.9%)	3 (2%)	**33 (21.6%)**
Total	**73 (47.7%)**	**63 (41.2%)**	**12 (7.8%)**	**5 (3.3%)**	**153 (100%)**

Panel B:	**Non-Equity Financed (N = 141)**				
			Business Size		
	Micro	Small	Medium	Large	**Total**
Business Stage					
Seed (First year)	9 (6.4%)	1 (0.7%)	0	0	**10 (7.1%)**
Early (2-5 years)	29 (20.6%)	12 (8.5%)	3 (2.1%)	0	**41 (29.1%)**
Expansion (6-9 years)	16 (11.3%)	16 (11.3%)	5 (3.5%)	0	**36 (25.5%)**
Later (10+ years)	26 (18.4%)	17 (12.1%)	5 (3.5%)	2 (1.4%)	**54 (38.3%)**
Total	**80 (56.7%)**	**46 (32.6%)**	**13 (9.2%)**	**2 (1.4%)**	**141 (100%)**

Source: Survey Data

The relationship between age and size is well established in the literature. Greiner (1972) outlines a stage model of organisation change in developing firms in which size is linearly related to age. Based on their study of Spanish manufacturing firms, Coad *et al*. (2013) find that aging firms experience an increase in size. Others demonstrate that the probability of survival increases with firm age and size (see Jovanovic, 1982; Frank, 1988).

4.5 Financing of Technology-Based Firms

This Section provides an in-depth depiction of the financing of technology-based firms across their lifecycle. A summary of useable responses by stage is provided in Table 4.8.[66] All 294 technology-based firms provided data for their seed year (Column I). Moving into the early-growth stage, this reduces to 282 (95.9%); 173 (58.8%) provided data for the expansion stage; and 83 (28.2%) for the later stage. This is in line with the age profile detailed above (Section 4.3). Corresponding proportions for equity (Column II) and non-equity (Column III) are provided.

Table 4.8. Observations across Stages

	I All Firms (%) (N = 294)	II Equity Financed (%) (N = 153)	III Non-Equity Financed (%) (N = 151)
	Number of Observations per Stage (%)		
Seed (First year)	294 (100%)	153 (100%)	141 (100%)
Early (2-5 years)	282 (95.9%)	151 (98.7%)	131 (92.9%)
Expansion (6-9 years)	173 (58.8%)	86 (56.2%)	87 (61.7%)
Later (10+ years)	83 (28.2%)	33 (21.6%)	50 (35.5%)

Source: Survey Data

Financing data is categorised by three sources of internal (personal investment, f-connections, retained profits, director's loan) and fourteen sources of external financing, including family/friends investment, debt (business overdraft, loan, mortgage), equity (private and corporate venture capital, business angel, government-sponsored equity financing), government financial support (grants) and others (trade credit, invoice discounting, leasing).

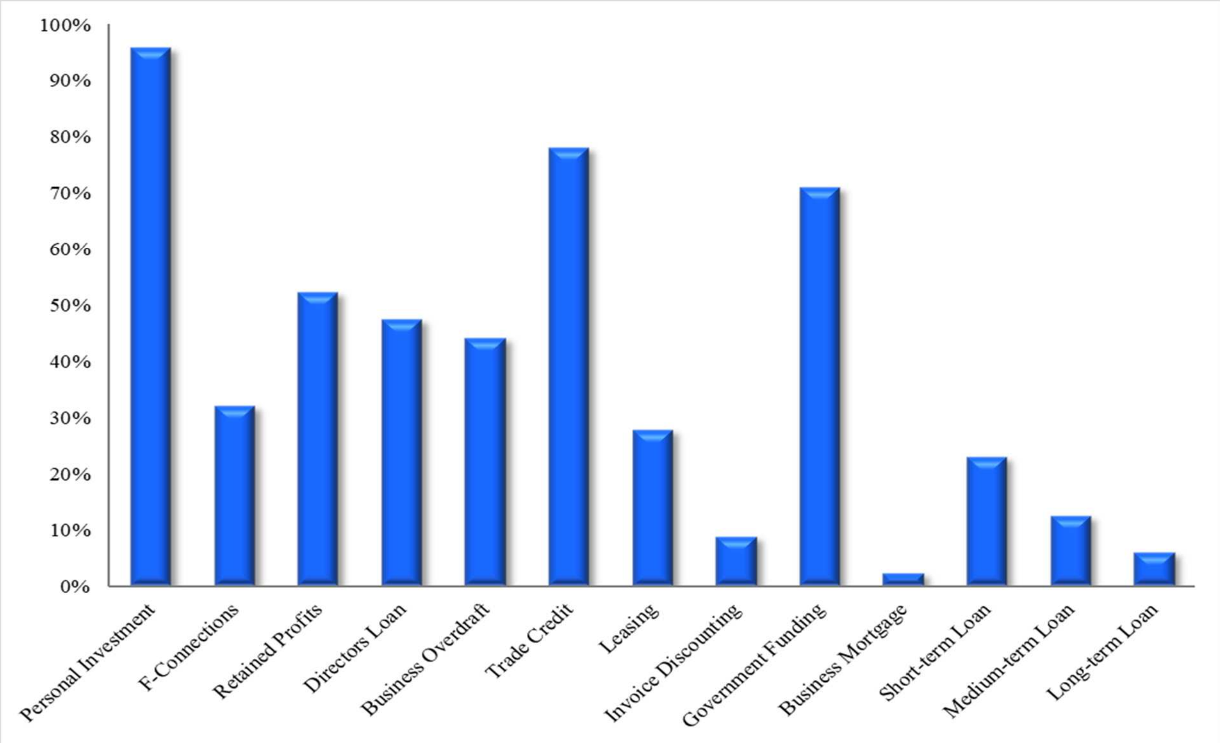
[66] To recap, respondents were asked to provide details of all new sources of financing used retrospectively over their lifecycle up to and including their stage at the time of data collection (see Chapter 3, Section 3.2, Subsection 3.2.2 for further details regarding question format and design). As such, all respondents excluding those in the seed stage at time of survey provided data for multiple stages.

Respondents were requested to provide details of all new financing obtained within each applicable stage.

Beginning with a general overview of the sources of funding used by technology-based firms, we see from Figure 4.1 that personal financing is the most common, used by 96% of firms over their lifecycle.[67] This is consistent with extant evidence for technology-based firms. Colombo and Grilli (2007), in their analysis of the sources of start-up capital used by Italian technology-based firms, found that 84% rely on personal savings of founders. In terms of external funding, trade credit is the most common source (utilised by 78.2%), in line with evidence presented by Lawless *et al*. (2014). In their analysis of the capital structure of SMEs across sixteen European countries, the authors report that trade credit is an extremely prevalent financial resource for Irish SMEs, although their sample is not limited to technology-based sectors. Sjögren and Zackrisson (2005), based on a comparison of the financing patterns of high-technology firms in Sweden and California, report that trade credit is a common source of funding. Following closely, grant funding is a common source of financial support, with almost three-quarters (71.1%) of technology-based firms obtaining a grant at some stage in their lifecycle. This is consistent with evidence provided in studies by Hogan and Hutson (2005b) and Mac an Bhaird and Lynn (2015). The former examines the capital structure of a sample of 117 Irish software firms and concludes that government grants are an important source of funding. The latter focuses on 18 firms operating in the Irish Centre for Cloud Computing, finding all but two accessed grant funding (mostly from Enterprise Ireland). In Ireland, grant funding is mainly sourced through Enterprise Ireland, Local Enterprise Offices and County Enterprise Boards.

[67] This general overview is based on all 294 firms (i.e. equity and non-equity financed) and thus excludes use of equity financing (as similar data is not available for non-equity financed firms).

Figure 4-1. Sources of Financing Employed by Technology-Based Firms



Source: Survey Data

Overdrafts are the most common form of debt, obtained by almost two-thirds (59.5%) of these firms. Finally, data shows that almost half (44.2%) reinvest earnings over their lifecycle. This is consistent with Mac an Bhaird and Lucey (2010). Using data gathered from 299 Irish SMEs, across all sectors, the authors report that retained earnings are an important source of finance. Hummel *et al*. (2013) report similar findings for innovative SMEs in Germany.

Next, a more detailed overview of the financing of these firms is provided in Table 4.9, which delineates sources of internal and external financing used according to stage of the lifecycle in which each source was obtained.[68] Beginning with the seed stage, data reveals that self-financing is the most common source of funds. Among equity financed firms, all but ten (6.5%) depended on the personal funds of founders during their initial year. On average, this

[68] As firms are separated into equity and non-equity financed groupings, this overview includes use of sources of equity according to stage in which they were obtained for equity financed firms.

accounted for approximately 66% (mean=66.3%; standard deviation=33.4%) of seed stage financing. Personal funds were used by 125 (88.7%) non-equity financed firms, accounting for, on average, 67% (mean=66.7%; standard deviation=35.1%) of seed stage financing. There is not a significant difference in the proportion of seed stage funding personally invested by equity and non-equity financed founders (*t (292)* = -0.041, p-value=0.967).

In addition to personal funds, a quarter of equity financed firms also received financial support from f-connections (i.e. family and friends). Use is slightly lower among non-equity financed firms (16.3%). There is evidence of a significant relationship between equity financing and f-connection funding during the seed stage (Pearson's Chi-square=2.799, d.f.=1, p-value=0.095), although the strength of the association between the two sources is weak (*Cramer's V* = 0.098).

Government financial support is also prevalent, with almost half (49%) of equity and just over a third (36.9%) of non-equity financed firms accessing grants. The most frequently sourced, all provided by Enterprise Ireland, are the Commercialisation of Research and Development (CORD) grant, High Potential Start-up (HPSU) feasibility study grants and innovation vouchers.[69] Overall, this data is consistent with Bozkaya and Van Pottelsberghe de la Potterie (2008) who find, for Belgian technology-based firms, that government-sponsored funds are the secondary source of seed stage finance, after personal funds.

Trade credit is used by over a third (38%) of equity and a third (33.3%) of non-equity financed firms during the initial year. Previous studies highlight the importance of trade credit, especially for young firms (see Berger and Udell, 1998; Robb, 2002). While often more expensive than bank credit, it is generally more accessible as information asymmetries tend to

[69] The CORD grant provides a maximum of €30,000 over 12 months; HPSU feasibility study grant offers funding for 50% of the expenditures on eligible projects, up to a maximum level of €15,000; Innovation voucher provides €5,000 which can be exchanged with a knowledge provider.

be less severe in trade credit relationships where the supplier providing credit has experience of the firm's sector and production process (Lawless *et al*., 2014).

In terms of debt, overdrafts are the most common form during the seed stage, although it should be noted that these are mostly secured using personal guarantees given by the founder(s). Nonetheless, this is consistent with extant evidence. In their study of Italian technology-based firms, Giudici and Paleari (2000) found that the most frequently employed source of capital at developmental stages, aside from self-financing, is a bank overdraft. North *et al*. (2013) use a survey of UK technology-based firms and report that, during the financial crisis between 2007 and 2010, over a third (36%) applied for an overdraft, with the majority (81%) being successful in obtaining the required overdraft facility. Based on survey data from the European Central Bank's Survey of Access to Finance in Europe, Lawless *et al*. (2014) report that Irish SMEs have the highest rate of use of overdrafts compared to firms in other European countries, although this study does not single out technology-based firms.

For equity financed firms, business angels are the predominant source of equity, with 44 (28.8%) firms obtaining angel investment during their initial year. This is consistent with research highlighting the importance of angels for nascent and start-up firms (see Megginson, 2004; Smith and Smith, 2004). Studies in the US by Freear *et al*. (1997) and Sohl (2003) show that angels have traditionally been the largest source of start-up and seed capital. Of the firms using angel financing, 14 (31.8%) obtained matched equity funding from Enterprise Ireland and 11 (25%) raised additional funding from venture capitalists within the seed stage. A total of 18 (11.8%) firms obtained venture capital, while 24 (15.7%) received government-sponsored equity funding.

Moving into the early-growth stage, financing patterns begin to diverge. Looking at equity financed firms, data shows that the most common sources of financing are government-sponsored equity and angel funding, used by 57.6% and 59.6% of firms respectively. Just over half (55%) obtained venture capital. Overall, for the 151 firms at this stage, the clear majority (90.7%) obtained some form of equity financing during their early-growth years.

Conversely, for non-equity financed firms, retained profits are the most common source of funding during the early-growth stage, with almost half (46.6%) re-investing earnings for capital requirements during this time-frame. In comparison, just over a fifth (21.2%) of equity financed firms utilised retained earnings. There is a significant relationship between equity financing at this stage and retained profits (Pearson's Chi-square=3.862, d.f.=1, p-value=0.049), although the strength of the association is rather weak (*Cramer's V*= 0.12).

With over half of equity and non-equity financed firm founders committing personal capital (58.3% and 54.2% respectively), self-financing remains common during early-growth years.[70] Equity financed firms were just as likely to use personal funding as their non-equity financed counterparts (Pearson's Chi-square=2.545, d.f.=1, p-value=0.141). F-connection funding is again more common among equity financed firms, with over a quarter (26.5%) obtaining funds from family/friends during their early-growth years, in comparison to a tenth of non-equity financed firms. F-connection funding at this stage is positively related to equity financing (Pearson's Chi-square=11.315, d.f.=1, p-value=0.001), with the two sources moderately associated (*Cramer's V* = 0.20).

Trade credit remains a popular financing tool, although a higher proportion of equity financed firms use this source (42.4% in comparison to 27.7% of non-equity). There is also increasing use of invoice discounting and leasing. Government financial support plays an important role in the early-growth stage. Just over a third (36.4%) of equity and just over a quarter (26.7%) of non-equity financed respondents depended on grant funding, again mostly

[70] Of these, 84 (95.5%) founders from equity and 63 (88.7%) founders from non-equity financed firms had also invested personal funds at the seed stage.

from Enterprise Ireland. Regarding debt, overdraft remains the most common source for equity and non-equity financed firms (23.2% and 24.4% respectively).

Progressing into the expansion stage, retained profits become the predominant source of finance. Just over a third (34.9%) of equity financed firms used retained profits as a source of capital, while almost two-thirds (65.5%) of non-equity financed firms re-invested earnings. Overall, this data is consistent with empirical evidence pointing to an increasing role of retained profits, which replace external financing as the firm grows and becomes profitable (see Cole, 2013; Bozkaya and Van Pottelsberghe De La Potterie, 2008). Again, evidence exists of a significant relationship between equity financing and retained earnings (Pearson's Chi-square=16.551, d.f.=1, p-value=0.000), and the strength of the association is moderate (*Cramer's V* = 0.31).

For equity financed firms, venture capital is the most common source of equity at this stage. All equity funding was raised through co-investment, either formal deals between investors or through independent investment into the firm during these years.[71]

Lastly, for firms at the later stage, data shows that retained profits are the most common source of finance. Again, use is higher among non-equity financed firms, with 88% re-investing earnings as capital during the later years. Observed increasing reliance on internally generated funding is consistent with the pecking order hypothesis (see Myers, 1984; Myers and Majluf, 1984).

[71] All government-sponsored equity financing was in the form of matched funds (6 (37.5%) received co-investment from angels while 10 (62.5%) obtained venture capital).

Table 4.9. Sources of Financing by Lifecycle Stage

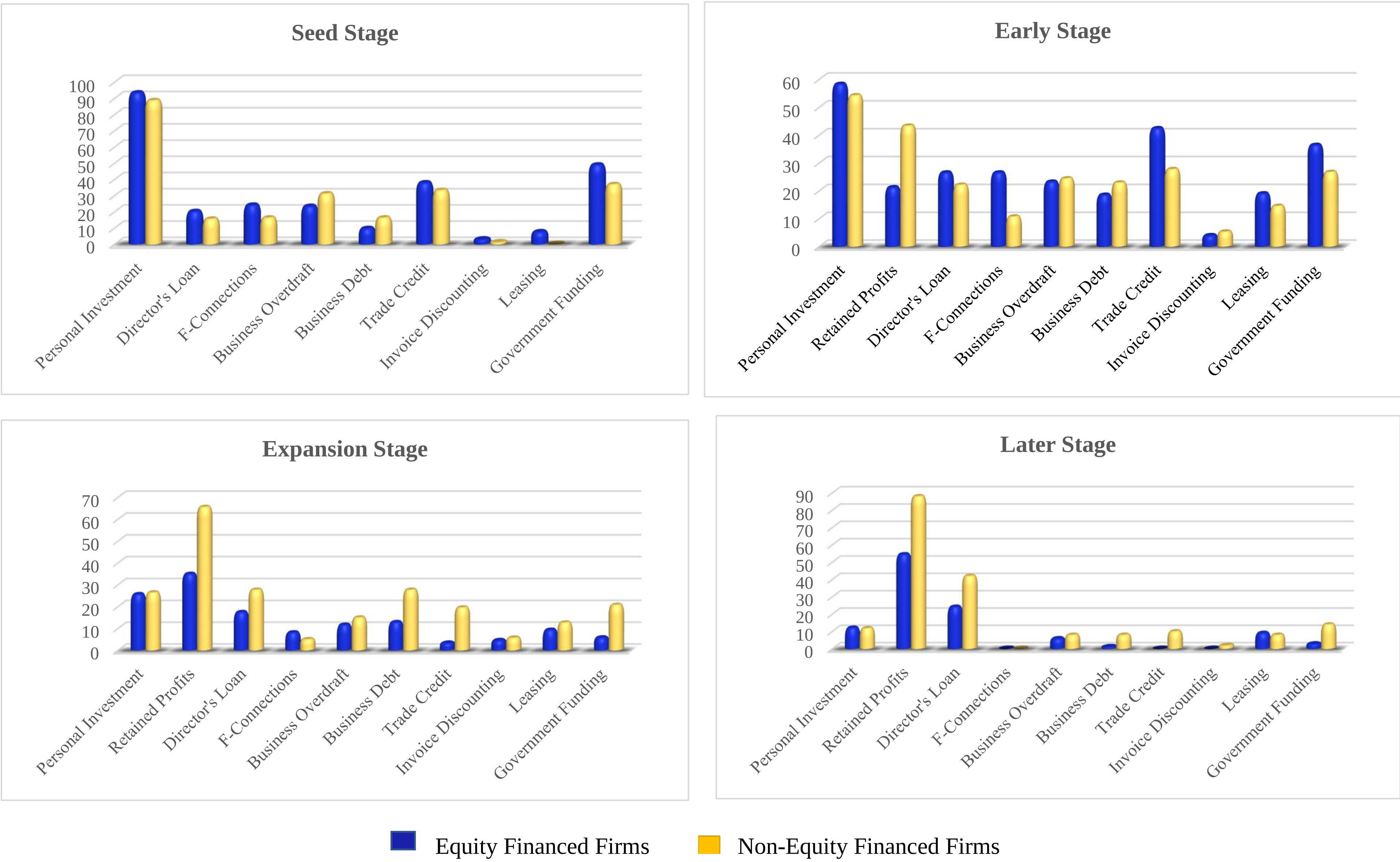
	Seed		Early		Expansion		Later	
	Equity (N=153)	**Non-Equity (N=141)**	**Equity (N=151)**	**Non-Equity (N=131)**	**Equity (N=86)**	**Non-Equity (N=87)**	**Equity (N=33)**	**Non-Equity (N=50)**
Internal Sources of Finance:								
Personal Investment	143 (93.5%)	125 (88.7%)	88 (58.3%)	71 (54.2%)	22 (25.6%)	23 (26.4%)	4 (12.1%)	6 (11.8%)
Retained Profits	0 (0%)	0	32 (21.2%)	61 (43.3%)	30 (34.9%)	59 (65.5%)	18 (54.5%)	44 (88%)
Directors Loan	31 (20.3%)	22 (15.6%)	40 (26.5%)	29 (22.1%)	15 (17.4%)	24 (27.6%)	8 (24.2%)	21 (42%)
External Sources of Finance:								
Debt Financing:								
Business Overdraft	36 (23.5%)	44 (31.2%)	35 (23.2%)	32 (24.4%)	10 (11.6%)	13 (14.9%)	2 (6%)	4 (8%)
Business Mortgage	1 (0.7%)	1 (0.7%)	0	0	0	4 (4.6%)	0	1 (2%)
Short-term Loan	9 (5.9%)	15 (10.6%)	18 (11.9%)	17 (13%)	2 (2.3%)	10 (11.5%)	1 (3%)	1 (2%)
Medium-term Loan	3 (2%)	6 (4.3%)	6 (4%)	8 (6.1%)	5 (5.8%)	9 (10.3%)	0	1 (2%)
Long-term Loan	2 (1.3%)	1 (0.7%)	4 (2.6%)	5 (3.8%)	4 (4.6%)	1 (1.2%)	0	1 (2%)
Equity Financing:								
Business Angel	44 (28.8%)	-	90 (59.6%)	-	16 (18.6%)	-	0	-
Venture Capital	18 (11.8%)	-	83 (55%)	-	35 (40.7%)	-	2 (6%)	-
Government-sponsored Equity	24 (15.7%)	-	87 (57.6%)	-	18 (20.9%)	-	0	-
Other Sources:								
F-Connections	49 (32%)	23 (16.3%)	40 (26.5%)	14 (10.7%)	7 (8.1%)	4 (5%)	0	0
Trade Credit	58 (38%)	47 (33.3%)	64 (42.4%)	39 (27.7%)	3 (3.4%)	17 (19.5%)	0	5 (10%)
Invoice Discounting	5 (3.3%)	2 (1.4%)	6 (4%)	7 (5.3%)	4 (4.6%)	5 (5.7%)	0	1 (2%)
Leasing	12 (7.8%)	0	29 (19%)	19 (14.5%)	8 (9.3%)	11 (12.6%)	3 (9.1%)	4 (8%)
Government Funding	75 (49%)	52 (36.9%)	55 (36.4%)	35 (26.7%)	5 (5.8%)	18 (20.7%)	1 (3%)	7 (14%)

Source: Survey Data

Finally, data presented in Figure 4.2 compares use of different types of financing across the four stages. To summarise, the two main differences observed in financing patterns are as follows: First, use of retained profits is more common among non-equity financed firms from the early-growth stage onwards. Overall, just over a quarter (26.5%) use retained earnings as a source for finance, compared to almost a fifth (17.7%) of their equity financed counterparts. There is evidence that use of retained earnings as a source of funding is dependent on whether the firm has obtained equity finance (Pearson's Chi-square=13.538, d.f.=1, p-value=0.000), and the association is moderate (Cramer's V = 0.2). Second, f-connection funding is more prevalent among equity financed firms, particularly during seed and early-growth stages. While almost a fifth (19.4%) of equity financed firms obtain financial support from f-connections at some point in their lifecycle, just over an eight (13%) of non-equity financed firms use f-connection funds. There is a significant relationship between equity financing and f-connection funding (Pearson's Chi-square=3.562, d.f.=1, p-value=0.056), although the two are rather weakly associated (*Cramer's V*=0.1).

Overall, the data shows that these firms actively manage and change their financing mixes as they progress through developmental stages, in line with the propositions of the financial lifecycle (see Roberts, 1991; Berger and Udell, 1998). Specifically, while personal funding is prevalent during nascent years, retained profits become a key source of funds moving into expansion and later stages, particularly for those without external equity financing.

Figure 4-2. Financing Patterns across Lifecycle Stages



4.6 Profile of Equity and Non-Equity Financed Technology-Based Firms

Entrepreneurial financing situations are characterised by large information asymmetries between entrepreneurs and investors (Denis, 2004). As discussed in Chapter 2 (Subsection 2.2.2), two mechanisms commonly used in attempting to mitigate these information asymmetry problems are signalling (transmission of privately held information by the entrepreneur) and screening (seeking of additional information by the external investor) (see Stiglitz, 2000; Janney and Folta, 2003). As such, characteristics specific to the firm and the entrepreneur may be used by entrepreneurs to communicate the inherent quality of the venture (i.e. signalling) or be assessed by equity investors in deciding whether to invest (i.e. screening) and can thus have an important impact on likelihood of obtaining equity finance (see Kaplan and Strömberg, 2000; Eddleston *et al*., 2016). The purpose of this Section is to introduce and consider attributes of technology-based. These factors are key to hypotheses development and empirical analysis going forward (Chapters 5, 6 and 7).

4.6.1 Organisational Form

The technology-based firms in the database are predominately privately held. Specifically, all 141 non-equity and 148 (96.7%) equity financed firms are private limited companies. For the cumulative sample, 5 (1.7%) firms are publicly traded, all of which had obtained equity funding from private investors prior to IPO. There is evidence that being a publicly traded company is dependent on having obtained equity financing (Pearson's Chi-square=4.688, d.f.=1, p-value<0.05), although the association is weak (*Cramer's V* = 0.1). This is unsurprising given that research consistently highlights that companies obtaining private equity are more likely to go public (see Sørensen, 2007; Nahata, 2008; Ragozzino and Blevins, 2016). At the time of writing no other firm in the sample had completed an IPO.

Although only a handful, the fact that the database contains both private and public firms is a unique feature, extending demand-side work which focuses on private (see Hsu, 2007; Patzelt, 2010) or public firms individually (see Audretsch and Lehmann, 2004; Castro *et al*., 2015). Thus, it is worth exploring the characteristics of these firms. The IPOs took place in 2000, 2006, 2007, and 2012. Table 4.10 presents data. Two are small-firms, two medium-sized and one large. There is evidence of a significant relationship between being a public company and size class (Pearson's Chi-square=24.783, d.f.=3, p-value=0.000), and the strength of the association is moderate (C*ramer's V* = 0.4). Two respondents were in the expansion stage, the remaining three in later, although there is no significant association (Pearson's Chi-square=5.846, d.f.=3, p-value>0.1). Four firms are in Dublin, one in Galway – in Dublin they are evenly split in knowledge-intensive and high-tech knowledge-intensive services; the latter is a medium-low technology manufacturing firm and there is no significant relationship with technological-intensity (Pearson's Chi-square=0.774, d.f.=4, p-value>0.1).

Table 4.10. Organisational Form – Profile of Equity Financed Private and Public Firms

	Private Company (%)	**Public Company (%)**	**Total (%)**
Size:			
Micro	73 (50%)	0	73 (47.7%)
Small	61 (40.9%)	2 (40%)	63 (41.2%)
Medium	11 (7.4%)	1 (20%)	12 (7.8%)
Large	3 (2%)	2 (40%)	5 (3.3%)
Total	**149 (100%)**	**5 (100%)**	**153 (100%)**
Test Statistic	Pearson's Chi-square=24.783, d.f.=3, p-value=0.000		
Stage:			
Seed (1 year)	2 (1.3%)	0	2 (1.3%)
Early (2 – 5 years)	65 (43.6%)	0	65 (42.5%)
Expansion (6 – 9 years)	51 (34.3%)	2 (40%)	53 (34.6%)
Later (10+ years)	30 (20.1%)	3 (60%)	33 (21.2%)
Total	**149 (100%)**	**5 (100%)**	**153 (100%)**
Test Statistic	Pearson's Chi-square=5.846, d.f.=3, p-value>0.1		

Source: Survey Data

4.6.2 Human Capital

Human capital describes the attributes and skills of the people within an organisation (Becker, 1975) and is categorised as being general or specific in nature. Briefly, general human capital, characterised as being generic and transferable, can be applied across firms and industries while specific can typically only be applied within the context of the firm/domain (see Dimov and Shepherd, 2005; Ucbasaran *et al*., 2008). This subsection profiles the human capital attributes of technology-based firms by focusing on the attributes of those leading the firm and on human capital embodied in the workforce.

Beginning with the person responding to the survey, all data was obtained from Chief Executive Officers (CEOs). Respondent role was further categorised as founder and non-founder. The term founder-CEO is used to describe a situation where a founder takes on the role of CEO (Bamford *et al*., 2006). Looking at Table 4.11, we see that, overall (Column I), the clear majority (89.5%) of firms are led by founder-CEOs[72], particularly equity financed (Column II). Moreover, the 3 (2%) respondents classed as non-founders have headed the firm since inception although they were not part of the founding team. Within non-equity financed firms (Column III), there is a slightly higher proportion of non-founder-CEOs (20%). Evidence exists of a significant relationship between equity financing and role (Pearson's Chi-square= 39.576, d.f=1; p-value=0.000), and the association is moderate (*Cramer's V* = 0.4).

Most (93.5%) of these founder-CEOs are men (Column I), consistent with evidence that reports that founders of technology-based firms are almost exclusively male (see Westhead and Storey, 1994; Harvey, 1994) and that women are encountered less in these sectors (see Mayer, 2006; Martin *et al*., 2015). There is not a significant relationship between gender and equity financing (Pearson's Chi-square=0.803, d.f=1, p-value=0.370). These individuals are

[72] Given this high representation, '*founder-CEO*' is used throughout this study to refer to the individual responding to the survey (i.e. the CEO).

primarily Irish (99%). Extant evidence suggest that domestic national origin can be advantageous for both firm survival and performance of the firm (see Cooper *et al*., 1994; Dahlqvist *et al*., 2000). There is not a significant relationship with equity financing (Pearson's Chi-square=2.931; d.f = 2; p-value=0.231). These results, however, must be interpreted with caution given the high proportion of male and Irish respondents.

The average age of founder-CEOs at the time of data collection was approximately 46 (mean=45.9, standard deviation=8.1) with a median and mode of 46 and 47 respectively. Overall, almost half (44.9%) were between the ages of 40 and 49 (Column I). In equity financed firms (Column II), most (46.4%) respondents were in the 40–49 category, with an average age of 46 (mean=46.11; standard deviation=7.92). Similarly, respondents in non-equity financed firms (Column III) are mostly (43.3%) in the same category (mean=46.07; standard deviation=8.12). This profile is in line with existing evidence from the technology-based sector. Westhead and Storey (1994) found that entrepreneurs in the UK mostly established their technology-based firm between 30 and 50 years of age. Based on a survey of US-born technology entrepreneurs, Wadhwa *et al*. (2010) report an average age of 39 when founding the company.

Table 4.11. Demographic Profile of Founder-CEOs

	I All Firms (%) (N = 294)	II Equity Financed (%) (N = 153)	III Non-Equity Financed (%) (N = 141)
Role:			
Founder & CEO	263 (89.5%)	150 (98%)	113 (80%)
CEO	31 (10.5%)	3 (2%)	28 (20%)
Total	**294 (100%)**	**153 (100%)**	**141 (100%)**
Test Statistic	*Pearson's Chi-square=39.576, d.f.=1, p-value=0.00*		
Gender:			
Male	275 (93.5%)	145 (94.8%)	130 (92.2%)
Female	19 (6.5%)	8 (5.2%)	11 (7.8%)
Total	**294 (100%)**	**153 (100%)**	**141 (100%)**
Test Statistic	*Pearson's Chi-square=0.803, d.f.=1, p-value=0.370*		
Nationality:			
Irish	291 (99%)	151 (98.7%)	140 (99.3%)
European	1 (0.3%)	0	1 (0.7%)
American	2 (0.7%)	2 (1.3%)	0
Total	**294 (100%)**	**153 (100%)**	**141 (100%)**
Test Statistic	*Pearson's Chi-square=2.931, d.f.=2, p-value=0.231*		
Age:			
< 30	5 (1.7%)	3 (2%)	2 (1.4%)
30 – 39	58 (19.7%)	28 (18.3%)	30 (21.3%)
40 – 49	132 (44.9%)	71 (46.4%)	61 (43.3%)
50+	99 (33.7%)	51 (33.3%)	48 (34%)
Total	**294 (100%)**	**153 (100%)**	**141 (100%)**
Test Statistic	*T statistic*[1] *= 0.436, d.f. = 292, p-value = 0.663*		

Source: Survey Data

Note: [1] The t-test is based on the actual age of the founder-CEO, the categories included in the table are simply used to illustrate the distribution

Attention now turns to human capital, detailed in Table 4.12. General human capital is measured through educational attainment and specific by experience (see Gimeno *et al*., 1997; Behrens *et al*., 2012; Teixeira and Tavares-Lehmann, 2014). Research shows that human capital in terms of education and experience are key factors in obtaining equity financing (see Gimmon and Levie, 2010; Patzelt, 2010; Ko and McKelvie, 2018).[73]

Educational attainment is classified using the National Framework of Qualifications, a ten-level system which gives an academic or vocational value to qualifications. Based on this framework, founder-CEO education is grouped into three categories: up to level 8 (up to Higher diploma or Bachelor degree); 9 (Masters degree or post-graduate diploma); and 10 (Doctoral degree). Overall (Column I), over half (54.8%) of these founder-CEOs are educated to level 8, over a third (37.8%) to level 9 and almost a tenth (7.4%) hold a doctorate. This profile is in line with extant data. Westhead and Storey (1994), for UK-based technology entrepreneurs, found that 85% held a graduate degree. For US-born entrepreneurs, Wadhwa *et al*. (2010) find that 31% had a Masters with 10% having a Ph.D. Education is slightly higher among founder-CEOs within equity financed technology-based firms (Column II). In non-equity financed firms (Column III), 7 (5%) respondents hold a second level qualification (Leaving Certificate).[74] There is a significant relationship between equity financing and founder-CEO education (Pearson's Chi-square=21.553; d.f.=1; p-value=0.000), and the association is moderate (C*ramer's V*=0.3). This is consistent with research highlighting the role of educational attainment as an informative signal in facilitating the firm's ability to raise external equity funding (see Engel and Keilbach, 2007; Colombo and Grilli, 2010).

[73] According to the resource-based theory, such resources allow individuals to accumulate a stock of skills, knowledge and capabilities that, when embedded in an organisation, can constitute valuable, non-imitable, rare and non-substitutable resources which are an important source of competitive advantage (Barney, 1991). Furthermore, expertise and education are key operational efficiencies that allow founder-CEOs to build competency and incorporate knowledge from diverse domains which can influence the firm's strategic actions (Galloway *et al*., 2017).

[74] Although formally classified as level 5, given the minute proportion in this category (2.4% overall) these are collapsed into one group for the purposes of analysis (up to Level 8).

Table 4.12. Education and Experience of Founder-CEOs

	I All Firms (%) (N = 294)	II Equity Financed (%) (N = 153)	III Non-Equity Financed (%) (N = 151)
Education:			
Up to Level 8	161 (54.8%)	64 (41.8%)	97 (68.8%)
Level 9	111 (37.8%)	74 (48.4%)	37 (26.2%)
Level 10	22 (7.4%)	15 (9.8%)	7 (5%)
Total	**294 (100%)**	**153 (100%)**	**141 (100%)**
Test Statistic	*Pearson's Chi-Square=21.553, d.f.=1, p-value-0.000*		
Industry-Specific Experience:			
1 – 9 years	28 (9.5%)	11 (7.2%)	17 (12%)
10 – 14 years	52 (17.7%)	26 (17%)	26 (18.4%)
15 – 19 years	62 (21.1%)	37 (24.2%)	25 (17.7%)
20+ years	152 (51.7%)	79 (51.6%)	73 (51.8%)
Total	**294 (100%)**	**153 (100%)**	**141 (100%)**
Test Statistic	*T statistic[1] = 0.349, d.f. = 292, p = 0.727*		
International Experience:			
0	84 (28.6%)	30 (19.6%)	54 (38.3%)
1 – 9 years	148 (50.3%)	90 (58.8%)	58 (41.1%)
10 – 14 years	55 (18.7%)	29 (19%)	26 (18.4%)
15+ years	7 (2.4%)	4 (2.6%)	3 (2.1%)
Total	**294 (100%)**	**153 (100%)**	**141 (100%)**
Test Statistic	*T statistic[2] = 2.187, d.f. = 292, p = 0.030*		

Source: Survey Data

Note: [1, 2] These t-tests are based on actual years industry-specific and international experience respectively, with the categories included in the table simply used to illustrate the distribution

Turning to specific human capital (Becker, 1975), two measures used in the literature are industry-specific and international work experience (see Kriechel and Pfann, 2005; Patzelt, 2010; Soriano and Castrogiovanni, 2012). For this study, industry-specific experience is proxied as years spent working in the same sector/industry as the current firm. On average, the founder-CEOs of technology-based firms had accumulated 18 (mean=18.5; standard deviation=7.6) years of industry-specific experience. Most (51.6%) have 20+ years' experience (Column I). This is similar for equity (Column II) and non-equity (Column III) financed firms. The average is approximately 18 years for each group (mean=18.7; standard deviation=7 for equity; mean=18.4; standard deviation=8.2 for non-equity). An independent samples t-test does not show evidence of a statistically significant association between industry-specific experience and equity financing (T statistic = 0.349, p-value= 0.727).

International experience is measured as experience gained through employment abroad (see Sambharya, 1996; Patzelt, 2010) prior to their role in the current firm. On average, these founder-CEOs spent 5 (mean=5.04; standard deviation=4.36) years working abroad – equity financed founder-CEOs have, on average, 6 years (mean=5.7; standard deviation=4.1) while non-equity have approximately 4 (mean=4.5; standard deviation=4.6). An independent samples t-test (T statistic=2.187, p-value=0.03 < 0.05) shows that the founder-CEOs of equity financed firms had statistically significantly greater international experience than those within non-equity financed firms. This is consistent with evidence provided by Patzelt (2010) who, to the best of the author's knowledge, is the only study to examine the impact of international experience on equity financing.

Interviews with equity financed firms allowed for the collection of supplementary data. First, respondents were asked about prior start-up experience, which can be an important signal for external investors (see Hsu, 2007; Gimmon and Levie, 2010). Over half (55.6%) of those interviewed had founding experience. Second, data pertaining to executive experience was gathered from the FAME database.[75] Almost two-thirds (64.7%) have experience as director of another organisation. Finally, respondents were asked, when providing details of educational attainment, if they had also completed an MBA – almost a quarter (22.2%) had.

The final measure of human capital is organisational human capital, proxied here as the percentage of employees who possess a third-level degree or equivalent. According to

[75] Due to the anonymous nature of non-equity financed firms it was not possible to identify all respondents and thus made this type of additional data collection impossible.

Hofheinz (2009) educational attainment is an effective means of assessing levels of skills in a workforce and the education of the workforce is a common measure of unit (firm) or aggregate human capital (see Becker, 1996; Fackler *et al.*, 2016). From Table 4.13 (Column I), we can see that levels are quite high, with all employees in almost half (49%) of these firms holding a third level or equivalent qualification. The profile is similar between the groups, although the proportion is slightly higher for equity financed (Column II) than non-equity (Column III). The average is 85% (mean=85.5%, standard deviation=20.8%), with a median and mode of 95% and 100% respectively – for equity the average is approximately 91% (mean=90.8%; standard deviation=13.5%); in non-equity it is approximately 80% (mean=79.8%; standard deviation=25.3%). Overall, this profile is not completely unexpected, considering the focus of this study. Given that those employed in technology-based firms are generally technically educated, such as software programmers, these firms are thus more likely to seek qualified employees (Bürgel *et al.*, 2012). An independent samples t-test reveals that levels of organisational human capital are higher within equity financed firms (T statistic=4.668, p-value= 0.000 < 0.01).

Table 4.13. Workforce Qualification Level

	I All Firms (%) (N = 294)	II Equity Financed (%) (N = 153)	III Non-Equity Financed (%) (N = 141)
Percentage of Workforce			
Less than 50%	13 (4.4%)	0	13 (9.2%)
50 – 60%	30 (10.2%)	10 (6.5%)	20 (14.2%)
70 – 85%	65 (22.1%)	35 (22.9%)	30 (21.3%)
90%	30 (10.2%)	15 (9.8%)	15 (10.6%)
95%	12 (4.1%)	8 (5.2%)	4 (2.8%)
100%	144 (49%)	85 (55.6%)	59 (41.8%)
Total	**294 (100%)**	**153 (100%)**	**141 (100%)**

Source: Survey Data

4.6.3 Market Extent

Let us now consider the geographic scope of technology-based firms. Respondents were asked to indicate the percentage of firm turnover generated by selling into five markets: local; regional; national; European; and international. These totals were then summed to provide a proxy for domestic (local, regional and national sales) and export (European and international) turnover. Firms in the sample for data analysis generate, on average, 54% (mean=53.96%; standard deviation=39.68%) of turnover through exports (median and mode of 60% and 100% respectively). Interestingly, there is an almost equal split between those generating 100% of their turnover within Ireland and those depending completely on international markets (17% for the former, 17.7% for the latter). An independent samples t-test (T statistic=6.89, p-value=0.000 <0.01) reveals that equity financed firms have significantly higher export turnover than their non-equity counterparts. Data presented in Table 4.14 details export activity.

Equity financed firms (Panel A) generate, on average, 68% (mean=68.2%; standard deviation=35.5%) of turnover through exporting (median and mode of 85% and 100% respectively). A quarter (25.5%) depend completely on export markets. In terms of the domestic market, over a quarter (28.7%) generate less than 20% of revenue in Ireland. On average, these firms generate 32% (mean=31.8%; standard deviation=35.5%) of turnover domestically (median and mode of 15% and 0% respectively). Non-equity financed firms generate approximately 38% (mean=38.2%; standard deviation=38.4%) of turnover in international markets (median and mode of 25% and 0% respectively). Just over a quarter (29.1%) do not engage in exporting. Domestic sales account for, on average, 62% (mean=61.8%; standard deviation=38.4%) of turnover (median and mode of 75% and 100% respectively). Overall, non-equity financed firms appear to be more dependent on the domestic market than equity financed.

Table 4.14. Market Extent

Panel A:	**Equity Financed (N = 153)**	
Sales as % Turnover	**Domestic**	**Export**
	Number of Respondents (%)	
0	39 (25.5%)	10 (6.5%)
< 20	44 (28.7%)	14 (9.2%)
20 – 39	14 (9.2%)	13 (8.5%)
40 – 59	14 (9.2%)	14 (9.2%)
60 – 79	16 (10.5%)	12 (7.8%)
> 80	26 (16.9%)	90 (58.8%)
Total	**153 (100%)**	**153 (100%)**

Panel B:	**Non-Equity Financed (N = 141)**	
Sales as % Turnover	**Domestic**	**Export**
	Number of Respondents (%)	
0	13 (9.2%)	41 (29.1%)
< 20	16 (11.4%)	27 (19.1%)
20 – 39	16 (11.4%)	7 (5%)
40 – 59	14 (9.9%)	20 (14.2%)
60 – 79	12 (8.5%)	11 (7.8%)
80 +	70 (49.6%)	35 (24.8%)
Total	**141 (100%)**	**141 (100%)**

Source: Survey Data

4.6.4 Competitive Environment

As discussed in Chapter 2 (Subsection 2.4.1), supply-side evidence shows that investors emphasise the firm's market and product in their investment selection (see MacMillan *et al*., 1985; Mason and Stark, 2004; Maxwell *et al*., 2011). The literature identifies two factors commonly used by investors in evaluating investment proposals – the uniqueness of the product/service and degree of competition in the marketplace (see Muzyka *et al*., 1996; Petty and Gruber, 2011). Consequently, these attributes are considered here. The first measure focuses on competitive pressure, approximated by a count of major rivals in the firm's main market (Power and Reid, 2015). The second focuses on product uniqueness, measured by the extent of product differentiation as compared to the product of their principal rivals (Power and Reid, 2015).

On average, respondents feel they face competition from approximately 22 (mean=22.2; standard deviation=116.2) rivals (median and mode 5 and 0 respectively). Data is presented in Table 4.15. Of the 294 firms, a third (33.7%) estimate that they have less than 5 rivals, while just over an eighth (14.6%) claim to have none (Column I). Non-equity financed appear to face a more competitive market (Column III). While equity financed face competition from an average of 4 (mean=4.5) rivals, the average for non-equity is 41 (mean=41.2). This number is driven up by twelve firms, eight of which claim to have 100 and four 1000 rivals. Almost a quarter (22.2%) of equity financed feel that they do not face any major rival; the corresponding figure for non-equity is 9 (6.4%). A test of the null hypothesis of equality of means was rejected, with equity financed firms facing significantly lower levels of competition [T statistic = -2.728, p-value=0.007 < 0.01].

Table 4.15. Extent of Rivalry

	I **All Firms (%)** **(N = 294)**	**II** **Equity Financed (%)** **(N = 153)**	**III** **Non-Equity Financed (%)** **(N = 141)**
Number of Rivals:			
0	43 (14.6%)	34 (22.2%)	9 (6.4%)
1 – 4	99 (33.7%)	62 (40.5%)	37 (26.2%)
5 – 9	66 (22.4%)	31 (20.3%)	35 (24.8%)
10 – 15	51 (17.3%)	19 (12.4%)	32 (22.7%)
20 – 25	23 (7.8%)	7 (4.6%)	16 (11.4%)
100	8 (2.7%)	0	8 (5.7%)
1000	4 (1.4%)	0	4 (2.8%)
Total	**294 (100%)**	**153 (100%)**	**141 (100%)**
Test Statistic	*T statistic*[1] = -2.728; d.f. = 292, p = 0.007		

Source: Survey Data

Note: [1] The t-test is based on the number of actual rivals (competitors), the categories included in the table are used to illustrate the distribution

Turning to product offering, uniqueness is explored through differentiation. Designed as a subjective measure that aims to gauge the degree of product differentiation (see Reid, 2002; Power and Reid, 2015), respondents were asked to compare products in their main product group with those of their rivals and self-appraise whether they were very similar, similar, different or very different. Just over a quarter (29.3%) feel that they have a similar product to that of their competitor, while over a third consider their product to be different (36.4%) or very different (34.4%). Equity financed firms appear to place greater emphasis on differentiation, with an almost equal split between different (39.2%) and very different (41.2%). Those remaining (19.6%) feel that their product is similar. Among non-equity financed, data is as follows: similar (36.2%); different (34%); very different (29.8%). There is a significant relationship between equity financing and product differentiation (Pearson's Chi-square=9.716; d.f.=2; p-value=0.008), with a moderate association between the two (*Cramer's V*=0.2). This is consistent with research highlighting uniqueness/differentiation as key investment criteria for equity investors (see Maxwell *et al.*, 2011; Petty and Gruber, 2011).

Comparing levels of differentiation and rivalry, those selling similar products have, on average, 68 (mean=68.5) rivals; different have 6 (mean=5.9); and very different have 3 (mean=3.1). A one-way analysis of variance (ANOVA) shows that there is a significant difference between the mean number of rivals across levels of differentiation ($F_{(2, 291)}$ statistic = 9.441, p-value=0.000. A Tukey post hoc test further revealed that the number of rivals is significantly lower for those selling different (5.9 ± 4.7, p=0.000) and very different (3.1 ± 3.8, p=0.001) products compared to similar (68.5 ± 4.7). There was no significant difference between different and very different groups (p=0.982).

Data presented in Table 4.16 details product differentiation and rivalry across equity (Panel A) and non-equity (Panel B) financed firms. Beginning with equity, one third (33.3%) of those with similar products have less than 5 rivals; almost a quarter (23.3%) between 5–9;

and almost a third (30%) 10–15 rivals. These firms face, on average, 9 (mean=8.6) rivals. Half of those selling different products have less than 5 rivals, with a quarter in the 5–9 group (mean=5.2 rivals). Of those with very different products, almost half (47.6%) have no major rivals, with over a third (34.9%) having less than five (mean=2.1 rivals). There is a significant difference between the mean number of rivals across levels of differentiation ($F_{(2, 150)}$ statistic = 20.929, p-value=0.000). A Tukey post hoc test shows that number of rivals is significantly lower for those with different (5.2 ± 4.5, p=0.003) and very different (2.1 ± 3.3, p=0.000) products compared to similar (8.63 ± 6.8), and between different and very different (p=0.001).

Turning to non-equity financed (Panel B), almost a third (31.4%) of those with similar products have between 10–15 rivals, with almost a quarter (23.5%) in the 20–25 category. These firms face, on average, approximately 104 (mean=103.8) rivals, although this is driven up by those claiming to have 100 or 1000. Of those rating their product as different, there is an equal split between those in the less than 5 group and 5–9 group, with one third (33.3%) a piece (mean=6.8 rivals). Of those with very different products, most (42.8%) face competition from less than 5 rivals (mean=4.5 rivals). There is a significant difference in the mean number of rivals ($F_{(2, 138)}$ statistic = 6.102, p-value=0.003) between the levels of differentiation. A Tukey post hoc test shows that number of rivals is significantly lower for those with different (6.8 ± 4.9, p=0.009) and very different (4.5 ± 4.1, p=0.010) products compared to similar (103.8 ± 266.1), but not between different and very different products (p=0.998).

Overall, it appears that the typical technology-based firm is selling a differentiated product and faces a relatively low level of competition in their market (i.e. occupies a niche position).

Table 4.16. Product Differentiation and Rivalry

Panel A	**Equity Financed (N = 153)**		
	Similar	**Different**	**Very Different**
Number of Rivals			
0	0	4 (6.7%)	30 (47.6%)
1 – 4	10 (33.3%)	30 (50%)	22 (34.9%)
5 – 9	7 (23.3%)	15 (25%)	9 (14.3%)
10 – 15	9 (30%)	9 (15%)	1 (1.6%)
20 – 25	4 (13.3%)	2 (3.3%)	1 (1.6%)
Total	**30 (100%)**	**60 (100%)**	**63 (%)**

Panel B	**Non-Equity Financed (N = 141)**		
	Similar	**Different**	**Very Different**
Number of Rivals			
0	0	2 (4.2%)	7 (16.7%)
1 – 4	3 (5.9%)	16 (33.3%)	18 (42.8%)
5 – 9	8 (15.7%)	16 (33.3%)	11 (26.2%)
10 – 15	16 (31.4%)	11 (22.9%)	5 (11.9%)
20 – 25	12 (23.5%)	3 (6.3%)	1 (2.4%)
100	8 (15.7%)	0	0
1000	4 (7.8%)	0	0
Total	**51 (100%)**	**48 (100%)**	**42 (100%)**

Source: Survey Data

4.6.5 Intangible Resources

In her seminal work, Penrose (1959) refers to resources as ‘productive services’ (tangibles) and ‘managerial services’ (intangibles). Although the continuous availability of the former and supply and release and development of the latter are both perceived to influence business growth directly, lack of appropriate intangibles is taken as the principal constraint on growth (Reid *et al*., 2017). In fact, it is a widely held view that a firm’s success may largely depend on the intangible resources it owns and controls (Bisbe and Malgueño, 2015). Technology-based firms are typically characterised by a high degree of intangible or knowledge-based resources, which can impact on their ability to access entrepreneurial finance (see Carpenter and Petersen, 2002a; Cassar, 2004). The purpose of this Subsection is to build a profile of the types of intangible assets held by technology-based firms.

Intangible resources can be measured on several dimensions.[76] In compiling a profile for the purposes of this study, respondents were presented with a list of eight possible intangible resources and asked to indicate all those applicable. Ample space was given to detail those not listed (see Chapter 3, Subsection 3.2.2). Generally, these were categorised as: customer-related (customer lists, open orders and production backlog, customer relationships; contract-based (construction permits, use rights, servicing contracts, lease agreements); and intellectual property (patents, trademarks, copyrights, trade secrets, etc.). Summary data is presented in Table 4.17. On average, respondents possess 2 (mean=2.5; standard deviation=1.3) of these intangible resources.

For the 294 technology-based firms in the database, customer contracts and relationships are the most common intangible asset (Column I), as indicated by over three-quarters (81%). This is similar across both groups – equity (84.3%) and non-equity (77.3%) (Columns II and III respectively). Customer contracts represent fairly certain economic benefits as they denote expected revenue whilst customer relationships represent future economic benefits in the form of potential business (Grant Thornton, 2013). Representing relational capital, customer relationships and associated loyalty lead to repeated exchange and represent a valuable intangible resource (Fernández *et al*., 2000).

Almost two-thirds (60%) hold intellectual property (IP) rights. IP provides legal protection, enhances importance and contribution of knowledge assets, and is generally considered to be an intangible resource which is an important asset (see Hall, 1992; Teece, 1998). Intangible resources protected by property rights are separable from the firm and exchangeable in a market context (Fernández *et al*., 2000). IP is considered an observable

[76] Although human capital is considered a key intangible (Reid *et al*., 2017) this aspect is assessed separately here (Subsection 4.6.2), as human capital is considered an important driver of equity financing (see Mason and Stark, 2004; Hsu, 2007; Behrens *et al*., 2012) and will thus represent a key factor for empirical analysis. Consequently, human capital is not included in this description of intangible assets, which focuses on intangibles possessed by technology-based firms in addition to knowledge and experience.

quality signal in attracting external equity investors (see Hoenig and Henkel, 2015; Zhou *et al*., 2016). From Table 4.17, it is evident that IP is more prevalent among equity (75.8%) compared to non-equity (42.6%) firms. Evidence shows a significant relationship between equity financing and possession of IP (Pearson's Chi-square=33.791; d.f.=1; p-value=0.000), with a moderate association (C*ramer's V*=0.3). This is explored in greater detail in Subsection 4.6.7.

Lastly, customer orders and production backlog are noted by almost half (47.6%) of the firms. Although coming in third place for equity financed firms, this resource is in second place for non-equity. Open orders represent relatively certain future economic benefits in that they identify the counterparty, the products/services to be supplied and the expected revenue (Grant Thornton, 2013). Following closely, particularly for equity financed firms, customer lists are notable, with just over a third (34.4%) citing this as an intangible resource. Such lists contain information regarding current and sometimes potential customers, which can be useful in improving the effectiveness of sales and marketing efforts (Grant Thornton, 2013).

Lastly, respondents provided details of other intangibles. For this discussion, these are grouped as follows: People (people/staff); Knowledge/Experience (know-how, capabilities, experience); Product/Service (unique or novel product/service); and Reputation. Although there was ample space allowed, few respondents from non-equity financed firms chose to include details of supplementary intangible resources, as evidenced in Table 4.17. This could be due to the data collection method (online survey), with respondents from equity financed firms guided through the interview and possibly taking more time to consider questions. It may also be indicative of the fact that, having gone through the equity processes, these founder-CEOs are simply more accustomed to identifying, promoting and highlighting assets. Over three-quarters (77.8%) considered the people within their organisation to be a key intangible resource. Over two-thirds (69.3%) listed knowledge as an intangible resource, with almost half (43.8%) noting their product offering. Furthermore, over an eighth (15.7%) feel their reputation is an important intangible asset. Among non-equity financed respondents, 4 (2.8%) listed knowledge; 12 (8.5%) their product/service offering; and 9 (6.4%) their reputation.

Overall, equity financed firms appear to possess higher proportions of intangible assets. Notable differences are possession of customer-related assets, particularly customer lists and relationships or contracts, and intellectual property. On average, equity financed hold 3 (mean=2.9; standard deviation=1.2) of the listed 8 intangible assets; non-equity financed possess an average of 2 (mean=2.1; standard deviation=1.2). A test of the null hypothesis of equality of means was rejected, with non-equity financed firms possessing significantly lower levels of these intangibles (T statistic = -5.977, d.f-=292, p-value=0.000 < 0.01).

Table 4.17. Profile of Intangible Assets

	I **All Firms (%)** **(N = 294)**	**II** **Equity Financed (%)** **(N = 153)**	**III** **Non-Equity Financed (%)** **(N = 141)**
Customer Lists	102 (34.7%)	73 (47.7%)	29 (20.6%)
Order/Production Backlog	140 (47.6%)	75 (49%)	65 (46.1%)
Customer contracts & relationships	238 (81%)	129 (84.3%)	109 (77.3%)
Lease Agreements	32 (10.9%)	20 (13.1%)	12 (8.5%)
Construction Permits	3 (1%)	3 (2%)	0
Use Rights	34 (11.6%)	20 (13.1%)	14 (9.9%)
Servicing Contracts	7 (2.4%)	7 (4.6%)	0
Intellectual Property	176 (60%)	116 (75.8%)	60 (42.6%)
Others[1]			
People	119 (40.5%)	119 (77.8%)	0
Knowledge/Experience	110 (37.4%)	106 (69.3%)	4 (2.8%)
Product/Service	79 (26.9%)	67 (43.8%)	12 (8.5%)
Reputation	33 (11.2%)	24 (15.7%)	9 (6.4%)
Test Statistic	*T statistic*[2] = -5.977; d.f. = 292, p = 0.000		

Source: Survey Data

Notes: [1] These are the intangible assets commonly noted as '*Others*' on questionnaire; [2] The t-test is based on the count of intangibles, the categories included in the table are simply used to illustrate the distribution.

4.6.6 Incubators and Spin-Offs

Incubators have become an institutionalised component of policies which aim to stimulate entrepreneurship, innovation and economic growth, typically established through public-private collaborations among universities, industry and government (see Etzkowitz, 2002; van Weele *et al*., 2017). Over the years, the focus of incubators has evolved to concentrate more on intangible services with higher value added, such as tutoring, mentoring, and networking (see Salvador, 2011; Tola and Contini, 2015).[77] The networking aspect is especially interesting for this study. Networking is considered a key feature of incubators (Van Rijsoever *et al*., 2017) and refers to activities which enhance a start-up's social capital by facilitating access to a wide range of players, including finance providers (see Hansen *et al*., 2000; Collinson and Gregson, 2003; Warren *et al*., 2009). Indeed, incubators are increasingly viewed as an intermediary between incubated firms and external finance providers (see Schwartz and Hornych, 2012; Stal *et al*., 2016).

There are approximately 900 incubators across Europe (Dee *et al*., 2011). In Ireland, a total of thirty have been established under Enterprise Ireland's Incubator Centre Scheme, including facilities at eight universities (such as Nova UCD, Invent DCU, Innovation Centre Maynooth and Gateway UCC) with an additional sixteen at Institutes of Technology (such as the Synergy Centre at the Institute of Technology Tallaght, DIT Incubation Centre and Tom Creen Business Centre in the Institute of Technology Tralee). In addition, six Bio-Incubation facilities have opened. Enterprise Ireland's Annual Report and Accounts 2012 notes twenty-two incubation centres on higher education campuses throughout Ireland, hosting some 320 companies which employ more than 1,400 people (Enterprise Ireland, 2013).

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[77] Extant studies tend to consider three generations of incubators: the first focusing on job creation and finding tenants for office buildings (Bruneel *et al*., 2012); the second moving towards additional provisions such as networking and offering business support services (Aerts *et al*., 2007); and the third exhibiting the expansion of these services, such that incubators participate more actively in business coaching and funding provisions (Bruneel *et al*., 2012).

Of the 294 technology-based firms in the database, 44 (15%) were in an incubator at the time of data collection. Most of these were based in the Rubicon Centre in Cork Institute of Technology and NovaUCD, with 12 each. Others include Invent DCU, Trinity Technology and Enterprise Campus, GatewayUCC, LINC (Institute of Technology Blanchardstown), Innovation in Business Centre (Galway-Mayo Institute of Technology), Enterprise Innovation Centre (Sligo Institute of Technology), Synergy Centre (Institute of Technology Tallaght), and the Research Incubation Centre (Institute of Technology Carlow). Of these incubator firms, 29 (66%) are equity financed, and there is a significant relationship between incubation and equity finance (Pearson's Chi-square=3.987, d.f.=1, p-value=0.046), although the association is rather weak (*Cramer's V* = 0.1).

A profile of incubator firms is provided in Table 4.18. Overall (Column I), these firms are mostly micro-enterprises. There is a significant relationship between incubation and size class (Chi-square=28.174, d.f.=3, p-value=0.000), and the strength of this association is moderate (*Cramer's V* = 0.3). This is unsurprising, given that incubators are specifically designed to offer support to micro and small start-ups (Stal *et al*., 2016). Just over half (54.5%) were in the early stage of their lifecycle, with a significant relationship and moderate association between incubation and stage of development (Chi-square=12.396, d.f.=3, p-value=0.006; *Cramer's V* = 0.21). Again, this is unsurprising given that incubation centres are intended to support new and young ventures (see Hughes *et al*., 2007; Bruneel *et al*., 2012).

Table 4.18. Profile of Incubator Firms

	I All Incubator Firms (%) (N = 44)	II Equity Financed (%) (N = 29)	III Non-Equity Financed (%) (N = 15)
Size:			
Micro (<10 employees)	39 (88.6%)	26 (89.7%)	13 (86.7%)
Small (10-49 employees)	5 (11.4%)	3 (10.3%)	2 (13.3%)
Medium (50-249 employees)	0	0	0
Large (250+ employees)	0	0	0
Total	**44 (100%)**	**29 (100%)**	**15 (100%)**
Stage:			
Seed (1 year)	4 (9.1%)	1 (3.5%)	3 (20%)
Early (2 – 5 years)	24 (54.5%)	17 (58.6%)	7 (46.7%)
Expansion (6 – 9 years)	10 (22.7%)	8 (27.6%)	2 (13.3%)
Later (10+ years)	6 (13.6%)	3 (10.3%)	3 (20%)
Total	**44 (100%)**	**29 (100%)**	**15 (100%)**

Source: Survey Data

Lastly, interviews with equity financed firms facilitated collection of supplementary information regarding founding of the business. Specifically, it enabled the author to distinguish between spin-offs and those founded as independent start-ups.[78] Based on their unique characteristics, it is possible that spin-offs may themselves be credible signals for equity investors. A distinctive feature is the strong impact of the parent organisation, which has both a direct and collateral impact (Helm and Mauroner, 2007). Briefly, spin-offs may benefit from their parent organisation's knowledge, experience and network of social ties or links, which can provide important strategic advantages (Fackler *et al.*, 2016). Additionally, the credibility endorsement by the parent enables the spin-off to overcome their lack of reputation and raises chances of survival and growth (Baum *et al.*, 2000). Indeed, spin-offs have been found to have a higher survival rate than other start-ups in the same industrial sector (see Callan, 2001; Egeln *et al.*, 2003).

[78] According to common definitions, a spin-off is an innovative start-up that emerges from a firm or public research organisation (Helm and Mauroner, 2007).

A total of 21 (13.7%) equity financed firms began as spin-offs. Of these, 19 (90.5%) are university spin-offs while the remaining 2 (9.5%) were spun-out from larger corporations. Additionally, 9 (42.9%) of these operate within an incubator, and there is a significant relationship with a moderate association between incubation and being a spin-off (Pearson's Chi-square=9.053; d.f.=1; p-value=0.003; *Cramer's V*=0.2). Further characteristics are provided in Table 4.19. Just over half (53.4%) are micro-enterprises, consistent with the literature. Salvador (2011), based on an analysis of Italian spin-offs, find the number of employees to be between two and four (micro firms). Clarysse *et al*. (2007), in an investigation of European spin-offs, show that they are very small at start-up, with mean employment of 1.6 people. Zhang (2009), in an explanatory analysis of US venture capital financed firms, reports that research spin-offs are significantly smaller than other venture capital backed firms. Spin-offs firms are, on average, 6 (mean=6.33; standard deviation=3.66) years old. Almost half (42.9%) are in the early stage, with a third (33.3%) in expansion. Salvador (2011) reports that spin-offs in Turin are predominantly young firms.

Table 4.19. Profile of Spin-out Firms

	Number of Firms (%)
Size:	
Micro	11 (53.4%)
Small	8 (38.1%)
Medium	2 (9.5%)
Large	0
Total	**21 (100%)**
Stage:	
Seed (1 year)	1 (4.8%)
Early (2 – 5 years)	9 (42.9%)
Expansion (6 – 9 years)	7 (33.3%)
Later (10+ years)	4 (19.0%)
Total	**21 (100%)**

Source: Survey Data

Overall, because asymmetric information associated with early stage technology-based firms pose significant upfront search costs to potential financial providers (Wright *et al*., 2006), it is possible that incubators and parental organisations can provide start-ups with access to key intangible resources, including networks, legitimacy and credibility, effectively screening and preparing start-ups for external investment (see Bruneel *et al*., 2012; Wright *et al*., 2006).

4.6.7 Innovation Activity

Innovation has been described as the defining challenge for businesses (Porter and Stern, 2001) and is broadly defined as the successful commercial introduction of a new product, service or process (Lippoldt and Piotr, 2009).[79] Innovation is especially important for technology-based firms who use knowledge as a major asset and must continually build on that knowledge to produce goods and services (Maldonado *et al*., 2009). A notable challenge in empirically examining innovation activity, however, lies in measuring the numerous dimensions of innovation (see Buddelmeyer *et al*., 2010; McGuirk *et al*., 2015). Common gauges applied include: innovation orientation (product or process) (see Roper, 2001; Fontana and Nesta, 2009; Børing, 2015); research and development (R&D) (see Hall, 2002; Brown *et al*., 2009, 2012); and intellectual property (see Audretsch *et al*., 2012; Hottenrott *et al*., 2016). The purpose of this Subsection is to build a profile of innovation activity through an examination of these dimensions. To this end, discussion focuses on frequency of innovation, R&D and intellectual property.

[79] According to the OECD's Oslo Manual (OECD, 2005), the term innovation refers to the implementation of technologically new products and processes or significant technological improvements in products and processes. The reader is referred to Chapter 3, Section 3.2, Subsection 3.2.2 for a detailed description of measures of innovation applied in this study.

Frequency of Innovation

Because of the unique characteristics of innovation, including information asymmetries, uncertainty and appropriability issues, firms actively introducing new products and processes are particularly susceptible to market failures (see Hall and Lerner, 2010; Audretsch *et al*., 2012).[80] Consequently, equity is typically considered the most appropriate form of finance for innovative firms (see Carpenter and Petersen, 2002a; Langeland, 2007; Wonglimpiyarat, 2016). Moreover, evidence shows that equity investors attach importance to innovativeness in selecting investments (see Landström. 1998; Mason and Stark, 2004).

This research considers two measures of firm-level innovation – product innovation (introduction of a new or significantly improved product) and process innovation (introduction of a new or significantly improved production process or the re-organisation of distribution methods or support activities) (see Gordon and McCann, 2005; McGuirk *et al*., 2015). Respondents were asked to self-appraise their firm's frequency of innovation at each stage of their lifecycle on a four-point scale with the following response categories: continuously, regularly, rarely or never. Related data is presented in Table 4.20.

For the 294 firms (Column I), over two-thirds (65%) rate product innovation activities as a continuous endeavour and a quarter (25.5%) as regular. Data for process innovation is similar, with over half (56.5%) describing activities as continuous and almost a third (31%) as regular. Activity seems more frequent among equity financed firms (Column II). Over three-quarters (77.8%) rate product innovation as continuous, with almost a fifth (19.6%) as regular. Over two-thirds (68%) consider process innovation as continuous, with over a quarter (26.1%) regarding activities as regular. Looking at non-equity financed (Column III), just over half

[80] Briefly, pursuit of innovation is often considered highly uncertain compared with investing in known technologies or implementing previously developed competencies, leads to riskier, more complicated and less linear start-up processes and has potentially skewed returns (see Beckman, 2006; Samuelsson and Davidsson, 2009; Galloway *et al*., 2017). Compounding this, lack of collateralizable assets, along with uncertain paybacks, results in limited access to external financing (Brown *et al*., 2009).

(51.1%) rate product innovation as continuous and almost a third (31.9%) regular. For process innovation, almost half (44%) regard activities as continuous and over a third (36.2%) regular.

Table 4.20. Frequency of Product and Process Innovation

	I All Firms (%) (N = 294)	II Equity Financed (%) (N = 153)	III Non-Equity Financed (%) (N = 141)
Product Innovation			
Continuously	191 (65%)	119 (77.8%)	72 (51.1%)
Regularly	75 (25.5%)	30 (19.6%)	45 (31.9%)
Rarely	26 (8.8%)	4 (2.6%)	22 (15.6%)
Never	2 (0.7%)	0	2 (1.4%)
Total	**294 (100%)**	**153 (100%)**	**141 (100%)**
Process Innovation			
Continuously	166 (56.5%)	104 (68%)	62 (44%)
Regularly	91 (31%)	40 (26.1%)	51 (36.2%)
Rarely	34 (11.6%)	9 (5.9%)	25 (17.7%)
Never	3 (1%)	0	3 (2.1%)
Total	**294 (100%)**	**153 (100%)**	**141 (100%)**

Source: Survey Data

A chi-square test for independence shows a significant relationship and moderate association between equity financing and frequency of product (Pearson's Chi-square=28.585; d.f.=3; p-value=0.000; *Cramer's V*=0.3) and process (Pearson's Chi-square=22.032; d.f.=3; p-value=0.000; *Cramer's V*=0.3) innovation. This is consistent with the extant literature (see Carpenter and Petersen, 2002; Langeland, 2007). Mina *et al*. (2013) study firms in the UK and US and find that having innovated a product or process is a significant signal for equity investors, helping firms to attract external equity. Additionally, the measure is a useful indication of how innovative the founder-CEO believes his or her business to be. According to DeTienne *et al*. (2015), those who perceive their idea as highly innovative may invest greater resources with the expectation of greater reward. One could argue that this perceived measure gives an insight into how these entrepreneurs present the uniqueness and innovativeness of their venture to potential investors. By promoting the innovativeness of their venture, entrepreneurs effectively position themselves to appeal to investors looking to access new, untapped markets (Parhankangas and Ehrlich, 2014).

Research & Development

Research and development (R&D) is considered a critical input into the innovation process (Hall *et al*., 2002), enabling firms to create new products and develop more efficient productive processes (Nunes *et al*., 2012). Financing constraints, however, have the potential to be considerable in the context of R&D-intensive firms (see Brown *et al*., 2009, 2012; Kerr and Nanda, 2015) and equity financing is generally considered the most feasible option for entrepreneurial finance.[81] Moreover, as R&D-intensity is an established predictor of the propensity to patent – an important signal for equity investors (Audretsch *et al*., 2012) – it seems plausible to expect that R&D-intensity may constitute an important signal for equity investors (Lahr and Mina, 2016).

In examining R&D two aspects are considered – frequency and expenditure (see Chapter 3, Subsection 3.2.2). First, R&D was measured using a categorical variable, where respondents self-appraised the frequency of R&D activities on a six-point scale from weekly to yearly. Data presented in Table 4.21 reveals that almost half of these firms undertake R&D daily, with over a quarter (26.9%) describing R&D as a weekly task. Looking at the data, almost two-thirds of equity financed firms carry out R&D activities daily, with just over a third (36.9%) of non-equity financed firms in this category. Less than five percent (4.6%) of equity financed firms undertake R&D on a longer scale (less than once a quarter, once a quarter, twice yearly, or yearly). For non-equity financed firms there is an almost equal split between those describing R&D as occurring on a weekly (27.7%) or longer (24.1%) basis. There is a

[81] Briefly, the nature of R&D investment – asymmetric information, uncertainty, skewed returns, lack of collateral value and intangible nature (see Brown *et al*., 2012; Kerr and Nanda, 2015) – infers that there is a financing hierarchy which consists almost entirely of internal and external equity finance, especially for younger and smaller firms (Brown *et al*., 2009).

significant difference between the frequency of R&D activities within equity financed firms compared to non-equity financed (Mann-Whitney U = 7506, p-value=0.000).

Table 4.21. Frequency of R&D

	I All Firms (%) (N = 294)	II Equity Financed (%) (N = 153)	III Non-Equity Financed (%) (N = 141)
Daily	144 (49%)	92 (60.1%)	52 (36.9%)
Weekly	79 (26.9%)	40 (26.1%)	39 (27.7%)
Monthly	30 (10.2%)	14 (9.1%)	16 (11.3%)
Longer	41 (13.9%)	7 (4.6%)	34 (24.1%)
Total	**294 (100%)**	**153 (100%)**	**141 (100%)**
Test Statistic	Mann Whitney U = 7506, p-value=0.000		

Source: Survey Data

The second measure focuses on business expenditure on research activity, with respondents asked to provide an estimate of the percentage of turnover dedicated to funding R&D activities, a measure commonly applied in the literature (see Hall and Bagchi-Sen, 2002; Müller and Zimmermann, 2009). R&D expenditure accounts for, on average, 37% (mean=36.6%; standard deviation=29.2%) of turnover. A breakdown across groups is provided in Table 4.22. Overall (Column I), most firms (27.9%) indicated that they dedicate less than 20% of turnover to R&D expenses. Equity financed firms (Column II) have the higher share of R&D expenditure, with an average of 48% (mean=48.4%; standard deviation=26.4%) of turnover dedicated to R&D activities. Among non-equity (Column III), expenditure accounted for, on average, 25% (mean=24.8%; standard deviation=26.6%) of turnover. A test of the null hypothesis of equality of means is rejected using an independent samples t-test, which reveals that non-equity financed firms have significantly lower expenditure on R&D (T statistic = -7.926, p-value=0.000 < 0.01). Expenditure on R&D is typically considered intangible activity

(Storey, 1994). Empirically, evidence shows that firms investing large amounts of capital in R&D employ relatively little debt (see Bougheas, 2004; Smart *et al.*, 2008).

Table 4.22. Expenditure on R&D as a Percentage of Turnover

	I All Firms (%) (N = 294)	II Equity Financed (%) (N = 153)	III Non-Equity Financed (%) (N = 141)
0	11 (3.7%)	-	11 (7.8%)
< 20%	82 (27.9%)	37 (24.2%)	68 (48.2%)
20 – 29%	46 (15.6%)	28 (18.3%)	18 (12.8%)
30 – 39%	23 (7.8%)	18 (11.8%)	5 (3.5%)
40 – 49%	23 (7.8%)	16 (10.5%)	7 (5%)
50 – 59%	32 (10.9%)	20 (13.1%)	12 (8.5%)
60 – 69%	23 (7.8%)	19 (12.4%)	4 (2.8%)
70 – 79%	18 (6.1%)	9 (5.9%)	9 (6.4%)
≥ 80%	36 (12.2%)	29 (18.9%)	7 (5%)
Total	**294 (100%)**	**153 (100%)**	**141 (100%)**
Test Statistic	T statistic[1] = -7.926, d.f. = 292, p-value = 0.000		

Source: Survey Data

Note: [1] The t-test is based on actual R&D expenditures, the categories included in the table are simply used to illustrate the distribution

Thus, it appears that R&D-intensity has an impact on equity financing, consistent with extant evidence. Casson *et al*. (2008) and Wang and Thornhill (2010) find a positive relationship between R&D investment and the use of equity financing. Based on their analysis of a sample of Canadian biotechnology start-ups, Baum and Silverman (2004) find that those with higher R&D expenditures obtain significantly more venture capital financing. This result is echoed by Lahr and Mina (2016) who, using a sample of UK and US-based businesses, find that R&D expenditure is a strong predictor of venture capital investment.

Intellectual Property

Expected future value of innovation activity tends to be determined by the firm's ability to protect the innovation effectively (Audretsch *et al*., 2012). In selecting intellectual property

(IP) for their firm, entrepreneurs have a choice of a range of approaches to protecting their innovative activities and output, ranging from formal (patent, trademark, copyright and registration of design) to informal (secrecy, complexity of design, lead time advantage and confidentiality agreements) mechanisms (see Børing, 2015; Hall *et al.*, 2014). Here we consider the forms of IP employed by technology-based firms.[82]

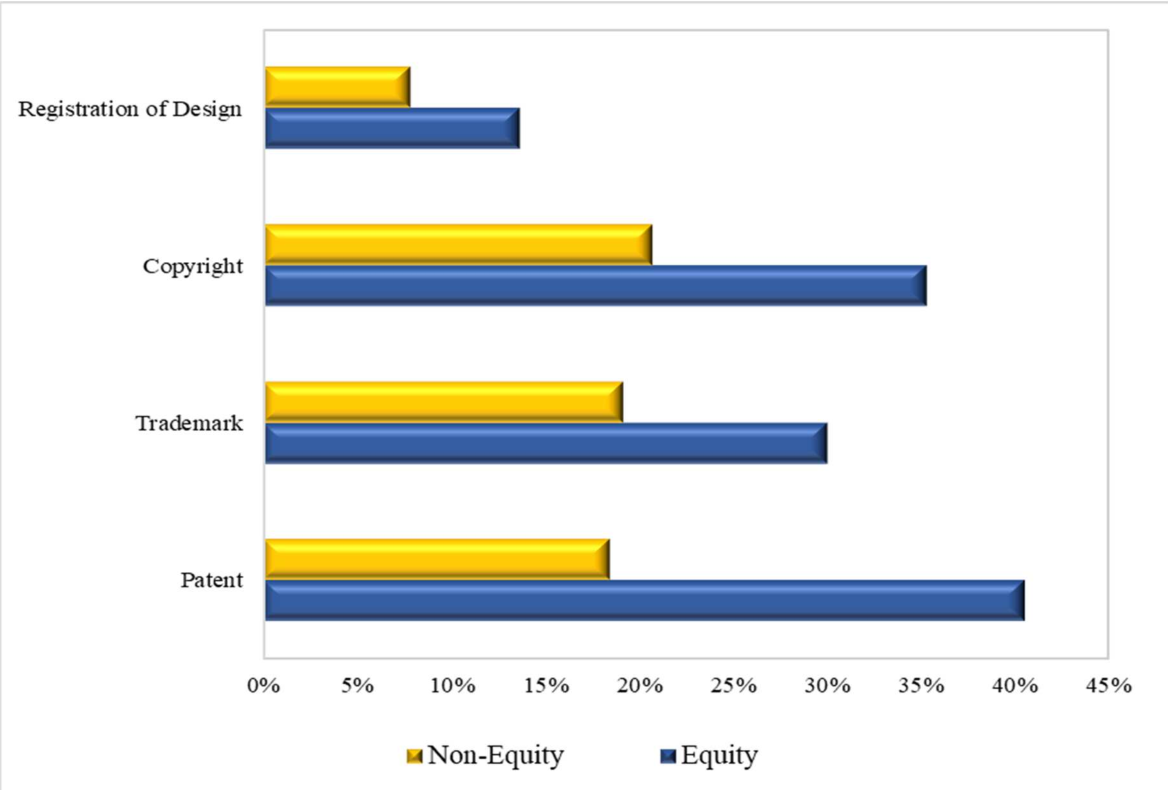
Beginning with formal intellectual property, Figure 4.3 provides a comparison of portfolios between equity and non-equity financed firms. The main forms of IP employed are patents, trademarks, registration of design and copyrights, the first three of which are registered rights while copyright is unregistered (Hall *et al.*, 2014). Patents, commonly utilised as a proxy for the output derived from invention or an innovation process (Rosenbusch *et al.*, 2011), also represent an observable signal of quality and play an important role in attracting external investors (see Hoenen *et al.*, 2014; Zhou *et al.*, 2016). Of the 294 technology-based firms, 89 (30.3%) have been granted at least one patent. Looking at each group, 62 (40.5%) equity financed firms hold patents compared to 26 (18.4%) non-equity. There is a significant relationship between patenting and equity finance (Pearson's Chi-square=20.927, d.f =1, p-value=0.000), consistent with existing evidence (see Audretsch *et al.*, 2012; Conti *et al.*, 2013).

Data was also collected pertaining to the number of patents granted, both within Europe and the United States. Equity financed firms with patents hold, on average, 9 (mean=9.02) patents; within Europe an average of 5; and average of 4 in the U.S. One firm has a total of 88 patents (40 in Europe; 48 in U.S.). This firm is a small-enterprise, in the later stage and operating in the *'Manufacture of medical and dental instruments and supplies'*, a low-tech manufacturing sector. Those non-equity financed firms with patents hold, on average, 2 (mean of 2.61) patents; within Europe an average of 2 (mean=1.87); and, in the U.S., an average of 1

[82] It should be noted that, because patent information is available through the Irish Patents Office, European Patent Office and United States Patent and Trademark Office, secondary data was gathered pertaining to patent stocks (see Chapter 3, Subsection 3.3.2 for details), to confirm data gathered from the survey. All other data presented herein is primary source data.

(mean=0.74). One respondent has 10 patents (5 in Europe; 5 in U.S.). This firm is a medium-sized enterprise, in the later stage and in the *'Manufacture of basic pharmaceutical products'*, a high-tech manufacturing sector. A test of the null hypothesis of equality of means was rejected, with non-equity financed firms holding significantly lower numbers of patents than equity financed firms (T statistic = -3.415, p-value=0.001 < 0.01]. This is consistent with the extant evidence highlighting the relationship between possession of patents and equity financing (see Baum and Silverman, 2004; Hsu and Ziedonis, 2008; Zhou *et al*., 2016).

Figure 4-3. Formal Intellectual Property (IP) Profile



Source: Survey Data

Trademarks exist to protect brands and marketing assets (see Sandner and Block, 2011; Zhou *et al*., 2016). Additionally, trademarks are considered to indicate readiness in product or service development (Greenhalgh and Rogers, 2006), market orientation and access (Block *et al*., 2014) and advancement in marketing (Mendonça *et al*., 2004) and, as such, may constitute an important signal for external investors (Zhou *et al*., 2016). Moreover, it has been noted that trademarks are a particularly fitting indicator of innovation within service firms and are often the most effective way to protect the service firm's IP rights (see Davis, 2009; Schmoch and Gauch, 2009). There is a total of 73 (24.8%) firms with trademarks. They are more common among equity financed firms – 46 (30%) compared to 27 (20.6%) firms. There is a significant relationship between trademark possession and equity finance (Pearson's Chi-square=11.552, d.f =1, p-value=0.001). This is consistent with Zhou *et al*. (2016) who find a significant positive relationship between trademarks and venture capital.

While analysis of the role of copyrights is limited, due in large part to the fact that there is no legal requirement to register creative work (Hall *et al*., 2014), evidence presented by Somaya and Graham (2006) shows that copyright is important as an IP mechanism for software firms. Additionally, using data from court actions, Mazeh and Rogers (2006) find that plaintiffs in copyright disputes have higher market values than a peer group of similar firms. Of the 294 firms, 83 (28.3%) employ copyright as IP protection – a total of 54 equity and 29 non-equity. Evidence reveals a significant relationship between copyrights and equity financing (Pearson's Chi-square=7.854, d.f.=1, p-value=0.005).

Lastly, although empirical evidence from the UK indicates that use of design protection is still relatively low (Moultrie and Livesey, 2011), registration of design is nonetheless a form of IP protection that allows firms to compete via design (Filitz *et al*., 2015). Approximately 10% of the firms in this database have a registered design. This is in line with descriptive findings presented by Amara *et al*. (2008) who, based on analysis of Canadian knowledge-intensive service firms, report that approximately 11% rely on registration of design in protecting IP. Use is a little higher among equity compared to non-equity financed respondents (13.7% for the former and 7.8% for the latter). There is a weak relationship between registration of design and equity financing (Pearson's Chi-square=2.655, d.f =1, p-value=0.103).

In practice, firms may simultaneously use various forms of IP, combining independent mechanisms which act to reinforce each other to protect innovations and inventions from imitation (see Amara *et al*., 2008; Hall *et al*., 2014). For example, the firm might begin by patenting their technology, followed by a trademark for the product line that supports this technology, finally registering the design rights to the machine or apparatus that supports this technology (Helmers and Schautschick, 2013). Empirically, evidence for the UK (Greenhalgh *et al*., 2003) and Australia (Loundes and Rogers, 2003) find correlations between the filing of patents and trademarks. Somaya and Graham (2006) find complementarity between patents, copyrights and trademarks. Amara *et al*. (2008), based on Canadian knowledge-intensive service firms, report that patents, registration of design patterns and trademarks are complementary mechanisms. Shepherd and Douglas (1999) posit that investors, aware of the fallibility of any one form of IP, look for firms that have created a web of IP protection. This web, according to the authors, would be woven around patents, if possible, and include the registration of brand names, product names, designs, trademarks and logos, such that any imitator will become tangled in the web. Thus, the firm's stock of formal IP rights may constitute a valuable signal in seeking equity finance.

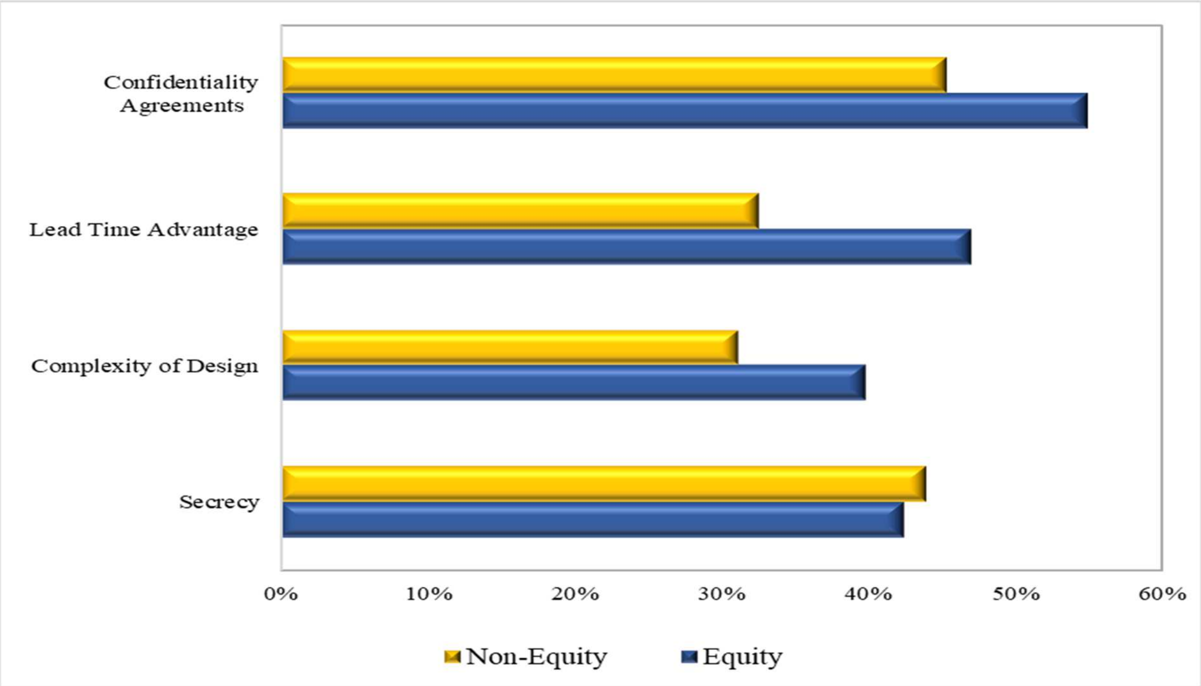
In total, 34 (11.6%) firms hold a patent and trademark, with a significant relationship between the two (Pearson's Chi-square=12.826, d.f.=1, p-value=0.000). The strength of this association is moderate (*Cramer's V*=0.2). A total of 31 (10.5%) hold a patent and copyright, again with a significant relationship (Pearson's Chi-square=3.034, d.f.=1, p-value=0.082) but weaker association (*Cramer's V*=0.1). Trademarks and copyrights are employed by 43 (14.6%) firms. These two are positively related (Pearson's Chi-square=45.094, d.f.=1, p-value=0.000), with a reasonably moderate association (*Cramer's V*=0.4). Registration of design is combined with patents by 19 (6.5%) firms. These are positively related (Pearson's Chi-square=14.842, d.f.=1, p-value=0.000), with a moderate association (*Cramer's V*=0.2). Registration of design is combined with copyrights in 12 (4.1%) firms and trademarks in 14 (4.8%) firms. A significant relationship, although with a relatively weak association, exists with trademarks (Pearson's Chi-square=6.887, d.f.=1, p-value=0.009, *Cramer's V*=0.1) but not copyrights (Pearson's Chi-square=45.094; d.f.=1, p-value=0.217).

Overall, almost a third (32%) hold one formal IP; just over an eighth hold two; 20 (6.8%) hold three. Eight (2.8%) possess all four. Although empirical evidence of the importance of the complementarity between formal IP protection in terms of access to equity financing is limited, Zhou *et al*. (2016) show that start-ups that apply for both patents and trademarks yield higher venture capital funding than firms that apply for only one of the IP rights. Generally, given that a product offering that is proprietary or can otherwise be protected is an important selection criterion (MacMillan *et al*., 1985), it is reasonable to expect strong IP protection, or a veritable web of IP (Shepherd and Douglas, 1999), to be a valuable signal for equity investors.

Secrecy, confidentiality agreements, lead time advantage and complexity of design are typically considered informal IP (see Arundel, 2001; Cohen *et al*., 2002; Zhou *et al*., 2016). In fact, Hall *et al*. (2013) combine three rounds of Community Innovation Survey (CIS) data for the UK with patent filings and report that only 4% of innovative companies in the UK employ patents to protect IP. Conversely, the authors report that companies rate lead time, confidentiality agreements and secrecy higher than patents as mechanisms to protect their innovations. Based on evidence from Canadian manufacturing firms, Hanel (2008) finds that firms constantly regard alternative IP mechanisms, particularly confidentiality agreements, as more important than patents.

Of the 294 firms surveyed, 126 (42.9%) utilise secrecy. Looking at Figure 4.4, there is a relatively even split between equity and non-equity financed firms (41.8% and 46.1% respectively). While half (50.3%) of equity financed firms enjoy lead time advantage, just over a third (34%) of non-equity financed employ this form of protection. Use of confidentiality agreements is relatively similar, with just over half (54.9%) of equity and almost half (44.7%) of non-equity. The complex design of an innovation also acts of a form of protection and is rather popular among technology-based firms, with 62 (40.5%) equity and 46 (32.6%) non-equity. Finally, while there is evidence of a significant relationship between use of both lead time advantage (Pearson's Chi-square=7.962, d.f =1, p-value=0.005) and confidentiality agreements (Pearson's Chi-square=3.066, d.f =1; p-value=0.080) and equity finance, this is not the case for secrecy (Pearson's Chi-square=0.137, d.f.=1, p-value=0.711) or complexity of design (Pearson's Chi-square=1.970, d.f.=1, p-value=0.160).

Figure 4-4. Informal Intellectual Property (IP) Profile



Source: Survey Data

Overall, it seems that equity financed firms possess larger IP portfolios than non-equity. This is consistent with prior research which shows that the IP portfolio a firm possesses represents an observable quality signal in seeking equity (see Block *et al*., 2014; Hoenig and Henkel, 2015; Zhou *et al*., 2016).

4.6.8 Financing Preferences

Financing preferences of the entrepreneur may impact capital structure (see Norton, 1991; Ang *et al*., 2010; Riding *et al*., 2012a). Grounded in the pecking order hypothesis of Myers (1984) and Myers and Majluf (1984), a potential financing hierarchy exists under which firms prefer internal finance and, if external finance is necessary, issue the safest security first. Thus, adverse selection implies that, where external finance is necessary, debt is preferred over equity (see Chapter 2, Section 2.2). From the entrepreneur's perspective, the hypothesis infers that the desire for independence and control potentially leads to a preference for internal rather than external finance. Effectively, entrepreneurs prefer internal sources that are least subject to information costs and involve less risk (Briozzo *et al*., 2016).

While there is a lack of empirical evidence linking financing preferences to use of equity the implication of asymmetric information coupled with desire to maintain control is that founders with a preference for internal financing are less likely to seek external equity. Indeed, an observed preference for debt over equity is often explained by entrepreneurs being unwilling to cede control (Howorth, 2001). Building on this notion, this study considers the role of entrepreneurial preference for internally generated funding on use of external equity financing. To the best of the author's knowledge, this provides novel empirical evidence.

Respondents were asked to indicate whether, when their organisation required financial resources, they preferred to utilise, where possible, internal sources before resorting to external. Almost three-quarters (74.8%) stated that they preferred to use internal funding as much as possible. This proportion was slightly higher among non-equity financed firms: while 70% of founder-CEOs from equity financed prefer internal funding, the corresponding figure for non-equity is 80%. Evidence exists of a significant relationship between being equity financed and preference for external funding (Pearson's Chi-square=4.059, d.f.=1, p-value=0.044), although the association is weak (*Cramer's V*=0.1). This is somewhat plausible, in that, if the entrepreneur prefers external funds it could be assumed that they are more willing to cede the independence and control necessary to acquire equity. Kaplan and Strömberg (2003) find that to gain venture capital, entrepreneurs must relinquish a stake of around 50% of their business.

4.6.9 Conclusion

The technology-based firms in the sample are predominantly privately held, led by founders that have assumed the position of Chief Executive Officer, particularly within equity financed firms. In any case, leaders are highly educated and experienced. Moreover, these firms possess high levels of organisational human capital. Equity financed firms generate a significantly higher proportion of turnover through exporting, with non-equity financed more dependent on the domestic market. Overall, technology-based firms engage in product differentiation and appear to cultivate market niches. Regarding intangible assets, equity financed firms possess a greater range of intangibles, most notably customer-based assets and intellectual property. It seems that, for smaller, younger firms, being located within an incubator facilitates access to equity financing. Innovative activity, overall, exerts a positive influence on equity financing. This is unsurprising given the proliferation of literature not only highlighting the importance of equity for innovative and R&D-based activity (see Wang and Thornhill, 2010; Mina *et al*., 2013) but also of the signalling value of patents and IP (see Audretsch *et al*., 2012; Block *et al*., 2014). Finally, founder-CEOs expressing a preference for externally as opposed to internally generate financing are more likely to utilise equity financing.

4.7 Profile of Equity Financing

It is well documented that external equity financing will inevitably engender agency costs, regardless of the type (source) of equity obtained (see Hart, 2001; Bonnet and Writz, 2012). Briefly, agency costs derive from information asymmetry and potentially conflicting interests (Jensen and Meckling, 1976) and will increase as the entrepreneur's relative ownership stake decreases (Bitler *et al*., 2005). Because of information asymmetries and associated uncertainty, the equity market has developed various mitigation tactics (see Chapter 2, Section 2.2.2) designed to alleviate agency costs and informational problems that emerge in financing high-risk, potentially high-reward projects (Gompers and Lerner, 2001).

There are a number of ways to mitigate agency conflicts: the investor can engage in information collection prior to investing, to screen out *ex ante* unprofitable or unpromising projects or entrepreneurs; the investor can engage in information collection and monitoring once the investment has been made; the investor can structure the financial contract to provide incentives for the entrepreneur to behave optimally; and the entrepreneur can engage in activities to signal potential to external investors (see Kaplan and Strömberg, 2001; Connelly *et al*., 2011). Within this context, this Section explores these facets of equity investment. Specifically, discussion begins with an examination of the use of various mitigation strategies and contract designs (for example, information gathering prior to investment, syndication, staging, board representation, etc.) before turning to demand-side thoughts and experiences of equity (for example, loss of control, risk sharing, non-financial benefits, etc.).[83]

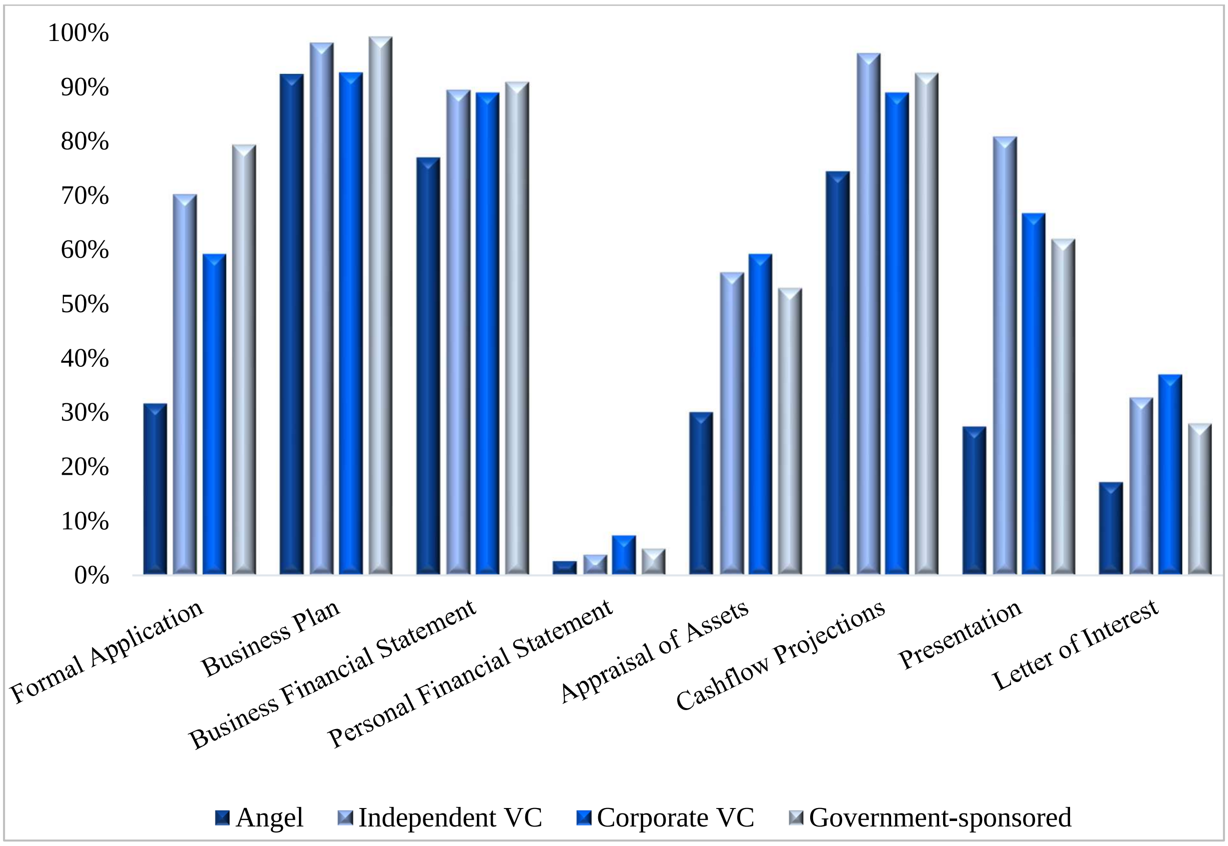
Prior to committing financial resources, equity investors attempt to mitigate adverse selection through systematic appraisal tactics and detailed scrutiny of investment proposal (see Muzyka *et al*., 1996; Reid, 1998). The due diligence process is a fundamental part of equity investment, designed to reduce adverse selection problems arising from the presence of

[83] Data herein is based solely on the sample of 153 equity financed firms.

asymmetric information (Wright *et al*., 2006). One of the most important sources of information is the business plan, which projects the future of the company (MacMillan *et al*., 1985), together with historic and future accounting data (Manigart *et al*., 2000). Appraisal can also include review of information regarding customer agreements, market prospects and references (see Wiltbank *et al*., 2009; Mitteness *et al*., 2012). To explore the sources of information required, respondents were asked to detail the documents and information entailed in the application process with each individual equity investor. Data is presented in Figure 4.5 by source of equity.

Briefly, most equity investors, regardless of the type, wish to see a business plan. Following this, cashflow projections and financial statements are important, especially when applying for venture capital (independent and corporate) and government-sponsored equity funding. Of note is the difference between formal (venture capital and government-sponsored equity) and informal (angels) investors. Specifically, aside from providing a business plan and various financial records, applications for angel funding appear to involve a lesser amount of information collection than applications for formal sources. This is consistent with extant research, with various authors noting that angels take a less formal approach to investment appraisal, particularly due diligence conducted (see Van Osnabrugge, 2000; Haines *et al*., 2003; Drover *et al*., 2017). Mason and Harrison (1994) found that most proposals are rejected by angels following examination of the business plan.

Figure 4-5. Sources of Information in the Application Process



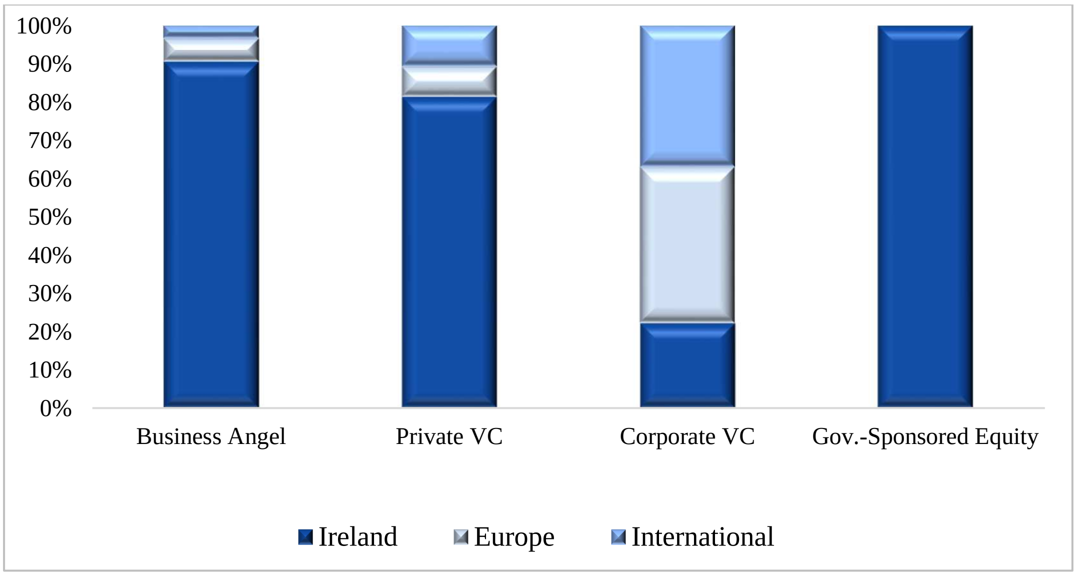
Source: Survey Data

An important source of information, for both entrepreneurs and investors, are references or referrals from mutual social connections (Shane and Cable, 2002). Here, just over half (52.1%) of those with angel finance were introduced to their investor through a referral. Almost half of those with independent (48%) and corporate (44.5%) venture capital also had a referral to their investor. Referrals are less common with government-managed funds (less than 5%). Common sources of referrals were business contacts, other investors or shareholders, personal contacts, bankers and company directors.

Another mechanism employed is spatial proximity (see Florida and Kenney, 1988; Martin *et al*., 2002; Mason, 2007). Data presented in Figure 4.6 depicts location for each source, in relation to the investee. Naturally, all government-sponsored equity investors are in

Ireland. Over three-quarters (77.7%) of corporate venture capital investors are located outside of Ireland, with an almost equal split between Europe (40.7%) and the US (37%). The remaining (22.2%) are in Ireland. For those obtaining independent venture capital, most (81.4%) have Irish-based investors, and almost of third (30.4%) are local venture capital firms. Just over a tenth (11.8%) are based in the same region as the investee firm. Similarly, the clear majority (90.6%) of angel investors funding indigenous technology-based firms operate within Ireland. Almost a third (32.5%) are local, while almost a quarter (23.9%) are within the same region as their investee.

Figure 4-6. Geographical Proximity



Source: Survey Data

This geographic profile must be considered in context. Specifically, in Ireland, the spatial distribution of equity suppliers, particularly venture capitalists and Enterprise Ireland, is highly clustered around the Dublin area. For example, venture capital financing providers including Fountain Healthcare, TVC Holdings, Growcorp, Ion Equity, NCB Ventures and Seroba are based in Dublin. Although Enterprise Equity and Kernel Capital have offices outside of Dublin (Galway and Cork for the former; Cork for the latter), headquarters are in

Dublin. This spatial clustering of equity finance suppliers is in line with evidence of clustering in the U.S. (see Florida *et al.*, 1991; Sorensen and Stuart, 2001), UK (see Mason and Harrison, 2002b) and Germany (Fritsch and Schilder, 2008). Moreover, those companies which might be considered investment targets also tend to be clustered around Dublin. Specially, of the 153 equity financed firms, 81 (52.9%) are based in Dublin. Examining location by investor type, over half of those financed through Enterprise Ireland's equity programme (52%), venture capital (53.8%) and angel investment (54.7%) are based in Dublin. Overall, spatial proximity appears to reflect clustering around Dublin for both equity providers and portfolio companies.

Once the investor has decided to commit financial resources, syndication (co-investment) is a prominent feature of investment. Co-investment occurs where two or more investors decide to share in the financing of an investee firm (Brander *et al.*, 2002). Although syndication is sometimes taken to mean that two or more equity investors formally share a round of financing (simultaneous investment), the term is also used more broadly to refer to situations where different investors co-invest in a project at different times or during the same round but do so independently with no formal agreement (Harrison and Mason, 2000; Brander *et al.*, 2002). The firms here, although using multiple sources over their lifecycle, do not always do so through formal syndication agreements. Thus, the term co-investment is used.

Briefly, various rationales are offered for co-investment. From the investor's perspective, co-investing may be based on a desire to share and reduce risk – investors attempt to share risk associated with an investment by involving another investor while also trying to reduce risk by sharing information (Lockett and Wright, 2001).[84] From the entrepreneur's perspective, a major benefit is increased capital infusions into the firm, while leveraging the

[84] It diminishes individual capital contributions, allowing investors to commit smaller amounts into a larger number of investees, diversifying their risk (Manigart *et al.*, 2006).

coaching potential of investors through exploitation of complementary resources, skills, networks and industry experience (see Andrieu and Groh, 2012; Cumming *et al*., 2017).

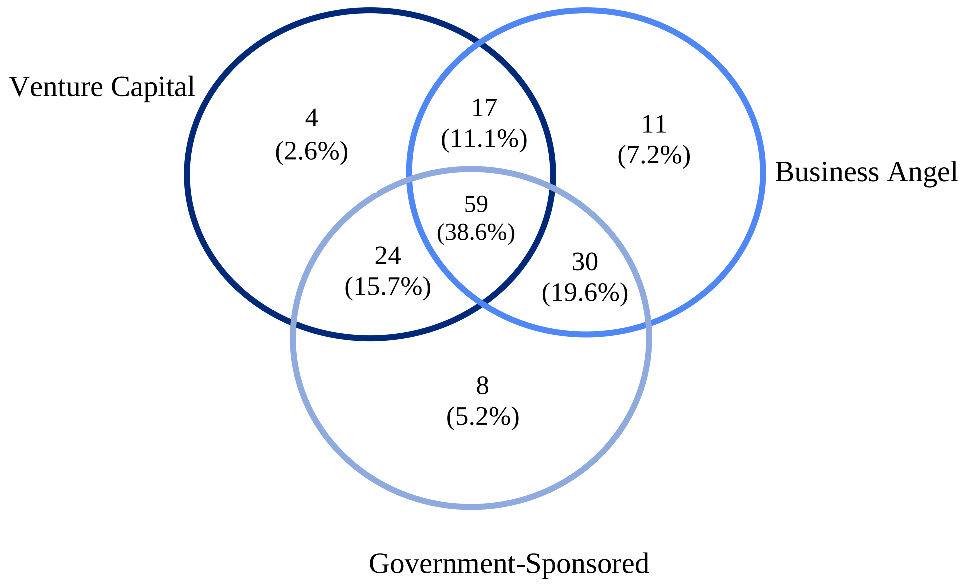
A total of 121 (79.1%) firms obtained financing from a government-managed equity fund, 117 (76.5%) used angel investment and 104 (68%) venture capital. As indicated in Figure 4.7, firms have mostly obtained equity capital from multiple sources, with over a third (38.6%) obtaining investment from all three sources over their lifecycle. Almost half (46.4%) have obtained funding from two sources. On average, firms obtained financing from 2 (mean=2.2) sources. A notable feature is co-investment with government-sponsored equity. Of those 121 firms obtaining finance from a government-managed fund, 113 (93.4%) had equity finance from at least one other source. This is unsurprising given that co-investment is pertinent for government-managed equity funds.[85]

Respondents were asked to provide details of multiple investors within each source. Of the 117 angel-financed, 57 (48.7%) have obtained funding from two angel investors (or an individual angel investor and an angel group such as HBAN). Of the 121 firms with government-sponsored equity, 10 (8.3%) have obtained finance from two public funds. This was composed of Enterprise Ireland (Seed and Venture Capital Programme) along with the Western Development Commission (N = 6) and Invest Northern Ireland (N = 4). Half (50%) of venture capital financed firms are funded solely by an independent venture capital firm, while almost a quarter (24%) have obtained financing from two independent venture capitalists. A total of 17 (16.3%) have received financial resources from private and corporate venture capital funds. Finally, almost a tenth (9.6%) have obtained investment from two private and

[85] Briefly, the basic principal upon which these funds are established is that public sector money typically follows private sector investors, who invest alongside them (Owen and Mason, 2017). Government-managed equity funds, such as Enterprise Ireland's Seed and Venture Capital Scheme, typically operate on a co-investment or matching basis (OECD, 1997) which requires the firm to obtain funding that will at least match the commitment from the public equity source (IVCA, 2012).

one corporate venture capital fund providers. Taking multiple investors within each source into account, firms obtain funding from, on average, 3 equity investors during the lifecycle.

Figure 4-7. Sources of Equity Utilised



Source: Survey Data

Once the investment decision has been made, equity investors incur risks specific to investing. Effectively, equity investors and entrepreneurs have potentially diverging interests and the fact that the latter associate substantial nonmonetary benefits with their role, and the very existence of the firm, results in further agency costs (Burchardt *et al*., 2016).[86] Thus, investors usually seek to protect their investment using contractual mechanisms and monitoring investees (see Wright and Robbie, 1998; Wong *et al*., 2009). Common mechanisms include staging investment, board representation, stock ownership and communication (see Lerner, 1995; Gompers and Lerner, 2001; Shepherd and Zacharakis, 2001).

[86] As discussed in Chapter 2 (Subsection 2.2.2), this misalignment can, in turn, lead to potential moral hazard problems, as the entrepreneur may divert funds and effort to serve private benefits, still unobservable to the investor (Bergemann and Hege, 1998).

Staging of capital infusions (see Neher, 1999, Wang and Zhou, 2004) gives equity investors not only an opportunity to monitor portfolio companies (Gompers, 1995) but also preserves their option to abandon the investment if needs be (Kaplan and Strömberg, 2001).[87] Staging is a common feature of equity investment among the firms surveyed. Business angel funds are staged in almost two-thirds (62.4%) of investments; government-sponsored equity funding in just over two-thirds (67.8%) of investments; and in almost three-quarters of both independent (70.6%) and corporate (74.1%) venture capital investment. This data is consistent with extant literature highlighting staged financing of portfolio companies as a prominent feature of equity investment (see Sahlman, 1990; Wright and Robbie, 1998; Wong *et al*., 2009).

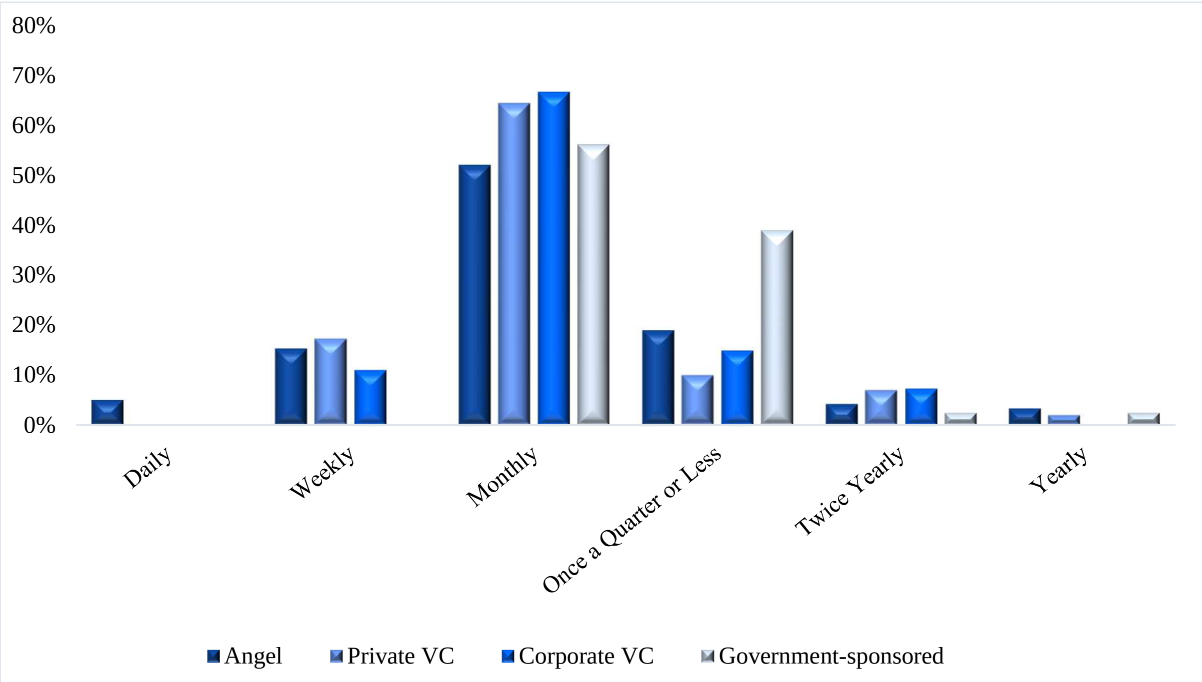
Representation of investors on the investee firm's board of directors is considered an important control right (see Kaplan and Strömberg, 2001; Cumming and Johan, 2013). According to Sahlman (1990) and Lerner (1995), board representation is driven by a need to monitor. Among the equity financed firms, three-quarters (75.2%) of those funded by angels have a representative as a board member. This number is slightly higher for those with independent (87.2%) and corporate (81.5%) venture capital. Of those with finance from a government-managed fund, just over a third (37.2%) have a representative on their board.[88] Sahlman (1990) finds that board seats are typically allocated to venture capitalists as part of a financing round. In their study Van Osnabrugge and Robinson (2000) find that a total of 60% of UK angels join the board of their investee companies.

Typically, equity investors are heavily involved with investees (see Gompers, 1995; Lerner, 1995). Early empirical work on investor effort employed measures such as the hours expended by the investor in dealing with the portfolio company (Gorman and Sahlman, 1989)

[87] Formally, staging is the sequential disbursement of finance to a portfolio company, often dependent on whether the investee has satisfied predetermined targets (Krohmer *et al*., 2009).
[88] By way of explanation, within the main government-sponsored equity fund in Ireland, Enterprise Ireland's Seed and Venture Capital fund, all funds provided through the scheme are managed by private sector fund managers, who oversee the investment and make all decisions necessary (Enterprise Ireland, 2018).

or frequency of face-to-face interaction (Sapienza *et al*., 1996). Gorman and Sahlman (1989) found that the average venture capitalist visits a portfolio company 19 times per year, spends 80 hours onsite and 30 hours of phone time in contact with the company. This is consistent with Zider's (1998) estimate of 80 hours per year. Mason and Harrison (1996) and Madill *et al*. (2005) report that angels are involved with investees in a hands-on capacity. To explore the level of interaction between firms and equity investors, respondents were asked to indicate frequency of interaction on a seven-point scale from daily to yearly. Data is presented in Figure 4.8. Beginning with angels, just over half (52%) interact with investors monthly. Almost two-thirds of those with independent private (64%) and corporate (67%) venture capital interact with their investors monthly. Interaction with government-managed funds is on a slightly lengthier basis. Specifically, no respondent interacts on a weekly or daily basis, over half (56%) interact with fund managers monthly and almost a quarter (24%) once a quarter.

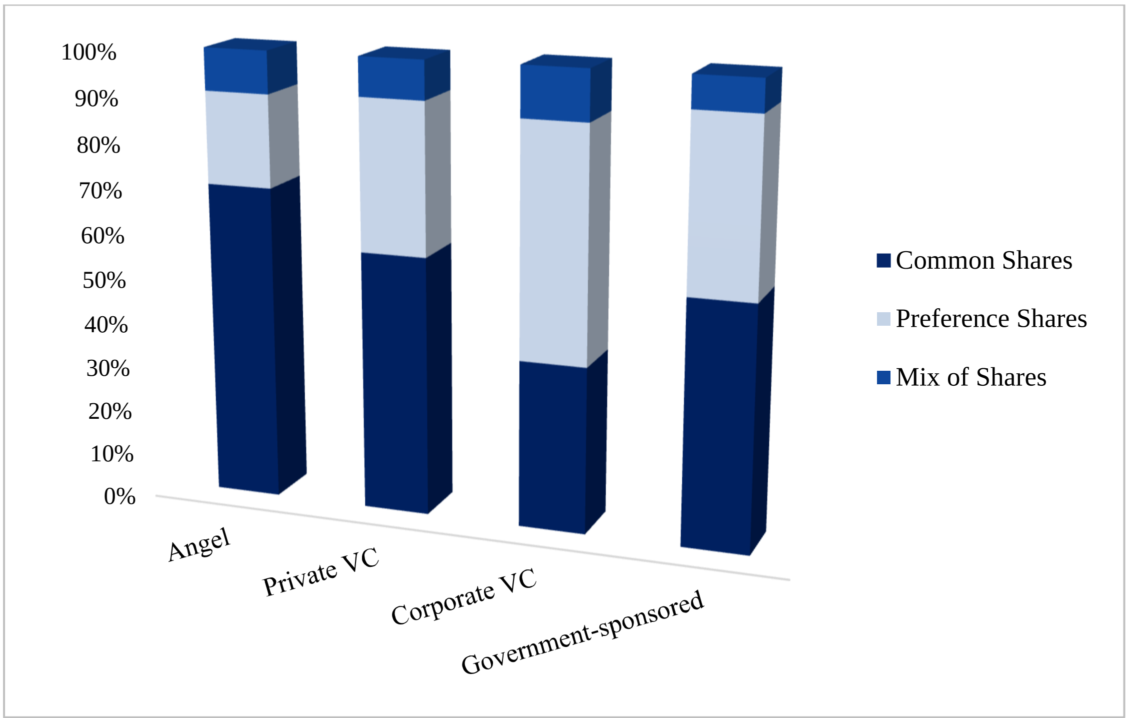
Figure 4-8. Frequency of Interaction



Source: Survey Data

Lastly, attention turns to the type of security used in contracting. Specifically, equity investors typically obtain common or preferred shares, or possibly a combination of both (Cumming and Johan, 2013). Briefly, preference stockholders have the rights to a stream of prespecified dividend payments and rank behind debt holders in bankruptcy proceedings (Cumming and Johan, 2013). Data is presented in Figure 4.9. Funding from angels, independent venture capitalists and government-sponsored equity funds is typically in the form of common stock. Preference shares are more prevalent with corporate venture capital investment.

Figure 4-9. Stock Ownership



Source: Survey Data

Next, attention turns to the attitudes and perceptions of founder-CEOs regarding various aspects of equity, from their decision to seek investment to their attitudes towards risk sharing, non-financial benefits and opinions regarding future use of external equity financing.

For a firm to be equity financed, the entrepreneur must decide to approach potential equity investors (Rasmussen and Sørheim, 2012). In addition to providing risk capital in exchange for partial ownership of the firm, these are typically active investors who seek to add value through their interaction with and advice for the managers of the firm, along with monitoring and possibly reorganisation of the company (see Bygrave and Timmons, 1992; Sapienza and Gupta, 1994; Arthur and Busenitz, 2003). Thus, in deciding to seek equity financing, the entrepreneur must bear certain consequences in mind. First, in entering a contractual relationship with an investor, the entrepreneur offers the investor not only an ownership stake in their venture but also shares the role of strategic decision-making (Reid, 1998).[89] Consequently, entrepreneurs must trade some control over their business to acquire equity (see Hellmann, 1998; Kaplan and Strömberg, 2003). Second, investors typically take an active and interventionist role in their investee firms (Wright and Robbie, 1998).[90] Third, obtaining external financing is costly (see Bruno and Tyebjee, 1985; Bhide, 1992). The time frame to obtain funds can be lengthy, the costs the entrepreneur endures to negotiate and conclude a financing deal high (Carpentier and Suret, 2006).[91] Timmons and Spinelli (2004) highlight the real time effort and energy required, along with the opportunity costs in expending resources when both the clock and calendar are moving.

[89] In fact, equity investment has long been deemed to be just as much, if not more, about managing and providing input to entrepreneurs as about providing financial resources, with investors taking a role in shaping and governing funded ventures (see Timmons and Bygrave, 1986; Barry *et al*., 1990).
[90] Common mechanisms employed, as considered previously, include appointment of independent (non-executive) directors, monitoring and interacting with investees (Sapienza *et al*., 1996; Reid, 1998; Wright and Robbie, 1998).
[91] The process is further prolonged if the funding round is the first attempt to raise finance (Hall, 2004).

Clearly, there are many dimensions to be considered in deciding to seek external equity. In evaluating these for in this study, potential considerations were grouped under three main headings, namely: Control (3 items); Intervention/Involvement (3 items); and Cost (1 item) (see Chapter 3, Subsection 3.2.2 for details). The question put to respondents was as follows: "*How important are the following considerations in your decision to seek external equity financing*?". These founder-CEOs were asked to rate each item on a five-point scale (from '*Unimportant*' to '*Very Important*'). Data is presented in Figure 4.10.

Issues relating to control appear to be important, with just over three-quarters (76.5%) considering loss of control over business decisions as important (39.9%) or very important (36.6%) in their decision to seek equity. Almost half (44.4%) consider loss of management freedom an important element, with almost a third (32.7%) rating it as very important. Almost half (45.8%) rate pressure to change their management team as an important matter, although a quarter consider this moderately important. Overall, data is consistent with the literature. The investment of self that virtually all entrepreneurs make in the venture they form is such that, while they give up a portion of the ownership of their firm in exchange for equity financing, they are likely to feel that the firm remains their baby (Arthurs and Busenitz, 2003).[92]

Moving onto concerns relating to intervention and interaction, almost three-quarters (73.2%) rate the fact that equity investment will entail increased monitoring of both themselves and their business as important (32.7%) or moderately important (40.5%). Appointment of a non-executive director is mostly considered to be of moderate importance (35.9%), although just over a quarter (28.8%) regard this as important. Over a third (39.2%) consider meeting of targets and milestones to be moderately important, while over a quarter (29.4%) regard this as

[92] Entrepreneurs have a strong sense of psychological ownership over and emotional attachment to their ventures (Pierce *et al*., 2001) and it is widely believed that they value independence and control, with the penchant for autonomy being a major motive for business ownership (see Cressy and Olofsson, 1997; Paul *et al*., 2007; Riding *et al*., 2012a).

important. The fact that equity investors will typically be involved, to some extent, in a monitoring and supervisory capacity appears to be a reasonably important matter.

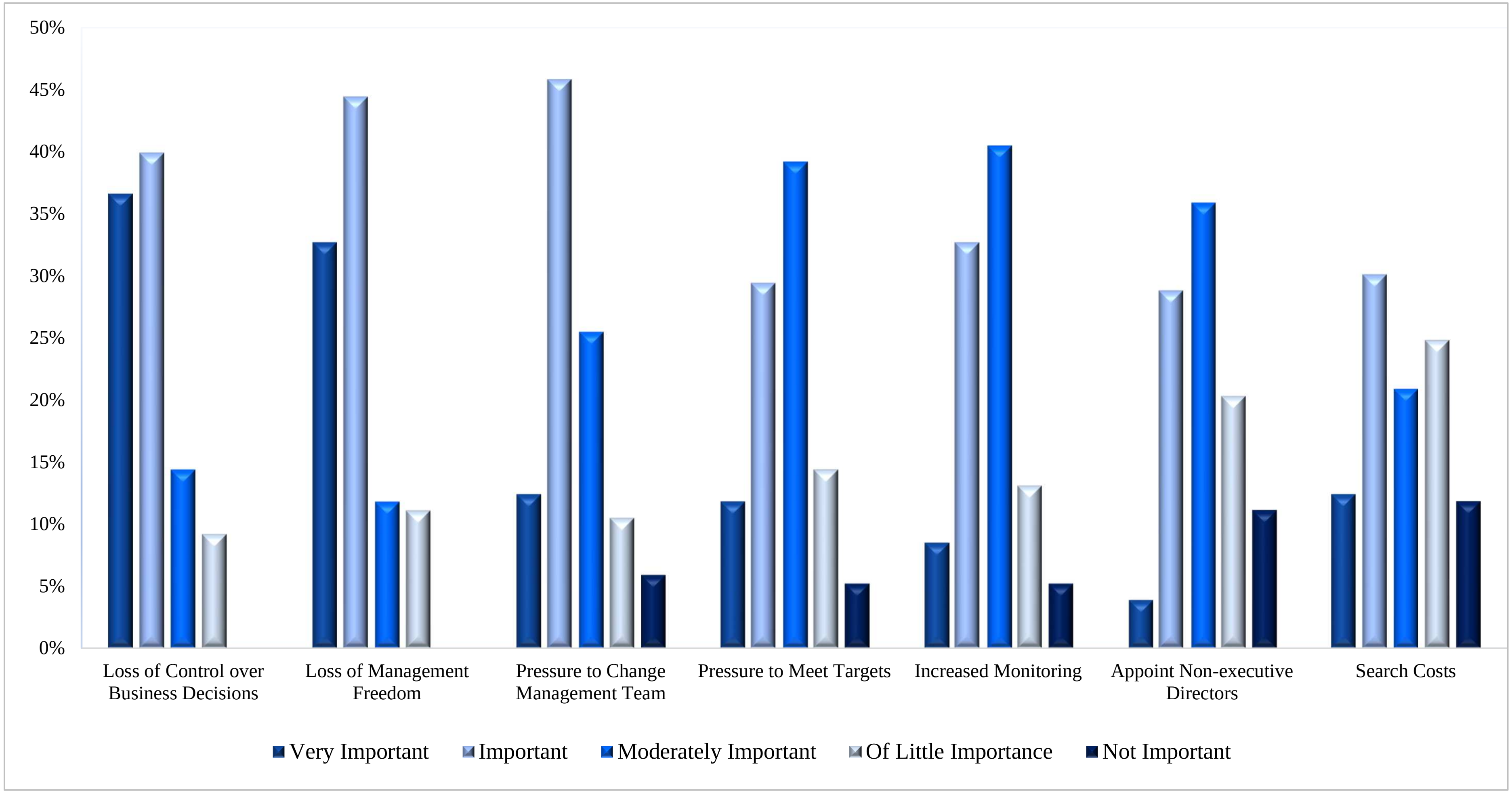
Finally, opinions appear more diverged in relation to the search costs involved in seeking equity. Specifically, although almost a third (30.1%) consider this to be an important consideration, almost a quarter (24.8%) rank it as of little importance and a fifth as moderately important. Carpentier and Suret (2006), based on data collected from Canadian technology-based firms, report that, even when they succeed, managers generally judge the process of raising external financing as long and expensive. To provide greater insight into sentiments regarding the decision to seek external equity, the following statements are taken from interview material:

"It is the most frustrating thing I have ever done…... it's a nightmare in Ireland…... much different in America. I would be aware of this in future rounds"

"Length of time it takes. It's a very lengthy process and ties you up for the best part of a year."
"Have to accept these things, they come with the agreement if you want investors…... a necessary evil."

"In a company like ours you just need the capital and that doesn't allow you to be too precious about losing control or the like. You have to get the capital."

Figure 4-10. Considerations in Seeking Equity Financing



Source: Survey Data

The entrepreneur's risk tolerance, specifically their desire to spread risk by involving external investors, can also impact on entrepreneurial financing (Amit *et al*., 1990).[93] The entrepreneur is assumed plausibly to be risk adverse because their wealth, including goodwill, is tied up in the firm (Reid, 1998). Equity investors take a stake in the business, sharing both upside and downside risks (Pfirrmann *et al*., 2012).[94] Thus, having an equity investor reduces the risk the entrepreneur is exposed to. The theoretical model developed by François and Hübner (2013) shows that the risk transfer opportunity offered through a relationship with a venture capitalist is powerful enough to induce the entrepreneur to transact with such an investor.

To explore this risk sharing aspect, respondents were asked to rate, for each equity investor, the importance of risk sharing on a five-point scale (1=unimportant; 5=very important). Data is presented in Figure 4.11. Overall, risk transfer is relatively unimportant, with over a third of those with angel (41%), independent venture capital (33.6%), corporate venture capital (37%) and government-sponsored equity (39.7%) rating the possibility of risk sharing with investors '*of little importance*' in their decision. To provide a richer sense of views towards risk sharing, the following statements are taken from interview material:

"Sharing the risk was not important to us at all, we just wanted the money upfront, we had no revenues to build the business. We were willing to take all the risk."

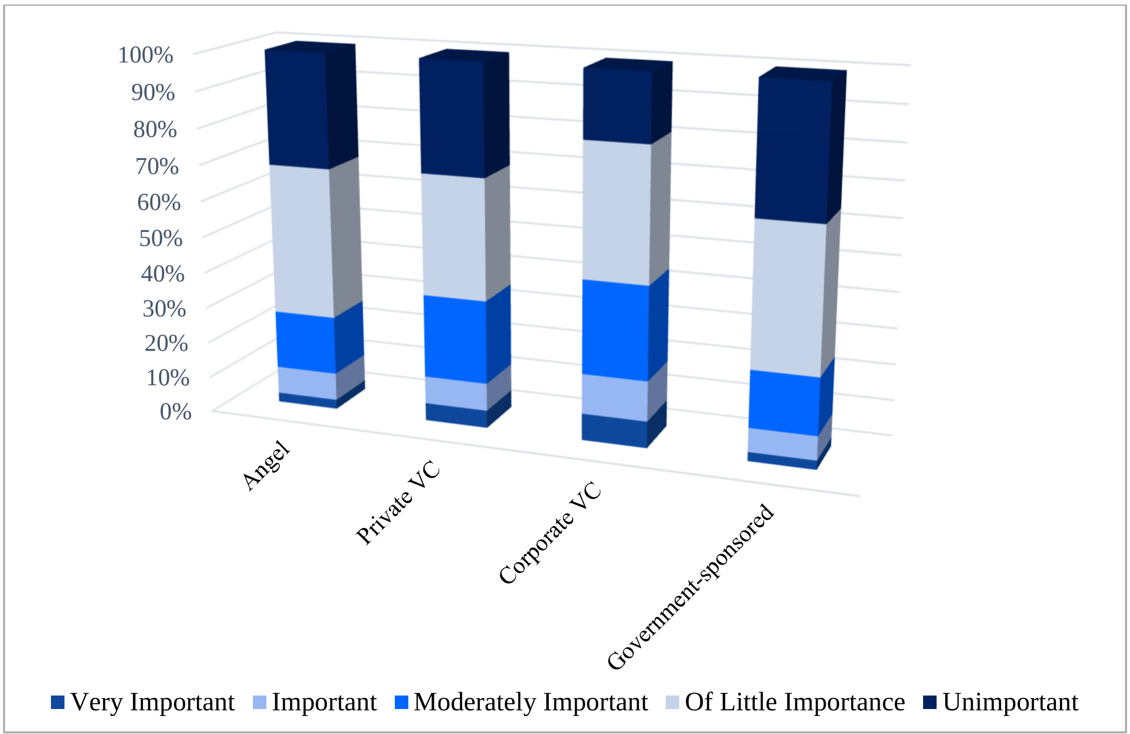
"We needed the money; risk wasn't a massive issue."

"Risk hasn't really been a factor in our decision to raise equity finance – we needed the capital and that was that."

[93] Business risk arises from the complex and turbulent competitive environment that technology-based firms operate in (see Gompers and Lerner, 2001; Reid and Smith, 2003; Cumming, 2007). Given that risk of failure is exacerbated in technology-based firms and failure can lead to financial loss or ruin at the personal level for the entrepreneur, the prospect of sharing risk with investors may feasibly play a role in financing decisions (see Amit *et al*., 1990; Reid, 1998; Ang *et al*., 2010; Coleman *et al*., 2016).

[94] The sharing rule implied by equity is such that both the investor and entrepreneur cannot, at the same time, have a claim of 100% in the firm (de Bettignies and Brander, 2007).

Figure 4-11. Risk Sharing



Source: Survey Data

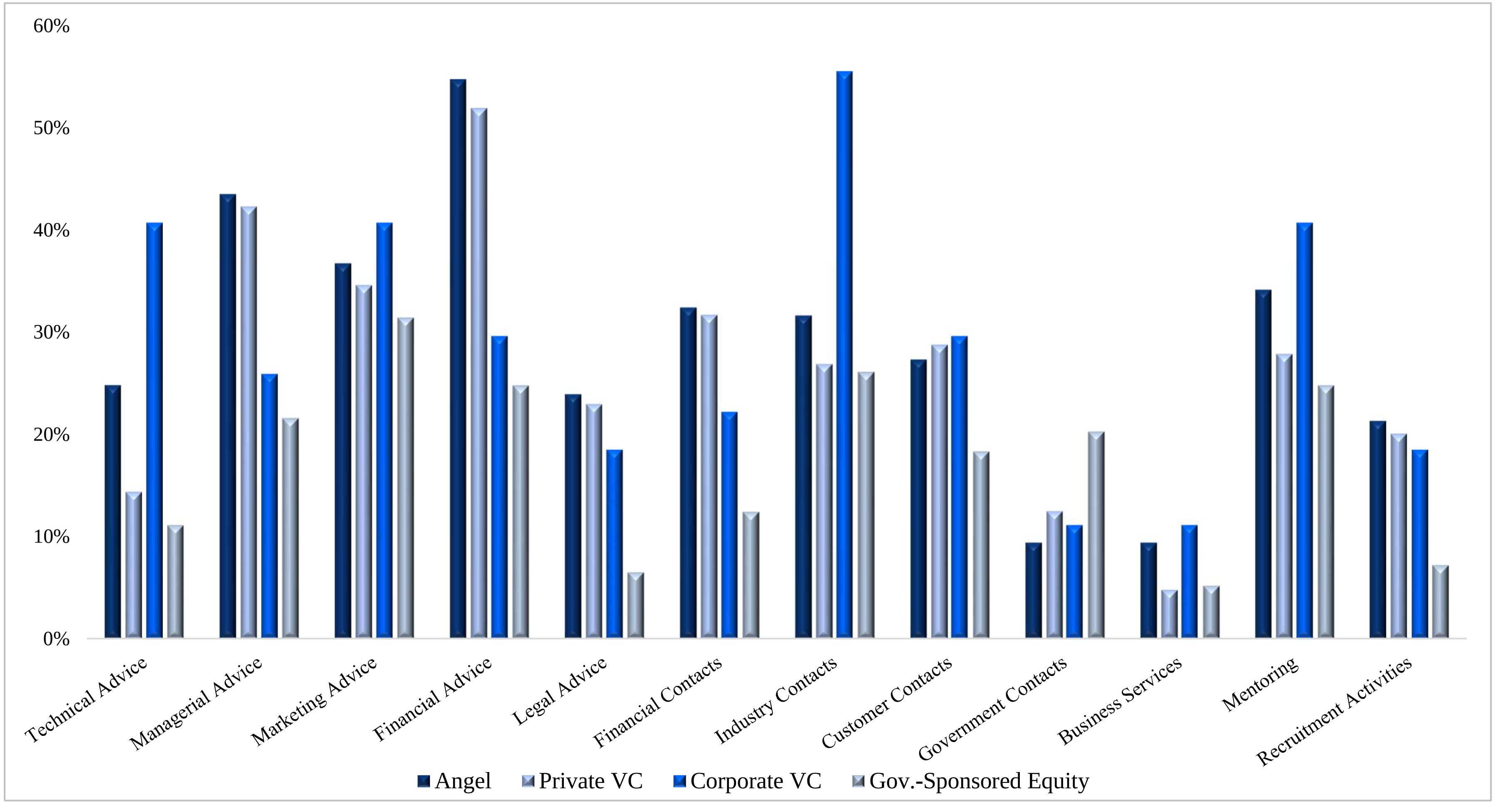
In addition to providing financing, equity investors typically actively involve themselves with investees, providing non-financial resources (see Politis, 2008; Landstrom and Mason, 2016). A review of the related literature uncovers a wide range of potential value-added activities. Using extant evidence, the measure was operationalised to examine twelve possible value-added benefits, with respondents asked to indicate, for each investor, whether they had provided such value-added support (see Chapter 3, Subsection 3.2.2). The forms of value-added are divided into three groups, namely: (1) Advice; (2) Contacts; and (3) Business development. Data is presented in Figure 4.12.

In general, guidance is the main non-financial benefit. Over half (54.7%) note that their angel provides financial advice, followed closely (43.5%) by managerial. Marketing advice (36.7%) and mentoring (34.1%) are in third and fourth place respectively. In terms of access to their social network, the most notable connection offered by angel investors is to financial contacts (32.4%), followed by industry contacts (31.6%). A fifth (20.5%) regard their angel investor to have not made any contribution beyond their financial investment. On average, respondents selected 3 (mean=3.5) non-financial value-added benefits attached to angels.

Findings are similar for independent venture capital. The top three benefits are financial (51.9%), managerial (42.3%) and marketing (34.6%) advice. Just over a fifth (21.2%) feel that their venture capitalist contributed only financial resources. On average, respondents selected 3 (mean=3.2) benefits. A notable difference when we look at corporate venture capital is the role of industry contacts. Although just over a quarter (26.9%) feel that independent investors provide access to industry contacts, over half (55.5%) indicated that they gained such connections through corporate investors. Moreover, a greater proportion (40.7%) note the technical advice offered by corporate investors. This compares to angels (24.8%), independent venture capitalists (14.4%) and government-sponsored equity (11.1%). Overall, respondents report, on average, 3 (mean=3.4) benefits from corporate investors, although almost a fifth (18.5%) state that they had not received any. Moving to government-sponsored equity, the main benefits are assistance with marketing (31.4%) and access to industry contacts (26.1%). Mentoring and financial advice are each noted by a quarter of respondents. Almost a quarter (22.3%) report that they have not received any non-financial resources. On average, those with government-sponsored equity funds selected 2 (mean=2.6) non-financial benefits.

Overall, some points are of note. First, mentoring activities appear to be greater with angel and corporate venture capital investment (34.1% and 40.7% respectively). Second, financial advice is greatest for angel (54.7%) and private venture capital (51.9%) investors. Just over a quarter of those with corporate venture capital and government-sponsored equity reported that investors provided such assistance (29.6 % and 24.8% respectively). Last, corporate venture capital investors are noted for their provision of technical advice (40.7%) and access to industry contacts (55.5%).

Figure 4-12. Non-financial Value-added



Source: Survey Data

Finally, data was gathered pertaining to viewpoint on potential sources of external equity for the future. Respondents were asked: "*Should your business require additional financing in the future, from which of the following sources will you attempt to raise these funds*?". Just over half (55.6%) with angel funding would seek this source again, while almost a fifth (16.7%) who have not used angels would consider this source going forward. Almost two-thirds (60.3%) of those with government-sponsored funding would use it again; almost a fifth (18.7%) of those who have not used this source would consider it in the future. Rates are higher for independent venture capital, with over three-quarters (80.8%) revealing that they would seek venture capital again should additional financing be required. Almost three-quarters (77.5%) of those without venture capital would consider this source going forward. Almost three-quarters (70.4%) with corporate venture capital would use it again, although just over a quarter (28.6%) of those who have not used this source would consider it in the future.

In summary, the foregoing discussion considered features of equity, along with entrepreneurial perspectives on the use of equity. The business plan, various financial statements and referrals are important sources of information in seeking financing. While indigenous technology-based firms obtain angel and private venture capital funds mostly from investors within Ireland, firms appear to go abroad for corporate investment. Co-investment and staging are commonplace. Angels and venture capitalists appear more likely to require board representation, frequently interact with firms and mostly hold common stock. Preference shares are most common for corporate venture capital. Turning to demand-side perspectives, in deciding to seek equity funding issues pertaining to control are important, although risk sharing does not seem to be key. These entrepreneurs mainly appear to benefit from the advice offered by investors, although corporate venture capital is noted for providing access to industry contacts. Overall, this Section has offered novel data on the equity financing of indigenous technology-based firms.

4.8 General Conclusions

The over-reaching purpose of this Chapter was to provide a picture of the technology-based firms examined in this thesis. The discussion began with details of general demographics, namely sectoral and geographical, firm age and size profiles. In short, most firms operate in knowledge-intensive service sectors (84%), are micro (52%) or small (37.1%) enterprises and in the early stage of their lifecycle (average age of 7.7 years). Next, attention turned to building a detailed profile of the sources of financing utilised by these firms across the lifecycle. Overall, data suggests support for the financial lifecycle (see Roberts, 1991; Berger and Udell, 1998), with personal funds prevalent during nascent and early-growth stages, and use of retained profits increasing into the expansion and later stages.

Following this, a unique characterisation of technology-based firms and entrepreneurs was presented. A comparison of equity and non-equity financed firms offered an introductory insight into potential drivers of equity financing. Specifically, discussion focused on organisational form, human capital, market extent, competitive environment, intangible resources, incubation, innovation, and financing preferences. In short, we saw that the firms in the sample for this study are predominantly privately held and mostly led by founders who have assumed the role of CEO. These individuals are highly educated, with over half (54.8%) educated to degree level. The remaining hold either a Masters (37.8%) or doctorate (7.4%). On average, these founder-CEOs have accumulated 18 years of industry-specific experience and 5 years of international experience. Organisational human capital is also noteworthy, with all employees in almost half (49%) of these firms holding a third level or equivalent qualification. These technology-based firms generate an average of 54% of turnover through exporting, with equity financed firms having a significantly higher proportion of turnover via exports in comparison to non-equity financed. We also saw that equity financed firms face significantly lower levels of competition in their main market and place greater emphasis on product differentiation. For the firms in this sample, the most common intangible assets are customer contracts and relationships (held by 81%) and intellectual property (held by 60%). A total of 44 (15%) of these firms are located in an incubator. The majority rate product and process innovation efforts as continuous (65% and 56.5% respectively) or regular (25.5% and 31% respectively). Frequency of innovation is significantly higher among equity financed firms. R&D expenditure accounts for, on average, 37% of turnover. Equity financed firms devote a significantly higher proportion of expenditure to R&D in comparison to non-equity financed. As regards intellectual property, 88 (29.6%) firms possess patents. Other forms include copyrights (28.3%), trademarks (24.8%) and registration of design (10%). As regards informal intellectual property, secrecy (42.9%) is the most common form. Lastly, to financing preferences, almost three-quarters (74.8%) of respondents stated that they prefer to used internal funding as much as possible. Overall, this detailed profile was intended to give the reader a sense of the sample compiled for this study.

Finally, attention turned to equity financing. To begin, we explored the characteristics of equity investment. We saw that co-investment is a common feature of equity financing, with technology-based firms obtaining funding from an average of two sources of equity. Over a third (38.6%) of these firms had obtained funding from all three sources (angel, venture capital (independent and/or corporate), and government-sponsored). By way of explanation, not only is co-investment a common feature of equity financing (Lockett and Wright, 2001) but, in the Irish context, government-sponsored funding is given on a matching basis (IVCA, 2012). Thus, firms will typically also raise funding from a private source (angel or venture capital) when they obtain government-sponsored funding. Staging of capital injections is a common feature of equity investment. Specifically, of those with angel financing, almost two-thirds (62.4%) obtained funding in stages, while over two-thirds (67.8%) obtained government-sponsored equity in stages. Almost three-quarters of independent (70.6%) and corporate

(74.1%) investment was staged. This is consistent with the extant literature highlighting the use of staged investment as a common control and monitoring mechanism in equity financing (see Gompers, 1995; Wong *et al*., 2009; Sharma and Tripathi, 2016). Regarding the location of investors, the majority of angels (90.6%) and independent venture capitalists (81.4%) are based in Ireland. Those with corporate venture capital have mostly (77.7%) sourced investment from outside of Ireland. Following this, emphasising the centrality of the entrepreneur, consideration turned to perceptions of and attitudes towards equity financing. Aspects examined included risk sharing, non-financial benefits provided and considerations in seeking equity. Issues pertaining to control are important to entrepreneurs, although risk sharing does not seem to be key. In terms of non-financial value added, entrepreneurs mainly felt that they benefit from the advice offered by investors.

The contributions of Chapter 4 lie in three areas. First, a detailed and unique profile of Irish technology-based firms is provided, including a comparison of equity and non-equity financed firms. This builds on and extends the work of Hogan and Hutson (2005b, 2006), using novel micro-micro data to construct a unique and comprehensive profile of technology-based firms and the entrepreneurs behind them. Second, a novel retrospective portrayal of the financing patterns of Irish technology-based firms over consecutive stages in the lifecycle is provided. This profile follows firms from birth as they evolve through their lifecycle, providing original evidence. Third, and finally, an in-depth and original description of equity investment, and entrepreneurs' attitudes towards utilising equity, is presented covering not only the type of equity investors active in the financing of Irish technology-based firms but the structure of equity investment. Overall, in addition to contextualising the study, the discussion herein provides a reference point for understanding the results of the quantitative analysis going forward, essentially serving as a facilitator of empirical investigation.

CHAPTER 5 :

DETERMINANTS OF EQUITY FINANCING FOR TECHNOLOGY-BASED FIRMS IN IRELAND

5.1 Introduction

Finance is one of the fundamental resources required for enterprises to form and subsequently operate and grow (Riding *et al*., 2012a). A key challenge for technology-based firms, however, is access to adequate financial resources (see Lindström and Olofsson, 2001; North *et al*., 2013).[95] Equity is considered a particularly suitable source of entrepreneurial finance for these firms (see Gompers and Lerner, 2001; Cumming *et al*., 2017). With this in mind, this Chapter undertakes a micro-micro-econometric analysis of Irish technology-based firms with a view to establishing those attributes which are likely determinants of equity financing.

Being equity financed can hardly be considered a random process – entrepreneurs choose whether to search for equity funding and investors carefully screen and select portfolio firms (Grilli and Murtinu, 2014b). Thus, for a firm to be equity financed, two conditions must be fulfilled: (1) founder(s) decide to seek external equity finance; and (2) equity investor(s) decide to invest in the firm (Rasmussen and Sørheim, 2012). Although an understanding of both components is necessary to fully comprehend the nuances of equity financing (Eckhardt *et al*., 2006), there is a preponderance of theory and evidence emphasising the supply-side, putting the decision-making process of investors in the foreground (Seghers *et al*., 2012). These studies rely on the accuracy of investors' insight into their own decision process and thus may suffer from cognitive and perceptual limitations, including recall and post-hoc rationalisation biases (Shepherd and Zacharakis, 1999). Essentially, as investors do not always make decisions in the way they think they do (Shepherd, 1999), examining investees should yield more exact evidence on determinants of equity (Gimmon and Levie, 2010). Entrepreneurs are the driving force of key decisions and, consequently, demand-side factors

[95] Capital market imperfections arise due to idiosyncratic attributes of technology-based firms, namely high levels of information asymmetry, the technological-intensity of their business model and the intangible nature of their assets (see Carpenter and Petersen, 2002a; Cumming *et al*., 2017). See Chapter 2, Subsection 2.2.2.

are likely to play a crucial role in entrepreneurial financing (Cassar, 2004). Addressing the dearth in the literature noted by Howorth (2001) and Gregoire *et al.* (2011) and responding to Rasmussen and Sørheim's (2012) call for greater focus on the demand-side, empirical analysis herein explores the attributes of equity financed firms with a view to ascertaining those factors that are significant determinants of equity financing.

This work builds on three noticeable gaps in the literature. First, research is largely segmented and predominantly focused on an individual source of equity. Specifically, evidence almost exclusively details the attributes of firms financed by (independent) venture capitalists (see Mann and Sager, 2007; Colombo and Grilli, 2010; Audretsch *et al*., 2012; Hoenen *et al*., 2014). Research on angel finance is restricted to examination of applications submitted to angels or angel groups (see Mitteness *et al*., 2012; Brush *et al*., 2012) or interactions between entrepreneurs and angels (Maxwell and Lévesque, 2010). To the best of our knowledge, nobody has, to date, examined government-sponsored equity from this perspective. We adopt a broad definition of equity, encompassing private (venture capital, angels) and public (government-sponsored) sources, to examine the attributes of technology-based firms, and the people within these firms, to identify the determinants of equity financing. As Moskowitz and Vissing-Jorgensen (2002) point out, venture capital accounts for a trivial fraction (less than 1%) of the private equity market. Thus, a more thorough analysis of alternative funding sources will allow for a more complete understanding of the factors driving equity financing. Second, demand-side work largely focuses on a narrow set of signals in isolation. These include human capital (see Gimmon and Levie, 2010; Behrens *et al*., 2012), patents (see Haeussler *et al*., 2014; Munari and Toschi, 2015), trademarks (see Block *et al*., 2014; Zhou *et al*., 2016), growth (Davila *et al*., 2003) and social ties (Shane and Stuart, 2002). By examining the impact of an array of factors we expand on existing evidence. Furthermore, some of the factors considered herein have not previously been examined in this context (i.e. perceived rivalry, differentiation, exporting, organisational human capital, perceived innovativeness) and thus provide novel evidence. Third, researchers commonly conduct empirical investigation in the context of a specific sector, including biotechnology (Hoenen *et al.*, 2014), biopharmaceutical (Behrens *et al*., 2012), software (Hogan and Hutson, 2005a), and nanotechnology (Munari and Toschi, 2015). Others (see Engel and Keilbach, 2007; Audretsch *et al*., 2012; Zhou *et al*., 2016) provide demand-side evidence but do not limit their focus to technology-based sectors. Our analysis complements these studies by utilising data from a unique sample across technology-based manufacturing and knowledge-intensive service sectors, adopting a broader classification of technology-based firms to provide original demand-side evidence of the determinants of equity financing.

Accordingly, the novelties of this Chapter lie in these three directions. First, a recent call for the development of a more diversified funding environment for Irish businesses, moving away from an over-reliance on debt-based financing, emphasises the need to encourage and facilitate the use of external equity financial resources (see Government Medium-Term Economic Strategy 2014-2020; O'Toole *et al*., 2015). Quantitative analysis presented herein, through adoption of a broad definition of equity finance, provides greater insight into the drivers of equity finance and this, in turn, serves to improve our understanding of potential contributory elements that enhance overall use of this form of entrepreneurial financing. This evidence may be used to cultivate and enhance access to equity funding. How entrepreneurs can improve their attractiveness to potential investors has been an important focus for policy (Mason and Kwok, 2010), but the academic literature has devoted little attention to this issue (Rasmussen and Sørheim, 2012). Second, empirical analysis investigates the impact of a diverse range of potential determinants of equity financing, capturing attributes of not only the technology-based firm but also the people within the firm. The signalling role of several of these factors has not previously been examined from the demand-side, including market rivalry, product differentiation, organisational human capital and financing preferences, and thus provides novel empirical evidence. Moreover, those studies that do present demand-side evidence tend to examine one type of signal in isolation, mostly human capital or patents (see Patzelt, 2010; Audretsch *et al*., 2012). Finally, analysis is based on primary-source data gathered from a unique sample of Irish technology-based firms, across technology-based manufacturing and knowledge-intensive service sectors. Data of this kind does not currently exist in the Irish context.

The empirical model estimated in this Chapter is also used to correct for sample selection issues going forward (Chapters 6 and 7), where analysis is based solely on equity financed firms (N=153). The two-step Heckman (1979) selection model is employed to compute an Inverse Mills' Ratio (IMR) which addresses selection bias that may arise due to unobservable factors affecting both the probability of a firm self-selecting its treatment (i.e. seek equity finance) and the treatment outcome (i.e. being equity financed). The probit regressions, which model the probability of the firm being equity financed, estimated here are used to generate linear predictions and associated Mills' ratio for inclusion as a regressor in quantitative analysis going forward. This Mills' ratio controls for the unobserved heterogeneity which affects a firm's probability of being equity financed (Bertoni *et al*., 2011).

The remainder of this Chapter is structured as follows. This introduction is followed by Section 5.2 which briefly outlines the theoretical background and reviews existing evidence to develop hypotheses. Next, Section 5.3 provides an overview of the data, key variables and model employed. In Section 5.4 results are presented and discussed. Finally, Section 5.5 concludes and highlights possible implications from empirical enquiry.

5.2 Theoretical and Empirical Background

Discussion begins with a brief synthesis of the theory upon which empirical analysis is based (Subsection 5.2.1). Following this, attention turns to hypotheses development (Subsection 5.2.2). Specifically, exploring the potential determinants of equity financing as initially identified in Chapter 2 (Subsection 2.4.1), the aim is to identify the information these signals convey to external investors and the effect this may have on the likelihood of obtaining equity finance.

5.2.1 Theoretical Perspective

As discussed in Chapter 2 (Subsection 2.2.2), the primary theoretical underpinning for this study is agency theory (Jensen and Meckling, 1976). At the pre-investment phase, two mechanisms are employed to mitigate agency issues: screening (seeking of additional information by the equity investor) and signalling (transmission of privately held information to potential investors by the entrepreneur) (see Stiglitz, 2000; Janney and Folta, 2003; Dehlen *et al*., 2014). In brief, external investors, who cannot assess unambiguous information regarding intrinsic quality, screen and filter potential investees based on the presence of attributes assumed to be correlated with desired, but unobservable, qualities (Weiss, 1995). Correspondingly, because equity investors cannot distinguish a good from bad investment opportunity when faced with a pool of firms in need of external finance (Hyytinen and Väänänen, 2006), entrepreneurs face the challenge of credibly informing potential investors of their quality through the communication of observable signals that contain information on unobservable attributes (Courtney *et al*., 2017). In considering potential determinants of equity financing herein, research on the screening criteria applied by equity investors (supply-side) and signals used by entrepreneurs (demand-side) is examined to identify drivers of equity.

A widely shared view in the literature is that equity investors possess screening capabilities (Chan, 1983) which enable them to attenuate issues resulting from information asymmetries (see Gompers and Lerner, 2001; Guerini and Quas, 2016).[96] In short, because external investors have difficulties valuing potential investees (given high levels of uncertainty and asymmetric information), they tend to rely on indirect indicators to measure potential, including attractiveness of the investment opportunity and attributes of the management team (MacMillan *et al*., 1985).[97] In general, researchers typically group investment criteria into four broad categories, namely: (1) product offering; (2) market characteristics; (3) entrepreneur and/or management team; and (4) financial considerations (see MacMillan *et al*., 1985; Muzyka *et al*., 1996; Franke *et al*., 2008; Kollmann and Kuckertz, 2010; Petty and Gruber, 2011; Carpentier and Survet, 2015 Woike *et al*., 2015).

Mirroring screening, signalling is fundamentally concerned with reducing information asymmetries between two parties (Connelly *et al*., 2011). Grounded in Spence's (1973, 1974) signalling theory, the assumption is that, in the presence of asymmetric information, the informed party (entrepreneur) can send observable signals to the less informed party (external investor).[98] Entrepreneurs seeking funding often use signals that partly substitute for incomplete information (see Busenitz *et al*., 2005; Courtney *et al*., 2017) and investors tend to rely on these signals in making investment decisions (see Amit *et al*., 1990; Higgins and Gulati,

[96] According to Chemmanur *et al*. (2011) screening is the investor's ability to select better options in the presence of information asymmetries.

[97] Most have a set of clearly defined criteria which influence the type of firms that they consider investing in (see Mason and Rogers, 1997; Mason and Harrison, 2002a) and a large body of research is committed to furthering our understanding of equity investors' decision-making process by providing insight into the criteria that drive evaluation and selection of investment opportunities (see Tyebjee and Bruno, 1984; Hall and Hofer, 1993; Zacharakis and Meyer, 2000; Mason and Stark, 2004; Franke *et al*., 2008; Petty and Gruber, 2011). The reader is referred to Chapter 2, Subsection 2.4.1.

[98] Spence's (1973, 1974) seminal work on labour markets demonstrated how a job applicant might distinguish themselves via the costly signal of education. He showed that more productive candidates do not receive higher wages than less productive unless the more productive candidates engage in activities that are positively related to unobserved quality and are costly to imitate. Accordingly, more productive candidates can use their educational achievement as a signal of productivity and hence can differentiate themselves from less productive counterparts. According to Spence (2002, page 407), signals are "*things one does that are visible and that are in part designed to communicate*". The reader is referred to Chapter 2, Subsection 2.2.2.

2006) because separating, a priori, high quality investees from those with less potential can be difficult (Davila *et al*., 2003).[99] Signalling theory is commonly applied by researchers to identify the attributes of the firm/entrepreneur which represent signals in obtaining external financial resources (see Coleman and Robb, 2011; Hottenrott *et al*., 2016).

Studies that deal with either screening or signalling are considered next with a view to identifying potential determinants of equity financing and developing related hypotheses.

5.2.2 Empirical Evidence and Hypotheses Development

In the proceeding discussion we examine the existing empirical evidence to identify which firm and entrepreneur attributes are potentially significant determinants of equity financing. These factors are considered within the following categories: (1) market and product; (2) incubation; (3) innovation activity; (4) human capital; and (5) financing-related. This categorisation in line with the literature considered in Chapter 2 (Subsection 2.4.1) and the attributes of equity financed firms profiled in Chapter 4 (Section 4.6).

Market and Product

It is clear from existing supply-side research that attributes of the firm's target market and product offering are important criteria for equity investors in evaluating potential investees (see Hall and Hofer, 1993; Petty and Gruber, 2011; Mitteness *et al*., 2012). A market deemed too crowded or competitive is a common cause for investment proposal rejection (see Petty and Gruber, 2011; Carpentier and Suret, 2015). Similarly, both Shepherd *et al*. (2003) and Rakhman and Evans (2005) find that equity investors rate little threat of competition as a desirable attribute of potential investees. Although there is a lack of demand-side evidence on

[99] An effective signalling device essentially allows potential investors to distinguish accurately between prospective investees in terms of quality and future returns on investment (Haeussler *et al*., 2014).

the role of market-related factors as signals, let us briefly consider why lower levels of rivalry may serve as a signal for entrepreneurs attempting to attract equity investors. Targeting niche markets represents an option for firms beyond saturated mass markets (see Debruyne and Reibstein, 2005; Gordon, 2011; Hamlin *et al*., 2012).[100] By pursuing a niche marketing strategy, the firm focuses on a smaller market for the advantages of higher prices and less competition (Varadarajan and Jayachandran, 1999). Furthermore, what starts out as a relatively small niche market can offer growth potential (Kotler and Keller, 2006), and thus develop into a larger and more attractive market in time (Debruyne and Reibstein, 2005). As such, if the firm's product offering is successful in a niche position it may potentially gain a head-start on rivals when the niche market grows (Dalgic and Leeuw, 1994). Thus:

> **Hypothesis 1**: *Market competition has a negative impact on the likelihood of obtaining equity financing.*

According to Carpentier and Suret (2015), investors are also attracted to opportunities that offer the potential of targeting a worldwide market. To the best of the author's knowledge, no evidence exists as to the impact of exporting as a determinant of equity financing. However, realistically, it is possible this may be a useful signal. It is well established that firms engaged in exporting enjoy higher growth rates, productivity and performance in comparison to non-exporting (see Lu and Beamish, 2001; Martins and Yang, 2009). Early studies by Wagner (1995) and Bernard and Wagner (1997) establish that firm growth and exporting are positively related. Melitz (2003) theoretically established that when a firm is exposed to trade, only the most productive will export and benefit since only they can bear the fixed costs of trade barriers. The positive association between exporting and efficiency has also been explained as the self-selection of the more efficient firms into the export market (Clerides *et al*., 1998).

[100] According to Porter's (1980) strategic approaches, focusing on specific needs of parts of the market rather than addressing the whole market (i.e. pursuing a niche marketing strategy) can be a source of a competitive advantage.

Furthermore, others report a positive correlation between exporting and both innovation and survival (see Roper and Love, 2002; Siedschlag *et al*., 2011; Wagner, 2014). Given these considerations the following hypothesis is proposed:

> **Hypothesis 2**: *Exporting has a positive impact on the likelihood of obtaining equity financing.*

Supply-side evidence suggests that investors attach importance to the uniqueness and competitiveness of the product offering (see Fried and Hisrich, 1995; Kaplan and Strömberg, 2000; Knockaert *et al*., 2010). Indeed, Petty and Gruber (2011) show that product-related factors play a key role in the investment decision making process of European venture capitalists, with a lack of product differentiation being a primary cause for proposal rejection, above factors relating to the management team. Similarly, Hindle and Wenban (1999) and Hindle and Lee (2002) find that the uniqueness of the product is key for angels. Although, to the best of the author's knowledge, no corresponding demand-side evidence exists, having a novel product offering should represent a positive signal by equity investors. Through product uniqueness, or innovativeness, the firms effectively position themselves to appeal to investors looking to access new, untapped markets (Parhankangas and Ehrlich, 2014). With a unique product, its relative specificity can create protection from fierce competition (see Porter, 1980; Tisdell and Seidl, 2004) as few competitors are neither willing nor able to offer such distinct products for a potentially small customer base (Schaefers, 2014). Moreover, customers are often willing to pay higher prices for distinct products (see Varadarajan and Jayachandran, 1999; Toften and Hammervoll, 2013). Thus, the following hypothesis is proposed:

> **Hypothesis 3**: *Product differentiation has a positive impact on the likelihood of obtaining equity financing.*

Affiliation

Entrepreneurs often depend on social ties and third-party certification to overcome information asymmetry and uncertainty prevalent in entrepreneurial financing (see Venkatarman, 1997; Shane and Cable, 2002; Hsu, 2007). Third-party intermediaries can mitigate information and agency issues by virtue of their reputation capital (see Megginson and Weiss, 1991; Jain and Kini, 1995; Jain *et al.*, 2008).[101] Incubation centres may play such a role. Obtaining the benefits of an image associated with an incubator location and acquiring credibility is an important advantage of incubation (see Ferguson and Olofsson, 2004; McAdam and McAdam, 2008). Incubators also offer business and technical assistance, which is important for successful development (Hackett and Dilts, 2004) and sustainable growth (Cockburn *et al.*, 2000). There is evidence that firms associated with incubators succeed at a greater rate than non-incubated firms (Mian, 1997). Colombo and Delmastro (2002), based on a study of Italian firms, found that incubated firms exhibited greater job growth, innovation, technology adoption and co-operative relations. Moreover, incubators provide entrepreneurs with valuable networks which can facilitate access to external investors (see Hansen *et al.*, 2000; Scillitoe and Chakrabarti, 2010). McAdam and McAdam (2008) examine high-technology firms based in university incubation centres in Ireland and the UK and find that incubators play a key role in facilitating access to venture capitalists. Effectively, the network provided by the incubator may be an important screening and signalling device (Burt, 1992), whereby the support of the incubation centre provides not only a third-party endorsement effect but also offers support mechanisms which ensure entrepreneurial stability, growth and potentially business survival (Schwartz, 2013). This suggests the following:

> ***Hypothesis 4****: The support of an incubation centre has a positive impact on the likelihood of obtaining equity financing.*

[101] Essentially, affiliation with reliable third parties can help to reduce uncertainty by endorsing the quality of the firm and affording it a measure of legitimacy (Plummer *et al.*, 2016).

Innovation Activity

Equity financing is considered a particularly important and appropriate source of funding for innovative firms (see Brown *et al*., 2009; Zhou *et al*., 2016), who are particularly susceptible to market failures (Hall and Lerner, 2010).[102] There are various reasons to expect that innovation activity may act as a signal to external equity investors. Innovation can have desirable side-effects on firm performance and growth (see Schumpeter, 1950; Romer, 1990; Geroski, 2005; Coad and Rao, 2008). An early study by Mansfield (1962) showed that successful innovators grew quicker, especially if they were initially small. Geroski and Machin (1992), find that innovating firms are more profitable and grow faster than non-innovators. Roper (1997) shows that innovative products introduced by firms made a positive contribution to sales growth. Similarly, Colombelli *et al*. (2013) find an unambiguous positive association between product, process and organisational innovation and sales growth. In addition to the direct effect on performance, learning during the innovation process (Van de Ven and Polley, 1992) generates absorptive capacity, defined as the capability to identify, assimilate, and apply knowledge (Cohen and Levinthal, 1990), which confers a competitive advantage (Zahra and George, 2002). Further benefits of innovation include economies of scale and scope, pre-emption of limited resources, advantages in further innovation, and the ability to set standards (see Shepherd and Shanley, 1998; Rosenbusch *et al*., 2011). Additionally, innovation activities have also been linked to the probability of survival (see Cefis and Marsili, 2006; Fontana and Nesta, 2009; Giovannetti *et al*., 2011; Børing, 2015).

Empirically, it appears that innovation is indeed an important signal to equity investors. Evidence presented by Hellmann and Puri (1998), based on firms located in Silicon Valley, shows that firms pursuing an innovator strategy are more likely to obtain venture capital.

[102] These firms are hit by significant market imperfections when seeking external finance due to three well-known reasons: first, innovation projects are risky, with uncertain and highly skewed returns; second, information asymmetries characterise innovation-intensive projects; and third, the majority of the investment is in intangible, knowledge-based assets (see Carpenter and Petersen, 2002a; Audretsch *et al*., 2012).

Likewise, for Austrian firms, Peneder (2010) reports that those with above average levels of innovation are more likely to obtain venture capital. Mina *et al*. (2013), for a sample of firms in the U.K. and U.S., find that product and process innovations constitute signals for potential equity investors and significantly helps firms to attract external investment. Based on this:

Hypothesis 5*: Innovation activity has a positive impact on the likelihood of obtaining equity financing.*

A critical input into the innovation process (see Hall, 2002; Brown *et al*., 2009), R&D can also provide important informational cues to equity investors. R&D enables the firm to create new products and develop more efficient productive processes (Nunes *et al*., 2012) while also driving technological advancements and firm growth (Chen *et al*., 2005). Using a sample of U.S. public companies, Lev and Sougiannis (1996) find a significant inter-temporal association between R&D and stock returns. Others report a positive association between R&D investment and firm market value (see Hall and Oriani, 2006; Hughes, 2008) and sales growth (see Del Monte and Papagni, 2003; Demirel and Mazzucato, 2012; Garcia-Manjón and Romero-Merino, 2012). According to Noel and Schankerman (2013) there are large, positive technology spill-overs from R&D for software firms. Furthermore, investment in R&D can also impact survival (see Hall, 1987; Esteve-Perez *et al*., 2004).

Existing evidence shows a positive correlation between R&D and equity finance. In their analysis of publicly-traded UK firms, Aghion *et al*. (2004) find that R&D-intensive firms are more likely to issue equity, with the use of equity increasing with R&D intensity. Casson *et al*. (2008) and Wang and Thornhill (2010) also find a positive relationship between R&D and equity financing. This result is echoed by Lahr and Mina (2016) who, using a sample of UK and US businesses, find that R&D expenditure is a strong predictor of use of venture capital. Essentially, because reducing information asymmetries via fuller disclosure is often of limited effectiveness in this arena (ease of imitation makes firms reluctant to reveal full details of innovative ideas), given that data pertaining to R&D expenditure is more readily available, it is feasible that this should be an effective and observable signal (Hall and Lerner, 2010). This leads to the following hypothesis:

> **Hypothesis 6:** *R&D activity has a positive impact on the likelihood of obtaining equity financing.*

Commonly used as a proxy for innovative output (Smith, 2005) patents can also represent an important signal (see Long, 2002; Hoenig and Henkel, 2015). In short, the knowledge generated through innovative activity exhibits, at least partly, characteristics and properties of a public good – it is non-excludable and non-rival in use (Arrow, 1962). Thus, in order to fully appropriate investments in innovative activity, the associated intellectual property must be guarded by protection mechanisms such as patents, which not only signal the ability to appropriate the returns of innovations but also the actual feasibility of the proposed project (Audretsch *et al*., 2012). Entrepreneurs may also be attracted to patenting in order to signal commercial value of their innovations (Hall and Ziedonis, 2001). Moreover, the ability to patent can serve as an indicator of future survival (Smith and Cordina, 2015) while, on the other hand, enabling investors to recover some salvage value from failing firms (Hall and Harhoff, 2012). In addition, patents may facilitate the licensing of technology (see Gans *et al*., 2008; Haeussler *et al*., 2009), giving the venture an additional source of revenue. Lending further support to the value of patenting as a signal, Helmers and Rogers (2011) study a panel of UK start-ups and find that those with patents show higher asset growth than those without and this asset growth, in turn, indicates the lucrativeness of investing in firms with patents.

Evidence confirms the importance of patent protection as a signal for external financiers (see Engel and Keilbach, 2007; Audretsch *et al*., 2012; Conti *et al*., 2013). Based on a sample of German and British biotechnology firms, Haeussler *et al*. (2009) find that as start-ups file patent applications, the hazard of obtaining venture capital increases. They argue that venture capitalists not only consider patent grants but also applications as useful signals because applications contain technical information that allows them to assess strength and weaknesses of the invention. Baum and Silverman (2004) report that biotechnology start-ups in possession of patent applications or grants receive significantly more venture capital funding than those without. Results presented by Hsu and Ziedonis (2008) suggest a significant effect of patents on investor estimates of firm value. With respect to the supply-side, patent protection is an important factor for investors in making the decision of whether to invest (see Feeney *et al*., 1999; Maxwell *et al*., 2011). In short, patents are considered evidence of the quality of the management team, that it is at a certain stage of development, and has defined and carved out a market niche (Lemley, 2001). Thus, the following hypothesis is proposed:

Hypothesis 7: *Patents have a positive impact on the likelihood of obtaining equity financing.*

Human Capital

Another key factor to consider in examining determinants of equity financing is the personal aspect, with both supply- and demand-side researchers in general agreement as to the importance of human capital in attracting external investment (see Dimov and Shepherd, 2005; Behrens *et al*., 2012; Rauch and Rijsdijk, 2013; Chowdhury *et al*., 2014). Prior studies have shown that the background of the entrepreneur/management can signal information regarding the credibility and quality of the firm (see Hsu, 2007; Patzelt, 2010). The indicators of human capital that are commonly applied, all focused on the individual level (i.e. founder/management team), include education level (Hsu, 2007), industry-specific experience (Behrens *et al*., 2012) and international experience (Patzelt, 2010). The signalling effects of these attributes are considered herein. Additionally, we argue that organisational human capital may also represent an important signal in accessing equity financing.

Some signals are effective because they imply a certification by third parties who, in this case, can be academic institutions (Weiss, 2004). Specifically, a founder's level of education can convey valuable information to external investors (see Rauch and Rijsdijk, 2013; Chowdhury *et al*., 2014). Highly educated individuals generally will not allow themselves to be connected to or involved in lower-quality ventures given associated opportunity costs (i.e. foregone benefit of the next available alternative) (Gimeno *et al*., 1997). Consequently, the higher the founder's education, the more attractive the rewards related to the venture they select might be expected to be (see Amit *et al*., 1995; Cassar, 2014). Moreover, higher levels of education are found to contribute to lower failure rates for technology-based firms (see Roberts, 1991; Storey and Tether, 1998; Colombo and Grilli, 2005a). Those who are highly educated are more likely to possess the tools necessary to manage a firm, along with the critical thinking skills required to evaluate business situations and establish more successful firms (see Colombo and Grilli, 2010; Coleman *et al*., 2013) and a recurring finding is that highly-educated entrepreneurs are more likely to run faster-growing businesses than those who are less educated (see Sapienza and Grimm, 1997; Kim *et al*., 2006).

Empirical evidence confirms that educational attainment acts as a valuable signal in attracting equity investors. In a study of entrepreneurs from firms in the Internet industry taking part in an MIT educational program, Hsu (2007) reports that start-up teams with a doctoral degree holder are more likely to be funded through venture capital. In their study of the determinants of venture capital financing of Irish software firms Hogan and Hutson (2005b) find that the education of the lead founder to degree level is positively related to venture capital funding. Gimmon and Levie (2010), examining founders of technology-based start-ups in Israel, find that those who have achieved a high academic status, such as a masters or doctorate degree, are more likely to attract external equity investors. Furthermore, based on a sample of

Italian technology-based firms, Colombo and Grilli (2010) establish that the university-level education of founders has a positive effect on the likelihood of receiving venture capital. Thus:

Hypothesis 8: *Founder-CEO educational attainment has a positive impact on the likelihood of obtaining equity financing.*

Although the literature predominantly emphasises the individual level, focusing entirely on the founder or management team (see Beckman *et al*., 2007; Colombo and Grilli, 2010; Behrens *et al*., 2012), it is argued that a substantial share of the firm's human capital resides in its workforce (Subramaniam and Youndt, 2005). Human capital theory posits that employees with higher levels of education will achieve more desirable outcomes by being more productive (Becker, 1975). Research shows that human capital embedded in the knowledge and skills of employees is a key contributor to the firm's capabilities and performance (see de Grip and Sieben, 2005; Chowdhury *et al*., 2014). Knowledge contained within employees not only leads to more efficient work (Rauch *et al*., 2005) but those with higher levels of education typically possess higher intellectual potential to learn and accumulate tacit knowledge (Hitt *et al*., 2001). Furthermore, empirical evidence suggests that there is a positive relationship between workforce qualification level and firm productivity (Arvanitis and Loukis, 2009) and innovation (Coronado *et al*., 2008). Educational attainment of employees can be particularly important for technology-based firms given that highly qualified personnel possess a greater ability to solve problems extemporaneously and to fluidly adapt to changes in the external environment (Wright *et al*., 2007), while also enabling the firm to implement new technologies more effectively (see Siegel *et al*., 1997; Siegel, 1999; Link and Siegel, 2007). As such, it is possible that a proportion of the value of technology-based firms is likely to be determined by the quality of its employees (Shrader and Siegel, 2007). Unfortunately, to the best of our knowledge, there is currently no empirical evidence of the role of organisational human capital as a determinant of equity financing. However, given the considerations outlined, it is plausible to expect that:

Hypothesis 9: *Workforce qualification level has a positive impact on the likelihood of obtaining equity financing.*

Moving to specific human capital, supply-side evidence clearly shows that equity investors look for entrepreneurs with relevant same-sector experience (see Hall and Hofer, 1993; Sudek, 2006; Clark, 2008; Patzelt, 2010). Carpentier and Suret (2015) find a highly significant relationship between industry-specific experience and the probability of successfully raising angel funding. Hsu *et al*. (2014) confirm that relevant experience is valued by angels and venture capitalists in evaluating investment opportunities. Overall, signals related to prior industry-specific experience offer three main insights: they imply that the individual possesses (1) tacit knowledge about customers and industry success factors; (2) experience with understanding opportunities in that industry; and (3) social ties with important stakeholders (Ko and McKelvie, 2018). Founders' industry-specific experience can signal knowledge of how to reduce uncertainty when identifying and evaluating business opportunities (Cassar, 2014). Those with industry-specific experience have typically accumulated important knowledge regarding the opportunities, threats, competitive conditions and regulations specific to their industry (Kor, 2003). Such experience is beneficial as the skills and information needed to effectively exploit an opportunity in a domain is uncodified and can only be learned through employment in the industry (see Cooper *et al*., 1994; Klepper, 2001). Industry-specific experience signals greater awareness of critical actions or threats to feasibility (Cassar, 2014), needed resources and sources through which they can be secured (Hellmann and Puri, 2002), and ways to manage the changing needs of the firm (Boeker and Wiltbank, 2005). Additionally, industry-specific experience can serve to build important networks within the industry (Eisenhardt and Schoonhoven, 1996). These connections may signal ability to easily collaborate with others and be viewed as legitimate in the eyes of key stakeholders (Aldrich, 1990).

From the demand-side, however, results on the significance of industry-specific experience in accessing equity financing are somewhat mixed. To illustrate, Patzelt (2010) finds that industry-specific experience has a positive impact on use of venture capital financing among biotech firms in the US and Europe, but only for firms with small management teams. Behrens *et al*. (2012) find that those with greater portions of specific human capital acquire more money in financing rounds. However, the authors report that this effect is contingent on the age of the firm – for older ventures, it appears that the management team have already proven their ability and are not as reliant on their experience as a signalling mechanism. From these studies, it appears that industry-specific experience has a temporal impact, providing a transient signal that becomes potentially less meaningful as the firm develops and the management team grows. Nevertheless, the signal does appear to have a positive impact, even if transitionary. As such:

Hypothesis 10: *Founder-CEO industry-specific experience has a positive impact on the likelihood of obtaining equity financing*

Another human capital-based signal is international experience. To the best of the author's knowledge, the only study which provides empirical evidence of the relationship between international experience and equity financing is that of Patzelt (2010), who finds that experience working abroad has a positive impact on the use of venture capital financing. Realistically, such experience could be considered beneficial in attracting financial resources. Having international experience results in unique knowledge which enables the individual to better understand foreign markets (Rivas, 2012). Studies show that previous international experience increases the speed of internationalisation for the firm (see Acedo and Jones, 2007; Osarenkhoe, 2009; Musteen *et al*., 2010). Internationally experienced entrepreneurs may have built up a social network in their former host country, which can facilitate finding foreign business partners (Herrmann and Datta, 2005), building a reputation (Holm *et al*., 1996) and acquiring valuable details on the market (Patzelt, 2010). Essentially, such experience acts to mitigate some of the risks associated with internationalisation and may signal that the firm has the potential for global growth (Sapienza *et al*., 2006). Thus:

Hypothesis 11: *Founder-CEO international experience has a positive impact on the likelihood of obtaining equity financing.*

Financing-related

Because this study adopts a demand-side viewpoint, it is important to observe that the entrepreneur's opinions of sources of financing can play a role in financing choices. In other words, building on the pecking order hypothesis (see Myers, 1984; Myers and Majluf, 1984), the financing preferences of the entrepreneur can impact financing decisions (see Norton, 1991; Ang *et al*., 2010; Riding *et al*., 2012a). The pecking order implies the existence of a financing hierarchy, whereby the desire to mitigate informational problems (while also maintaining control and independence) leads to a preference for internal rather than external finance. Although there is a lack of empirical evidence linking financing preferences to use of equity financing the implication of asymmetric information coupled with the desire to maintain control is that founders with a clear preference for internal financing will be less likely to seek external equity financing. Essentially, those entrepreneurs that wish to maintain control of their firm will be less likely to seek external financial support and bear the loss of control that comes with external equity financing (Hogan *et al*., 2017). As such:

Hypothesis 12: *Entrepreneurs' preference for internal sources of funding has a negative impact on the likelihood of obtaining equity financing*.

Moreover, the entrepreneur's choice regarding use of other (non-equity) sources of funding may also impact on equity financing. Beginning with internal funding, while it is well established that financing often begins with the entrepreneur investing personal capital into their business (see Roberts, 1991; Berger and Udell, 1998), the literature also shows that personal investment can signal commitment to and optimism in the venture (see Busenitz *et al*., 2005; Goranova *et al*., 2007). As originally outlined by Leland and Pyle (1977), the entrepreneur's willingness to invest in their own firm acts as a signal of quality and the value of the firm increases with the equity share held by the entrepreneur. Investing personal funds, the entrepreneur shows that they believe in their firm and are confident of and committed to its success (see Manigart and Meuleman, 2004; Atherton, 2012). It can also signify stronger bonds with the firm and greater optimism for future performance (Goranova *et al*., 2007). In short, founders of high-quality firms can demonstrate quality and commitment to outside investors by retaining a large proportion of equity (Connelly *et al*., 2010), thereby reducing the level of uncertainty (Ahlers *et al*., 2015). Thus, ownership retained by the founder(s) can signal the firm's true value and potential, which should help to lessen informational problems (see Busenitz *et al*., 2005; Ahlers *et al*., 2015), leading to the following:

Hypothesis 13*: Personal investment in the firm has a positive impact on the likelihood of obtaining equity financing.*

Turning to external sources of funding, recent work by Conti *et al*. (2013) suggests a signalling role for f-connection funding. The authors present a theoretical model within which '*FFF*' (founder, family and friends) funding is a signal of commitment. The model assumes that family/friends have private information about the firm, given their proximity to the founder. Although they may not be informed about the technology, they do possess valuable information regarding founder attributes, such as dedication, which can affect the project's value. Thus, f-connections may act to reduce the information asymmetries involved in equity investment and act as a signal to potential investors. Their results show that, although not a significant signal for accessing venture capital financing, FFF investment is significant for angel funding.[103] More generally, it is possible that the entrepreneur's personal network may not only facilitate the acquisition of financial resources but may also represent a critical conduit for information flows (Stuart and Sorenson, 2007) which reduce the transaction costs associated with information search and processing (Mesquita and Lazzarini, 2008). Following Conti *et al*. (2013):

> **Hypothesis 14***: F-connection funding has a positive impact on the likelihood of obtaining equity financing.*

As discussed in Chapter 2 (Subsection 2.2.2), according to Ross (1977) firms can convey private information through the proportion of debt in their capital structure. In short, debt constitutes a costly signal in distinguishing high-quality from low-quality firms as only successful firms with higher revenues can support greater leverage. Accordingly, only high-quality firms can make interest payments over the long-term, while low-quality firms will be unable to sustain such payments. Debt can also be a reliable signal due to its effective governance role (Epure and Guasch, 2019). This type of governance is similar to the management control system that outside investors tend to impose after entering entrepreneurial firms (Davila and Foster, 2007). Through this market type governance (David *et al*., 2008), debt raises accountability to external constituents and enacts a mechanism of monitoring and control of firm cash flows and more generally firm operations (see Jensen, 1986; Kochhar, 1996). Failure to adhere to debt related obligations can lead to outcomes as dire as losing control of the firm (Grossman and Hart, 1982). Finally, debt is easily observable in financial

[103] In the model the authors examine the signalling potential of '*FFF*' investment, which includes personal investment by the founder. Unfortunately, therefore, it is not possible to disentangle the effect – in other words, the signal may be related to either founder personal investment or family-friends investment.

statements and has costly underpinnings – it entails higher screening and monitoring costs, and lenders institute an ongoing governance and control mechanism (Epure and Guasch, 2019). Thus, once produced, the debt signal is credible since it fulfils the observability and costliness conditions (see Spence, 2002; Connelly *et al*., 2011). Empirically, Epure and Guasch (2019), using data collected through the Kauffman Firm Survey, find that a positive relationship exists between debt and external equity financing. Moreover, their results show that the positive signalling effect is driven by business debt (personal debt has an insignificant effect on equity finance). Relatedly, Audretsch and Lehmann (2004), using a data set of high-tech firms listed on the Neur Market in Germany, find that the likelihood of obtaining venture capital is inversely related to the extent to which the firm is financed by debt. Thus, it appears that it is excessive debt that acts to reduce the incentive of an equity investor to invest in the firm. Overall, taking these considerations together, we conjecture that obtaining debt can serve to mitigate information asymmetries, not only by demonstrating firm quality (Ross, 1977), but also through the governance it imposes (Epure and Guasch, 2019). As such:

Hypothesis 15: *Debt finance has a positive impact on the likelihood of obtaining equity financing*.

In summary, the literature identifies a range of potential factors that may determine whether a firm is equity financed. A synopsis of the hypothesised effect of the 15 factors considered herein is provided in Table 5.1.

Table 5.1. Summary of Hypotheses

	Factor	Hypothesised Effect
Market & Product:		
H1	Rivalry	-
H2	Export Activity	+
H3	Product Differentiation	+
Affiliation:		
H4	Incubator	+
Innovation Activity:		
H5	Frequency of Innovation	+
H6	R&D	+
H7	Patent	+
Human Capital:		
H8	Educational Attainment	+
H9	Workforce Qualification	+
H10	Industry-specific Experience	+
H11	International Experience	+
Financing-related:		
H12	Financing Preference	-
H13	Personal Investment	+
H14	F-Connection Funding	+
H15	Debt Financing	+

Source: Author’s Own

5.3 Data and Methods

This Section provides an overview of the data, key variables and econometric model employed in quantitative analysis. A range of summary statistics, along with a brief account of how variables are defined, is also provided.

5.3.1 Data

Data used in quantitative analysis is drawn from evidence collected from a novel sample of Irish technology-based firms. Briefly, empirical investigation is based on primary-source data gathered through survey instrumentation administered in face-to-face interviews with equity financed firms, along with a condensed self-administered version to non-equity financed firms, mostly completed online. A total of 294 (response rate of 43%) firms participated, consisting of 153 equity and 141 non-equity financed technology-based firms (the reader is referred to Chapter 3 for greater detail regarding fieldwork and Chapter 4 for an in-depth characterisation of the firms in the dataset).

5.3.2 Methods

The aim of quantitative analysis is to examine the determinants of equity financing. To do so, two probit regressions are estimated. The main probit model, with the dependent variable, *EquityFinanced*, is as follows:

$$Y_i = X_i\beta + u_i \qquad (5.1)$$

where the dependent variable Y_i takes a value of '*1*' if firm i is equity financed and '*0*' otherwise; the matrix X_i contains observations on those factors thought to affect the use of equity financing (i.e. market and product, human capital, innovation activity, financing-related); the vector β includes the estimated parameter coefficients; and u ~ N (0, 1). Each regression is estimated using maximum likelihood with robust standard errors. Marginal effects[104] and elasticities[105] at the means are also calculated.

Obtaining external financing is especially difficult for nascent firms, when information asymmetries are especially pronounced and problematic (Berger and Udell, 1998). Indeed, as Hsu (2004, page 1805) states "*particularly for entrepreneurs without an established reputation, convincing external resource providers such as venture capitalists (VCs) to provide financial capital may be challenging*". Thus, equity investors may have to rely on different signals to demonstrate the legitimacy and potential of a firm at the seed stage (Ko and McKelvie, 2018). To examine this aspect, a second probit model is estimated as follows:

$$Y_{iseed} = X_{iseed}\beta + u_{iseed} \tag{5.2}$$

where the dependent variable Y_{iseed} takes a value of '*1*' if firm *i* is equity financed during its seed year and '*0*' otherwise; the matrix X_{iseed} contains observations on those factors thought to affect the use of equity financing, with six variables measured for the seed stage (detailed below); the vector β includes the estimated parameter coefficients; and $u \sim N(0, 1)$.

These probit estimations are also used to generate Inverse Mills' Ratios (IMRs) to address selection bias that occurs going forward (Chapters 6 and 7). Specifically, the seed probit (5.2) provides the seed IMR while the main regression (5.1) provides the IMR for use in all other estimations which focus on the early-growth and expansion stages of the lifecycle.

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104 Marginal effects represent a change in the probability of being equity financed if a metric variable increases by 100 per cent or the value of an indicator variable changes from zero to one (Engel, 2004). For the normal distribution marginal effects are calculated as $\frac{\partial E[y|x]}{\partial x} = \phi(x'\beta)\beta$ (Greene, 2008).

105 Calculate elasticities at the point of means for Y_i with respect to X_i in the form $\frac{\partial y}{\partial x} = \frac{\partial log y}{\partial log x}$

5.3.3 Variables

The binary dependent variable is *EquityFinanced*, an indication of whether the firm has obtained equity investment. Just over half (52%) of the firms in the database are equity financed. This dependent variable is related to a set of explanatory factors which capture the influence of attributes of the technology-based firm on use of equity financing. Specifically, following the structure utilised in the related literature (see Kollmann and Kuckertz, 2010; Petty and Gruber, 2011; Carpentier and Survet, 2015 Woike *et al.*, 2015), potential determinants of equity financing are grouped within the following categories: market and product (rivalry, exports and product differentiation); incubation; innovation activity (frequency of innovation, R&D, patents); human capital (founder-CEO education and experience, organisational qualification level); and financing-related (financing preferences, sources of non-equity financing). Summary statics and definitions are provided in Table 5.2, with associated correlation matrix following in Table 5.3. The reader is referred to Chapter 4 for greater detail and discussion of these measures. Additionally, six of these factors are measured at the seed stage for the seed probit and these are detailed below.

Market and Product

Three variables are included to capture the impact of attributes of the firm's market and product. First, competitive pressure is approximated by a count of the number of major rivals the firm faces in the main market for its product (Power and Reid, 2015). Although, on average, respondents felt they faced competition from approximately 22 rivals (mean=22.2; standard deviation=116.29) this number is driven up by five firms, all non-equity financed, claiming to have one thousand.

Next, *Exports*, the percentage of total revenue generated in foreign markets, measures export sales. The clear majority (83%) export, generating, on average, approximately 54% (mean=53.9%; standard deviation=39.7%) of turnover through exporting.

The extent of product differentiation, *ProductDiff*, is a subjective measure that aims to gauge the degree of product differentiation. Respondents were asked to compare products in their main product group with those of their rivals and self-appraise whether they were very similar, similar, different or very different. In general respondents feel they differentiate their product, with over a third (36.7%) indicating that they offer a different product in comparison to that of their rivals. This is closely followed by those who rate their product as very different (35.7%). The variable is a self-appraised measure, as utilised by Reid (1993) and Power and Reid (2015). It is scaled to be greater, the greater product heterogeneity.

Incubation

The variable *IncCentre*, which takes a value of '*1*' if the firm is located within an incubator and '*0*' otherwise, provides a proxy for not only third-party certification but also the role of the assistance and network of an incubator in accessing equity finance. Of the 294 technology-based firms, 44 (15%) were based in an incubation centre.

Innovation Activity

Three measures are included to capture innovation activity, namely: frequency of innovation (product and process); inputs dedicated to the innovation process (R&D); and outputs derived from the innovation process (patents).

First, innovation orientation is classified as being product or process (see Roper, 2001; Cefis and Marsili, 2012). Respondents were asked to self-appraise their firm's frequency of innovation, with the following response categories: continuously (coded '*4*'), regularly (coded '*3*'), rarely (coded '*2*') or never (coded '*1*'). Unsurprisingly, data reveal high levels of innovation. Most stated that their firm currently undertakes both product (68.7%) and process (60.5%) innovation on a continuous basis. Although respondents were asked to indicate levels of product and process innovation separately these measures cannot be included in the one estimation due to high correlation (Kendalls Tau_b = 0.700, p-value=0.000). Instead, frequency is calibrated as the sum of product and process innovation. Thus, a maximum of '*8*' indicates that the firm undertakes both forms of innovation on a continuous basis, while a minimum of '*2*' indicates that the respondent specified 'never' for both. Higher values of the variable represent a higher frequency of product and process innovation. Over half (55.8%) rate innovation activities as continuous, while one (non-equity financed) respondent stated that their firm does not undertake any form of innovation.[106]

The second measure, capturing inputs to innovation, is the percentage of the firm's total revenues dedicated to expenditure on R&D (see Hall, 1987; Rosenbusch *et al.*, 2011; Børing, 2015; Micucci and Rossi, 2017). For the technology-based firms in the dataset, spending on R&D activities accounts for, on average, 37% (mean=36.62%; standard deviation=29.17%) of total expenditure.

Finally, capturing outputs from innovation, the variable *Patent* takes a value of '1' if the firm possesses at least one granted patent and '0' otherwise. Of the 294 technology-based firms, a total of 88 (29.9%) hold at least one patent.

[106] To ensure the robustness of the model including this measure, probit estimations were replicated using individual measures of innovation (product and process). No differences were found in results.

Table 5.2. Description of Variables

Variable	Definition	All Firms (N = 294)	Equity Financed (N = 153)	Non-Equity Financed (N = 141)
		Number (%) [a] / Mean (Std. Dev.) [b]		
Market and Product				
Rivalry	Number of major rivals the firm faces in its main market	22.15 (116.19)	4.60 (5.17)	41.2 (165.9)
Exports	Export sales as a percentage of total sales for the last fiscal year	53.96 (39.68)	68.18 (35.52)	38.52 (38.27)
ProdDiff	= ‘1’ (very similar); = ‘2’ (similar); = ‘3’ (different); = ‘4’ (very different)	2.08 (0.79)	2.22 (0.75)	1.94 (0.81)
Incubation				
IncCentre	= ‘1’ if located in an incubation centre; = ‘0’ otherwise	44 (15%)	29 (19%)	15 (10%)
Innovation Activity				
TotalInno	Sum of product and process innovation, where 2 is the lowest and 8 the highest	6.97 (1.34)	7.37 (0.97)	6.45 (1.55)
R&DExpend	Percentage of R&D expenditures in total revenues	36.62 (29.17)	48.38 (26.46)	23.85 (26.55)
Patent	= ‘1’ patent holder; = ‘0’ otherwise	89 (30.3%)	62 (40.5%)	27 (19.1%)
Human Capital				
FoundEdu	= ‘1’ (up to Degree); = ‘2’ (Masters); = ‘3’ (Ph.D.)	1.53 (0.63)	1.68 (0.65)	1.36 (0.58)
WorkQual	Percentage of employees who possess a third level or equivalent qualification	85.51 (20.76)	90.75 (13.47)	79.82 (25.34)
FoundIndExp	Number of years’ experience working in the firm’s industrial sector	18.54 (7.60)	18.69 (7.02)	18.38 (8.21)
FoundIntExp	= ‘1’ if experience working abroad prior to current role; = ‘0’ otherwise	210 (71.4%)	123 (80.4%)	87 (61.7%)
Financing-related				
FinancingPref	= ‘1’ if entrepreneur prefers to utilise internal finance; = ‘0’ otherwise	220 (74.8%)	107 (69.3%)	113 (80.1%)
PersInvestSeed	Percentage of total seed stage capital personally invested by founder(s)	66.26 (34.07)	66.33 (33.38)	66.17 (34.93)
FConnections	= ‘1’ if firm received f-connection funding; = ‘0’ otherwise	95 (32.3%)	57 (37.3%)	38 (27%)
Debt	= ‘1’ if firm obtained debt financing; ‘0’ otherwise	120 (40.8%)	49 (32%)	71 (50.4%)
Firm-specific Control Variables				
SizeCurrent	Number of full-time equivalent employees in 2011	25.3 (55.7)	29.7 (65.8)	21.5 (41.9)
Age	Elapsed years from foundation to exit; to Dec. 2016 otherwise	7.70 (5.58)	6.64 (3.70)	8.84 (6.91)
ServiceFirm	= ‘1’ knowledge-intensive service firm (NACE 58-63, 66, 69-75, 78, 79, 82); = ‘0’ otherwise	247 (84%)	130 (85%)	117 (83%)

Note: [a] Number (percentage) reported for dummy variables; [b] Mean (standard deviation) reported for ordinal and scale variables

Human Capital

To capture the influence of human capital four variables are included. First, founder-CEO education, a common proxy for general human capital (see Gimmon and Levie, 2010; Teixeira and Travares-Lehmann, 2014), is classified using the National Framework of Qualifications (NFQ), a ten-level system which gives an academic or vocational value to qualifications. As such, *FoundEdu* is a rank of the top three levels, where: 1 = up to Degree (Level 8); 2 = Masters (Level 9); and 3 = Ph.D. (Level 10). Over half (54.8%) are educated up to degree; just over a third (37.8%) to Masters; with 22 (7.4%) holding a Ph.D. The next two variables focus on specific human capital, proxied through experience (see Colombo and Grilli, 2005a; Dimov and Shepherd, 2005). Founder-CEO industry-specific experience is measured by years' experience working in the industrial sector of the firm, irrespective of their function (Carpentier and Suret, 2015). Respondents have, on average, 18 (mean=18.5, standard deviation=7.6) years of experience (median and mode of 20). Next, *FoundIntExp*, is a dummy variable, set equal to '*1*' if the founder-CEO had experience working abroad prior to their role in this firm, and '*0*' otherwise (Patzelt, 2010). Almost three-quarters (71.4%) of the founder-CEOs have international experience.

For organisational human capital, the variable *WorkforceQual* measures the percentage of employees who possess a third-level degree or equivalent. Education or qualification level of the workforce is a common measure of unit (firm) or aggregate human capital (see Becker, 1996; Fackler *et al*., 2016). In almost half (48.6%) of firms every employee (100%) possesses a third-level or equivalent qualification. The average is 85% (mean=85.5%; standard deviation=20.7%) of employees. This is not unexpected, considering the focus of this study. Given that those employed in technology-based firms are generally technically educated, such as software programmers, these firms are thus likely seeking qualified employees (Bürgel *et al*., 2012).

Financing-related

Four variables are included to capture various aspects relating to financing choices and their impact on equity finance. First, as depicted in the pecking order hypothesis (see Myers, 1984; Myers and Majluf, 1984), the entrepreneur's financing preferences may influence capital structure decisions. *FinancingPref* is equal to '*1*' where the respondent prefers to utilise internal financing, '*0*' if they prefer external sources. Three-quarters (74.8%) of respondents stated that they prefer internal sources, where possible, when they require additional finance. Second, use of alternative sources of entrepreneurial financing may impact on use of equity as a financial resource. *PersonalInvest*, measures the percentage of total seed stage financing raised from the personal funds of the founder(s). Personal capital comprised 100% of start-up finance for almost a third (30.3%) of firms while almost a tenth (8.8%) did not use any personal funds during this phase. The average is 66% (mean=66.5%; standard deviation=20.7%), highlighting the importance of personal funds when starting a technology-based firm. Two dummy variables focus on the impact of use of alternative external sources of funding, namely f-connection (family and friends) and debt. Almost one-third (32.3%) have obtained funding from f-connections. Nearly half (40.8%) accessed some form of debt financing (short, medium or long-term business loan or mortgage).

Control Variables

Three control variables are also included. Firm age and size are common control variables and demographics utilised in the related literature (see Coleman and Robb, 2012; Puri and Zarutskie, 2012). Firms in the database range in age (years trading) from one to forty years, with an average age of approximately 8 (mean=7.70; median=6; standard deviation=5.58). Firm size, measured by the number of full-time equivalent employees, ranged from one to over five hundred, with an average of approximately 25 (mean=25.06; standard deviation=54.78) employees.

To control for sector fixed effects, the dummy variable *ServiceFirm* takes a value of '*1*' if the firm operates in a knowledge-intensive service sector and '*0*' otherwise. This dummy controls for the fact that 84% of firms in the database are knowledge-intensive service firms. Briefly, technology-based firms were identified for inclusion in this empirical study using the sectoral approach (Eurostat, 2013), based on the NACE Rev. 2 system (see Chapter 3, Subsection 3.2.1 for a full outline).

Seed Stage Estimation

For the seed stage probit, the dependent variable (*EquityFinancedSeed*) becomes an indicator of whether the firm was equity financed at their seed stage. A total of 57 (19.4%) firms obtained equity financing during their seed year. In this probit six of the explanatory variables change to measures applicable for this stage. First, *TotalInnoSeed* becomes a measure of the frequency of product and process innovation undertaken by the firm during the seed stage. Unsurprisingly, data shows high levels of innovation at the seed stage, with almost two-thirds (61.2%) of respondents rating both product and process innovation as continuous at this stage. Second, the variable *PatentSeed* now takes a value of '*1*' if the firm possessed a patent during their seed year and '*0*' otherwise. Of the 294 technology-based firms, 25 (8.5%) possessed a patent at the seed stage. Third, industry-specific experience is measured as the number of years of same sector experience up to the seed year. On average, these founder-CEOs had 11 (mean=11.4 years, with standard deviation=7.6) years of industry-specific experience up to the start-up of the present firm. Fourth, *FConnectionsSeed* takes a value of '*1*' if the firm received f-connection funds during the seed year, and '*0*' otherwise. Almost a quarter (24.1%) of firms obtained financial support from their family and friends during their initial year of operation. Fifth, *DebtSeed* takes account only of debt finance obtained during the seed stage. Of the 294 technology-based firms, 41 (13.9%) had debt funding during their seed year. Sixth, the control variable *SizeSeed* measures firm size during the seed stage. Firms had approximately 5 (mean=5.4, standard deviation=12.9) employees during their seed year. One final note, because the estimation is based only on the seed stage, the control variable *Age* is excluded from the estimation.

To close, a correlation matrix for explanatory variables is presented in Table 5.3, modified for seed stage variables in Table 5.4. In general, correlations among the variables are mostly moderate to low (no correlation is above 0.5), suggesting limited potential for distortions. From Table 5.3, the notable exceptions are the relatively high correlations between R&D expenditure and innovation (r = 0.41) and R&D expenditure and age of the firm (r = -0.39). These correlations are significant at p-value<0.001 but are not deemed so high as to cause serious problems of multicollinearity. Looking at Table 5.4, all correlations are low, again suggesting limited potential for distortions.

Table 5.3. Correlation Matrix

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1)	EquityFinanced	1.0000											
(2)	Rivalry	-0.1576*	1.0000										
(3)	Exports	0.3740***	-0.0468	1.000									
(4)	ProductDiff	0.1765*	-0.2134*	0.0754	1.000								
(5)	IncubationCentre	0.1165**	0.0214	0.0016	0.1495	1.0000							
(6)	TotalInno	0.3132*	-0.0256	0.1947*	0.1498*	0.1304**	1.0000						
(7)	R&DExpend	0.4208	-0.1432	0.3283*	0.1684*	0.1270**	0.4077*	1.0000					
(8)	Patent	0.2324*	-0.0888*	0.2999*	0.0349	0.0764	0.1917*	0.2815	1.0000				
(9)	FoundEdu	0.2516*	0.0172**	0.1679*	0.1249**	0.1782*	0.0713	0.1787*	0.1767*	1.0000			
(10)	FoundIndExp	0.0204	0.0109	0.0623	-0.0101	-0.1503*	0.0133	-0.0995***	0.0616	-0.0989**	1.0000		
(11)	FoundIntExp	0.2067*	0.0648**	0.2432*	0.0748	-0.0302	0.1203*	0.1852*	0.1054	0.0749	0.0468**	1.0000	
(12)	WorkforceQual	0.2635*	0.0187	0.2054*	0.0929	0.1714*	0.1744*	0.2689*	0.1606*	0.2186*	-0.1193**	0.2045*	1.0000
(13)	FinancingPref	-0.1175**	0.0114	-0.0564	-0.0194	0.0016**	-0.1099	-0.1489	-0.0273***	-0.0867	-0.0694*	0.0322	-0.0368**
(14)	PersInvestSeed	0.0428	0.0358	-0.0725	0.0414	0.0126	-0.0034	-0.0092	0.0179	0.0645	-0.0529	0.0532	0.0232
(15)	FConnections	0.1101**	-0.0832*	0.0842	0.0298	-0.1268**	0.0158	0.0873	-0.0912	0.0221	-0.0422	-0.0138	0.0216
(16)	Debt	-0.1863*	0.0200	-0.1462	-0.0245	-0.0768*	-0.1255*	-0.1589	-0.0802	-0.0248	0.0962	-0.0263	-0.1240**
(17)	SizeCurrent	0.0633	-0.0512	0.1635***	-0.0268	-0.1472***	-0.0185	-0.1073	0.1868*	-0.0111	0.1894***	0.0643	-0.1228**
(18)	Age	-0.1977*	0.0214	-0.1129**	-0.1164**	-0.1981*	-0.3183*	-0.3851*	-0.0227	0.0009	0.3055*	-0.1358**	-0.2718*
(19)	ServiceFirm	0.0271	-0.0383	0.0066	0.0685	0.0009	0.1700**	0.0695	-0.1166**	-0.0032	-0.0290	0.0117	0.1003***

		(13)	(14)	(15)	(16)	(17)	(18)	(19)
(13)	FinancingPref	1.0000						
(14)	PersInvestSeed	0.1117*	1.0000					
(15)	FConnections	-0.0518	-0.1328	1.0000				
(16)	Debt	-0.0446*	-0.1135	0.0181***	1.0000			
(17)	SizeCurrent	-0.0077	0.0622	-0.0284	-0.0138	1.0000		
(18)	Age	0.0065	0.0056	-0.1153**	0.1172**	0.2453***	1.0000	
(19)	ServiceFirm	0.0036	0.0379	0.0632	-0.1098	-0.0466	-0.1187**	1.0000

<u>Diagnostics</u>: * significant at $p< 0.1$, ** significant at $p< 0.05$, *** significant at $p< 0.01$

Table 5.4. Correlation Matrix – Seed Stage

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1)	EquityFinanced	1.0000											
(2)	Rivalry	-0.1576*	1.0000										
(3)	Exports	0.3740***	-0.0468	1.0000									
(4)	ProductDiff	0.1765*	-0.2134*	0.0754	1.0000								
(5)	IncubationCentre	0.1165**	0.0214	0.0016	0.1495	1.0000							
(6)	TotalInnoSeed	0.3582*	-0.0476**	0.2893*	0.1556*	0.0587*	1.0000						
(7)	R&DExpend	0.4208	-0.1432	0.3283*	0.1684*	0.1270**	0.3176*	1.0000					
(8)	PatentSeed	-0.0002	-0.0448	0.1604***	0.0610	-0.0253	0.1045*	0.0660	1.0000				
(9)	FoundEdu	0.2516*	0.0172**	0.1679*	0.1249**	0.1782*	0.1058**	0.1787*	0.0544*	1.0000			
(10)	FoundIndExpSeed	0.0837*	-0.0516	0.1349**	0.0787	-0.0421*	0.1090	0.1528*	0.0176	-0.1444*	1.0000		
(11)	FoundIntExp	0.2067*	0.0648**	0.2432*	0.0748	-0.0302	0.0895***	0.1852*	0.0578	0.0749	0.1223	1.0000	
(12)	WorkforceQual	0.2635*	0.0187	0.2054*	0.0929	0.1714*	0.1465*	0.2689*	0.0013*	0.2186*	0.0700***	0.2045*	1.0000
(13)	FinancingPref	-0.1175**	0.0114	-0.0564	-0.0194	0.0016**	-0.0750	-0.1489	0.0082	-0.0867	-0.0240	0.0322	-0.0368
(14)	PersInvestSeed	0.0428	0.0358	-0.0725	0.0414	0.0126	-0.0374	-0.0092	0.0031	0.0645	0.0076	0.0532	0.0232
(15)	FConnSeed	0.1917***	-0.0758**	0.0549	0.0221	-0.0808	0.1074**	0.1114**	-0.0865	0.0701	0.0391	0.0404	0.0839**
(16)	DebtSeed	-0.1350**	0.0304	-0.1307	-0.0912	-0.0588	-0.0525	-0.1134	-0.0171	-0.1028	-0.0470	0.0155	-0.1094**
(17)	SizeSeed	-0.0003	-0.0417	0.0789	0.0352	-0.0848*	0.0188	-0.1057***	0.1459**	0.0396**	0.0591	0.0580***	-0.2159***
(18)	ServiceFirm	0.0271	-0.0383	0.0066	0.0685	0.0009	0.1070*	0.0695	-0.0999**	-0.0032	0.0863	0.0117	0.1003***

		(13)	(14)	(15)	(16)	(17)	
(13)	FinancingPref	1.0000					
(14)	PersInvestSeed	0.1117*	1.0000				
(15)	FConnSeed	-0.0573	-0.1428*	1.0000			
(16)	DebtSeed	-0.0380*	-0.2685	-0.0723**	1.0000		
(17)	SizeSeed	0.0218	-0.0761	-0.0105	0.0091	1.0000	
(18)	ServiceFirm	0.0036	0.0379	0.0727	-0.0387***	-0.1214	1.0000

Diagnostics: * significant at p< 0.1, ** significant at p< 0.05, *** significant at p< 0.01

5.4 Results

This Section outlines the results of econometric analysis, the aim of which is to ascertain the determinants of equity financing. Two standard probit models are used, with robust standard errors. Results are presented in Tables 5.5 and 5.6, with standard errors in brackets. Marginal effects (Column II) and elasticities at the means (Column III) are also reported. Wald Chi-square, which assess the explanatory power of the estimates, of 90.61 and 63.06 (with p-value<0.001) respectively indicate that the models are statistically significant. Thus, we can have confidence in the results of the estimations. In considering these results, we are interested in the direction and significance of coefficients. Specifically, positive (negative) coefficients (β) increase (decrease) the probability of the firm being equity financed. Discussion now turns to an assessment of key findings.

Beginning with Table 5.5, consistent with hypothesis 1, the negative and significant coefficient on *Rivalry* indicates that it is those technology-based firms who face lower levels of competition in their main market that are more likely to be equity financed. Looking at the average marginal effect (Column II), significant at the 1% level, the firm is approximately 0.02 times less likely to be equity financed for each one-unit increase in the number of rivals it faces in its main market. The elasticity (Column III) of the coefficient, at -2.4629, is the highest observed in the estimate. Specifically, a 1% increase in number of rivals, *ceteris paribus*, is associated with a decrease in the probability of being equity financed by 2.5%. That occupying a market niche is a determining factor in accessing equity financing is consistent with the work of Petty and Gruber (2011), Kollmann and Kuckertz (2010) and Carpentier and Suret (2015) who find that equity investors mostly disregard potential investees operating in markets deemed too crowded or saturated.

Results also show, corroborating hypothesis 2, a positive and significant relationship between exporting (*Exports*) and equity financing. The less the dependence on national markets, or put another way, the greater the proportion of turnover generated by exporting the greater the likelihood that the firm will be equity financed. The average marginal effect (Column II) of exporting on equity financing is 0.0015. The coefficient has a relatively high elasticity (0.5391), which is highly significant (p-value<0.01). Thus, a 1% increase in the proportion of turnover generated exporting, *ceteris paribus*, will increase the firm's probability of being equity financed by approximately 0.5%. Although no other study, to the best of the author's knowledge, provides comparable empirical evidence, it is somewhat in line with extant research. In his analysis of the impact of venture capital on firm growth, Peneder (2010) reports that venture capital backed firms have a stronger orientation towards international markets. According to Riding *et al*. (2012b), Canadian SMEs pursuing an export strategy are more likely to seek to equity financing. Similarly, in their study of French and Canadian SMEs, St Pierre *et al*. (2011) find that venture capital backed firms are more likely to export.

Moreover, the third variable within this group, *ProdDiff*, is positive and significant, confirming hypothesis 3. Indeed, in terms of magnitude, this coefficient is the fourth largest observed in the probit estimation (Column I). Thus, those offering a more unique or differentiated product are more likely to obtain equity financing. The average marginal effect (Column II), although weakly significant at p-value<0.1, is 0.0392. The coefficient has a relatively high elasticity (0.5484), suggesting that a 1% increase in the level of product differentiation, *ceteris paribus*, will increase the firm's probability of being equity financed by approximately 0.5%. This finding is consistent with existing evidence highlighting the importance of the product offering in investment appraisal. Kaplan and Stromberg (2004) estimate that venture capitalists in the US are attracted by the product on offer in at least 40% of cases. Others report that the uniqueness of the product is a key factor for both venture capitalists and angels (see Hindle and Wenban, 1999; Hindle and Lee, 2002; Petty and Gruber, 2011; Lumme *et al*., 2013).

Table 5.5. Determinants of Equity Financing

	I β (Std. Error)	II Marginal Effects (Std. Error)	III Elasticities at the Mean (Std. Error)
Market and Product:			
Rivalry	-0.0722*** (0.0019)	-0.0165*** (0.0018)	-2.4629** (1.1199)
Exports	0.0066*** (0.0024)	0.0015** (0.0008)	0.5391*** (0.2255)
ProdDiff	0.2223* (0.1380)	0.0392* (0.0289)	0.5484* (0.5353)
Incubation:			
IncubationCentre	0.3018 (0.2454)	0.0672 (0.0685)	0.0617 (0.0598)
Innovation Activity:			
TotalInno	0.1552** (0.0708)	0.0345** (0.0200)	1.6219** (0.8295)
R&DExpend	0.0107*** (0.0039)	0.0024** (0.0012)	0.5854** (0.2451)
Patent	0.0504 (0.2046)	0.0457 (0.0534)	0.0865 (0.0956)
Human Capital:			
FoundEdu	0.3985** (0.1447)	0.0871** (0.0433)	0.8954** (0.3948)
FoundIndExp	0.0143 (0.0126)	0.0032 (0.0031)	0.3944 (0.3749)
FoundIntExp	0.3250* (0.1982)	0.0689* (0.0431)	0.3561* (0.2406)
WorkforceQual	0.0106** (0.0049)	0.0025** (0.0014)	1.4354** (0.7222)
Financing-related:			
FinancingPref	-0.2089* (0.2057)	-0.0974* (0.0611)	-0.4433* (0.2621)
PersonalInvestment	0.0006 (0.0027)	0.0001 (0.0001)	0.0587 (0.2759)
FConnection	0.2958* (0.1929)	0.0729* (0.0575)	0.1502* (0.0983)
Debt	-0.4683*** (0.1862)	-0.1065** (0.0500)	-0.3062** (0.1403)
Control Variables:			
SizeCurrent	0.0021 (0.0018)	0.0004 (0.0004)	0.0751 (0.0730)
Age	-0.0142 (0.0203)	-0.0036 (0.0048)	-0.1842 (0.2476)
ServiceFirm	-0.2777 (0.2964)	-0.0666 (0.0881)	-0.3447 (0.367)
Constant	-2.3265* (0.8334)		
Log Likelihood	-134.4464		
No. Observations	294		
Wald Chi-square (18)	90.61		
Pseudo R^2	0.3395		
Prob > Chi^2	0.0000		

Notes: (1) Robust standard errors in parentheses; (2) Significance levels: * p<0.1; ** p<0.05; *** p-<0.01;

Moving to innovation activity, the positive and significant coefficient *TotalInno* suggests that, consistent with hypothesis 5, higher levels of innovation have a positive impact on equity financing. From Colum II, the probability of being equity financed is 0.03 times greater when frequency of innovation increases by one unit. The effect is statistically strong (p-value<0.05) and the coefficient has a very high elasticity (1.6219). This is the second largest elasticity in the estimate, suggesting that innovativeness is a major determinant of whether the firm will be equity financed. Two factors can be rationalised as lying behind this result. First, because of the unique characteristics of innovation (i.e. information asymmetries, uncertainty and the potential non-exclusive nature of investment in intangible assets (Audretsch *et al*., 2012), innovation is naturally associated with equity finance (see Carpenter and Petersen, 2002; Langeland, 2007). Corroborating this, evidence generally points to a detachment between innovation and debt (see Colombo and Grilli, 2007; Cosh *et al*., 2009). Second, innovation activities of technology-based firms can enhance their ability to attract equity investors. Briefly, although extremely innovative projects are highly uncertain, they provide the possibility of high returns to the initial investment, with the positive relationship between innovativeness and firm growth and performance, as well as survival, being well documented (see Thornhill, 2006; Cohen, 2010; Cefis and Marsili, 2012). This can serve as a signal of potential and, therefore, attract equity investors. To illustrate, Hellmann and Puri (2000) show that venture capitalists are more likely to invest in firms with more innovative product market strategies.

Additionally, *R&DExpend* has a highly significant (p-value<0.01) coefficient with a positive sign, as predicted in hypothesis 6. The coefficient has a relatively high elasticity such that each 1% increase in the amount of revenue devoted to R&D expenditure, *ceteris paribus*, increases the probability of being equity financed by approximately 0.6%. This finding supports the evidence that equity is a key financial resource for R&D-intensive firms (see

Aghion *et al*., 2004; Casson *et al*., 2008; Wang and Thornhill, 2010). Brown *et al*. (2009) report a strong link between R&D activity and both internal and external equity financing. This is also consistent with the discussion of Hall (1992, 2002), which holds that debt is generally disfavoured by R&D-intensive firms.

Moving to human capital, overall results corroborate the signalling role of education and experience in accessing external equity financing. First, confirming hypothesis 8, the positive and significant (p-value<0.05) coefficient on *FoundEdu* indicates that firms run by highly educated individuals are more likely to be equity financed. Indeed, in terms of magnitude, the coefficient is the second largest observed in the probit (Column I). Based on the average marginal effect (Column II), the predicted probability of the firm being equity financed is 0.09 times greater for every one-level increase in founder-CEO education. The coefficient also has a high elasticity (0.89), which is the fourth largest elasticity observed (Column III). Corroborating this, Gimmon and Levie (2010), Zarutskie (2010) and Unger *et al*. (2011) highlight the role of entrepreneurial education in attracting equity finance. More generally, Bates (1990) reports that educational attainment is correlated with the munificence of received financial resources.

Turning to organisational human capital, employee education has a positive significant effect on equity finance, supporting hypothesis 9. Specifically, *WorkforceQual* has a positive and significant coefficient (p-value<0.05), suggesting that the greater the proportion of employees with a third level or equivalent qualification, the more likely the firm will be equity financed. The average marginal effect (Column II) suggests that the probability of being equity financed is 0.003 times higher for each one-unit increase in the mean proportion of qualified (i.e. those who have obtained a third-level or equivalent qualification) employees. The high and positive elasticity (Column II), shows that a 1% increase in the proportion of qualified employees, *ceteris paribus,* is associated with an increase in the probability of the firm being equity financed of approximately 1.4%. In terms of magnitude, this is the third largest elasticity in the estimate, suggesting that organisational human capital is an important driver of equity finance. Although, to the best of the author's knowledge, no other study provides empirical evidence linking organisational human capital to the use of equity financing, this finding is in harmony with work emphasising the crucial role of firm-level, or organisational, human capital (see Banerjee, 2013; Chowdhury *et al*., 2014; Millán *et al*., 2014).

Moreover, founder-CEO international experience also shows, as predicted in hypothesis 11, a positive and significant impact on usage of equity finance. Its marginal effect (Column II), although weakly significant (p-value<0.1), suggests that those firms with a founder-CEO who has experience working overseas are approximately 7% more likely to be equity financed. The coefficient has a moderate and positive elasticity (0.3561). The finding is consistent with that provided by Patzelt (2010), who highlights the positive relationship between international experience and venture capital financing.

Looking at financing-related factors, three coefficients are significant. Consistent with hypothesis 12, the negative, although weakly significant (p-value<0.1), coefficient on *FinancingPref* suggests that it is entrepreneurs with a preference for utilising external sources of funding that are more likely to be equity financed. Looking at estimated marginal effects (Column II), preferring external rather than internal sources of financing increases the firm's probability of being equity financed by 9%. This effect has a relatively high elasticity of 0.44 (Column III). This is a somewhat plausible result, in that, if the entrepreneur prefers external funding it could be assumed that they are more willing to cede the independence and control necessary to acquire equity investment. Kaplan and Strömberg (2004) find that to gain venture capital investment, entrepreneurs must relinquish a stake of around 50% of their business. In contrast, those who wish to maintain control may be less likely to seek external equity financing and bear the loss of freedom that comes with obtaining equity investment (Manigart and Struyf, 1997), thus preferring to fund their business with internal capital as much as possible.

Turning to the impact of alternative sources of financing, the positive and significant (p-value<0.1) coefficient on *FConnection* indicates that having obtained funding from family and friends has a positive impact on equity financing. This offers support to hypothesis 14. Looking at the marginal effect (Column II), having obtained f-connection funding increases the probability of equity financing by approximately 7%. The size of the elasticity of this effect is 0.15. This is a plausible result in that, firstly, the entrepreneurial finance literature highlights the importance of family and friends as a critical source of capital, particularly for young ventures (see Roberts, 1991; Berger and Udell, 1998), and, secondly, f-connection funding is generally considered a source of capital that complements the funds provided by other investors. To illustrate, Agrawal *et al*. (2011) and Conti *et al*. (2013) both highlight the role of f-connection investment as an effective signal of entrepreneurial commitment in supporting access to external equity finance.

Last, the negative and highly significant (p-value<0.01) coefficient on *Debt* indicates that equity financing is inversely related to debt financing, contradicting hypothesis 15. This coefficient is the largest observed in the probit (Column I). The results show that the marginal effect, again the largest observed, of the coefficient (Column II) is -0.1065 indicating that equity financed firms are approximately 10% less likely to utilise debt. This finding is coherent with evidence pointing to a lack of debt for technology-based firms (see Giudici and Paleari, 2000; Hall, 2002; North *et al*., 2013). This is also consistent with the pecking order (see Myers, 1984; Myers and Majluf, 1984) modified for technology-based firms (Hogan and Hutson, 2005b). Conversely, it may also indicate that those successfully obtaining equity financing have less need to seek debt funding. Moreover, this finding may be interpreted as providing evidence of the substitute relationship between debt and equity in the financing of technology-based firms, as proposed by Audretsch and Lehmann (2004).

Finally, a note regarding non-findings. Specifically, coefficients on incubation (H1), patents (H7), industry-specific experience (H10) and personal investment (H13) were not found to be statistically significant in this estimation. Nonetheless, the sign (positive) on each coefficient is consistent with the hypothesised impact of these factors on equity financing.

To summarise, the findings of the main model are as follows: Market and product-related factors represent important signals in accessing equity financing. Equity financed firms are those with more differentiated product offerings, operating in niche markets and with higher levels of export activity. This reflects supply-side evidence which highlights the importance of characteristics of the market environment and product offering for equity investors in selecting investees (see Petty and Gruber, 2011; Carpentier and Suret, 2015). Innovation and R&D activity are also positive signals in accessing equity financing. This is hardly surprising, not only given that equity finance is typically associated with innovative enterprises (see Carpenter and Petersen, 2002a; Hall, 2010) but also because innovative projects provide the potential of high returns to investment, which appeals to equity investors (see Hellmann and Puri, 2000; Thornhill, 2006; Choen, 2010). In terms of human capital, founder-CEO education and international experience positively impact on equity financing, with education having the larger impact. Although the scientific and specialised knowledge effect of education is particularly valuable in the context of technology-oriented firms (Colombo and Grilli, 2005a), highly educated founder-CEOs also signal that the firm is a credible one (Hsu, 2007) and that they have the knowledge and skills to move the firm through stages of development (Behrens *et al*., 2012). Additionally, findings show that organisational human-capital represents an important signal, with the quality of the firm's employees beneficial in attracting and obtaining external equity financing. Finally, entrepreneurs in equity financed technology-based firms prefer using external as opposed to internal sources of finance but are less likely to use debt. It is possible that these entrepreneurs understand, implicitly or explicitly, that the greater information opacity (Brierley, 2001) and innovation-intensive nature (Hall, 2002) of their enterprises, and the increased risk that this creates for external investors (Riding *et al.*, 2012a), necessitates this source of external entrepreneurial financing. These firms are more likely to depend on family and friends as a source of capital and are less likely to have debt financing. Thus, it appears that while f-connection funding complements external equity financing, debt and equity may, on the other hand, be substitutes in the financing of technology-based firms (Audretsch and Lehmann, 2004).

Moving next to the probit for the seed stage (Table 5.6), we can see that *Rivalry* is again a negative and significant determinant of equity financing, consistent with hypothesis 1. In terms of magnitude, the coefficient, although weakly significant, is the second largest observed in this estimation (Column I). Looking at the marginal effect (Column II), a firm is approximately 0.003 times less likely to be equity financing during their seed year for each one-unit increase in the number of rivals it faces in its main market. The elasticity (Column III), the third highest observed, suggests that a 1% increase in the number of rivals, *ceteris paribus*, decreases the probability of being equity financed at the seed stage by 2.1%. This serves to emphasise the signalling role of occupying a niche position.

Results also show that export activity is positive at the seed stage, confirming hypothesis 2. The average marginal effect (Column II), although weakly significant at p-value<0.1, is the largest observed in the estimate at 0.0038. Looking at the elasticity (Column III), remaining significant at p-value<0.1, we see that a 1% increase in the proportion of the firm's turnover generated through exporting, *ceteris paribus*, increases the likelihood of being equity financed at seed by 0.6%. This supports Carpentier and Suret (2015), who argue that investors seek investees that offer the prospect of targeting a worldwide market.

Table 5.6. Determinants of Equity Financing – Seed Stage

	I β (Std. Error)	II Marginal Effects (Std. Error)	III Elasticities at the Mean (Std. Error)
Market and Product:			
Rivalry	-0.0427*	-0.0033*	-2.0863*
	(0.0267)	(0.0009)	(1.6894)
Exports	0.0048*	0.0038*	0.5774*
	(0.0028)	(0.0004)	(0.3313)
ProdDiff	0.0730	0.0057	0.3353
	(0.1532)	(0.0105)	(0.7354)
Incubation:			
IncubationCentre	0.0921	0.0076	0.0304
	(0.2586)	(0.0230)	(0.0859)
Innovation Activity:			
TotalInnoSeed	0.1368	0.0106	2.1718
	(0.1087)	(0.0135)	(1.6997)
R&DExpend	0.0031	0.0002	0.2525
	(0.0036)	(0.0033)	(0.3042)
PatentSeed	-0.0803	-0.0059	-0.0151
	(0.3078)	(0.0222)	(0.0575)
Human Capital:			
FoundEdu	0.0271	0.0021	0.0913
	(0.1709)	(0.0133)	(0.5765)
FoundIndExpSeed	0.0016	0.0001	0.0406
	(0.0139)	(0.0011)	(0.3499)
FoundIntExp	0.3577	0.0244*	0.5634
	(0.2321)	(0.0262)	(0.3499)
WorkforceQual	0.0167**	0.0011*	2.5905**
	(0.0064)	(0.0009)	(1.3873)
Financing-related:			
FinancingPref	-0.1556	-0.0129	-0.2568
	(0.2039)	(0.0206)	(0.3432)
PersonalInvestment	-0.0138***	-0.0013***	-2.4552***
	(0.0029)	(0.0011)	(0.7258)
FConnectionSeed	0.0816	0.0066	0.0435
	(0.1994)	(0.0176)	(0.1065)
DebtSeed	-0.3671	-0.0226	-0.1129
	(0.3059)	(0.0247)	(0.0973)
Control Variables:			
SizeSeed	0.0052	0.0004	0.0621
	(0.0069)	(0.0006)	(0.0841)
ServiceFirm	0.0118	0.0009	0.0218
	(0.2751)	(0.0211)	(0.5097)
Constant	-2.2631**		
	(1.0283)		
Log Likelihood	-107.6287		
No. Observations	294		
Wald Chi-square (18)	63.06		
Pseudo R^2	0.2556		
Prob > Chi^2	0.0000		

Notes: **(1)** Robust standard errors in parentheses; (2) Significance levels: * p<0.1; ** p<0.05; *** p-<0.01;

None of the factors within the innovation group are significant in the seed estimation. Moving to human capital, it is organisational workforce qualification that has a positive and significant (p-value<0.05) effect, suggesting that the greater the proportion of employees with a third level or equivalent qualification, the more likely the firm will be equity financed. It is the second largest coefficient in the estimation (Column I) and, once again, support hypothesis 9. The average marginal effect (Column II) suggests that the probability of being equity financed is 0.02 times higher for each one-unit increase in the mean proportion of qualified employees. The high and positive elasticity (Column III), shows that a 1% increase in the proportion of qualified employees, *ceteris paribus*, is associated with an increase in the probability of the firm being equity financed at the seed stage of approximately 2.6%. This is the largest elasticity observed in the seed estimation. This finding confirms the positive signalling role of organisational human capital in attracting equity investment.

The final significant coefficient in this estimate is *PersonalInvestment*. Interestingly, and contrary to hypothesis 13, the coefficient is negative and significant at p-value<0.01). It is the fourth largest coefficient observed in the seed estimate (Column I) and suggests that those firms obtaining equity financing at the seed stage have less reliance on the personal funds of the founder. According to the average marginal effect (Column II), the probability of being equity financed at the seed stage is 0.0013 times higher for each one-unit decrease in the proportion of seed stage funding committed by the founders. The elasticity (Column III) suggests that a 1% decrease in the proportion of seed stage funding raised from personal funds, *ceteris paribus*, is associated with an increase in the probability of the firm being equity financed of approximately 2.5%. Overall, rather than exerting a positive signalling impact as suggested by the literature (see Leland and Pyle, 1977; Ahlers *et al*., 2015), it appears that those with equity financing have less recourse to their own personal funds in starting their business.

Rather than assuming signals are stable across the firm's lifecycle, the seed model points to a dynamic element by focusing on the signals effective in obtaining equity finance during the seed year. The findings suggest that, at the seed stage, the entrepreneur should focus on demonstrating the strength of the firm's market and that the competencies needed for successful product development are present within the firm. Specifically, from the findings, we see that those facing little competition and targeting export markets are more likely to be equity financed during their seed year. Furthermore, organisational human capital represents an important signal at this stage. Taken together it appears that, in the initial stage, when the firm has not yet had the opportunity to demonstrate that it can accomplish later stages of the lifecycle (Behrens *et al*., 2012), it is important to signal to potential investors the existence of a promising market position and the ability (through the knowledge of employees) to develop the product going forward. Moreover, results suggest that, contrary to our hypothesis, those entrepreneurs obtaining equity financing during their seed stage have less recourse to personal funding.

5.5 General Conclusions

This Chapter asks what drives the equity financing of Irish technology-based firms. Specifically, analysis draws on both screening and signalling (Spence, 1973; 1974) literature to examine the factors effective in obtaining equity finance. Responses to an in-depth survey allowed measurement of typically difficult-to-observe variables such as market rivalry, product differentiation, innovativeness, financing preferences and personal commitment. Interesting conclusions emerge from the findings of analysis and these are the focus herein.

The results of empirical analysis suggest that market and product-related factors are central in equity financing. Findings support supply-side evidence that equity investors are attracted to unique product offerings targeting markets that are not too crowded (see Shepherd *et al*., 2003; Petty and Gruber, 2011). Exporting is also positively related to the likelihood of being equity financed, reflecting the findings of Carpentier and Suret (2015) who report that investors are looking for firms that display the potential of targeting a worldwide market. This is hardly surprising given that exporting is associated with growth (Zahra *et al*., 2000) and survival (Wagner, 2013). Results show that the frequency of innovation and investment in R&D both have positive signalling effects, with the former having the larger impact. This highlights the importance of equity financing for those conducting innovation, supporting the existing evidence (see Hall, 2010; Wang and Thornhill, 2010; Mina *et al*., 2013). Technology-based firms led by founder-CEOs with higher levels of educational attainment and international experience are more likely to be equity financed. Moreover, organisational human capital, contained within employees, also represents a positive signal for equity financing. Given the complex nature of technology-based firms and the associated need to understand the scientific methods and devices necessary for the product development process (Behrens *et al*., 2012), the fact that education, of both the founder-CEO and workforce, is a key signal is hardly surprising.

Furthermore, results reveal that entrepreneurial financing preferences impact on equity financing. Specifically, it is those with a preference for external funding that are more likely to be equity financed. Realistically, those that favour outside sources of funding may feasibly be assumed to be more willing to cede the control necessary to obtain that external investment and, thus, be more likely to seek external equity investors (Hogan and Hutson, 2005b). These results also lend support to the modified pecking order as proposed by Brierly (2001). Finally, as regards the impact of non-equity sources of finance, those with f-connection are more likely to be equity financed. This reflects the findings of Conti *et al*. (2013). Conversely, debt negatively impacts on equity financing. This is consistent with the findings of Audretsch and Lehmann (2004) and, more generally, in line with those reporting a lack of debt for technology-based firms (see Colombo and Grilli, 2007; Coleman and Robb, 2012).

To close, let us briefly consider the findings for the seed stage. Market rivalry and export activity are significant signals for those raising equity financing during their seed year, emphasising the key role of market characteristics in attracting equity investors. The findings highlight the advantage of organisational human capital, the knowledge and skills contained within the firm's employees. For a new technology-based firm the primary assets are often the knowledge and skills contained within the firm (Colombo and Grilli, 2005a). Taken together, these results suggest that signals indicating a promising market position and the ability to successfully develop the product and move forward are key to raising external financing. Finally, the negative impact of personal investment suggests that those with equity investment during their seed year have less recourse to personal funding.

This analysis heeds the recent call to pay attention to the effects of multiple signals (see Connelly *et al*., 2011; Plummer *et al*., 2016), rather than only examining signals in isolation. Essentially, most studies focus on the effect of a single, specific firm characteristic, such as human capital or patenting activity (see Higgins and Gulati, 2006; Audretsch *et al*., 2012). The evidence provided herein examines the role of a multifaceted array of factors as signals to equity investors. Additionally, by focusing on the characteristics of those firms that are equity financed, this research offers important insight into the criteria actually applied by equity investors in selecting portfolio firms. This avoids noted issues, including biases in self-reporting and accuracy of recall (Shepherd and Zacharakis, 1999), in supply-side research into investment criteria. Indeed, empirical results show that equity investors possess only limited understanding of their own decision process, which raises concerns regarding the validity of self-reported data (see Zacharakis and Meyer, 1998; Shepherd, 1999). By relying on data gathered from those who have successfully obtained equity investment, this research overcomes such shortcomings and provides a unique portrayal of criteria applied.

These findings offer avenues for **policymakers** to explore. Overall, results highlight the importance of equity for innovative technology-based ventures entering untapped markets. The fact that there is a lower likelihood of these firms receiving debt finance serves to emphasise the role of entrepreneurial equity funding for such firms. Thus, these findings accentuate the need for policymakers to continually facilitate access to and encourage use of equity financing to ensure these high-growth and high-potential ventures have the financial resources required for growth and development. This specific group of businesses, whose role as engines of economic growth is well recognised, are particularly susceptible to capital market imperfections (see Carpenter and Petersen, 2002a; Ullah *et al.*, 2010). The challenge for policymakers is not only how to decrease these imperfections (Colombo and Grilli, 2005a) but also how to urge entrepreneurs to consider equity as a viable financial resource. The Department of Finance SME Credit Demand Survey consistently reports that Irish SMEs are accessing equity financing in relatively small numbers. Specifically, data shows that only 1% of Irish SMEs are seeking venture capital financing and, similarly, only 1% are seeking angel investor funding. This is supported by an AIB study which found that 1% of SMEs said that they had secured investment from either a venture capital or equity fund.[107] To the degree that equity financing instruments can be developed and promoted, entrepreneurs can establish and develop these high-growth and high-potential innovative firms. Moreover, by highlighting the relationship between f-connection funding and equity financing, results also reveal a role for policymakers in providing training and information on the benefits of assorted financing options and the role of diverse personal financial networks in facilitating access to financing. Although not specifically examined in each wave of the Department of Finance SME Credit Demand Survey, where the data is available it shows that only 1% of Irish SMEs are approaching family and friends for funding. Essentially, findings herein suggest that financing instruments should not be seen in isolation but as a set of interacting policies.

For **entrepreneurs**, the results from empirical analysis offer guidance as to the different attributes that they can rely on to signal quality to external equity investors. Specifically, these findings highlight the factors that entrepreneurs should emphasise in their applications for external equity investment. This can, ultimately, improve their chances of successfully obtaining equity funding. Provided with a more detailed understanding of the criteria equity investors apply in their decision making, entrepreneurs can attempt to optimise their profile and make a clear and concise presentation of their venture's quality. Overall, these findings can aid entrepreneurs in improving the attractiveness or investment readiness (Mason and Harrison, 2004) of their ventures.

Lastly, for **equity investors**, the findings inform on the factors that are significant criteria in investment selection. In other words, by focusing analysis on those firms that have successfully raised equity financing, we offer a detailed insight into desired investment characteristics. This can prove particularly useful for novice equity investors, who can learn

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[107] Available at https://group.aib.ie/content/dam/aib/group/Docs/Press%20Releases/2017/equity-finance-the-irish-equity-challenge.pdf

and benefit from this information. In this regard, the results also inform the equity investor community in terms of training individuals entering the profession. Additionally, equity funds can apply the findings presented herein to develop a clearer understanding of their own decision processes. For example, deviations between agreed-upon investment policies and actual decisions can be uncovered and addressed. Furthermore, equity investors could apply these findings in benchmarking their own decision process – a practice that could be particularly beneficial, as there seems to be room for improvement in the decision-making process of equity investors (see Shepherd and Zacharakis, 2002; Franke *et al*., 2008).

In conclusion, although these results provide a valuable insight into equity financing, the work nonetheless has limitations. Analysis touches on lifecycle impacts by estimating a seed probit but, overall, the main model assumes that the determinants of equity are constant throughout the lifecycle. A more comprehensive examination of how these factors change over the lifecycle would provide more in-depth empirical evidence. The same can be said for an examination of the determinants of the sources of equity, rather than the broad definition adopted here. These extensions are addressed in Chapter 6 next. One issue which arises, however, is that analysis is based solely on the sub-sample of equity financed firms (N=153) and, thus, engenders a selection bias. To deal with this issue, a Mills' ratio will be inserted as a control variable in all regressions. The seed IMR will be used in seed estimations while the Mills' ratio computed in the main estimation will be used for other stages. This variable controls for the unobserved heterogeneity which affects a firm's probability of being equity financed (Bertoni *et al*., 2011).

CHAPTER 6 :

DETERMINANTS OF SOURCES OF EQUITY FINANCING OVER THE LIFECYCLE

6.1 Introduction

According to Achleitner and Braun (2014), entrepreneurial financing should be analysed across two dimensions – the stage of the firm at the time of financing and the respective sources of capital involved. With this in mind, and building on the analysis in Chapter 5, the aim of this Chapter is to explore whether the determinants of equity financing differ when examined according to source of equity (angel, venture capital, government-sponsored), stage of the lifecycle (seed, early-growth, expansion), and given the relationship (substitutes/complements) between these sources. Taken as a whole, the intention is to complete the empirical investigation into the determinants of equity financing.

Given heterogeneity among equity investors (Block *et al*., 2018), it is possible that different investors are attracted to different factors (i.e. signals). However, a gap in the existing literature becomes particularly evident once this heterogeneity is taken into consideration. Specifically, both supply-side (see Knockaert *et al*., 2010; Petty and Gruber, 2011) and (limited) demand-side (see Patzelt, 2010; Zhou *et al*., 2016) evidence of the determinants of equity finance focus primarily on the analysis of a sole investor category, predominantly venture capitalists. In practice, entrepreneurs typically raise equity funding from a multitude of sources (Bellavitis *et al*., 2017) and these sources differ along many dimensions, including investment targets, screening methods, skills and competencies, governance and objectives (see Bertoni *et al*., 2013; Drover *et al*., 2017). As such, there is a clear need for analysis that not only takes the entrepreneur's perspective (Rasmussen and Sørheim, 2012) but also distinguishes between these different equity investors (Hanssens *et al*., 2015). We address this gap, and provide novel empirical evidence, by asking: "***How do the determinants of equity financing vary across the different sources (business angel, venture capital, government-sponsored) of equity?***"

Furthermore, the financial lifecycle's (see Roberts, 1991; Berger and Udell, 1998) premise that financing evolves over time with the firm's changing characteristics insinuates that the determinants may potentially depend on the firm's stage. Heterogeneity across stages raises the question of whether the factors significant in obtaining equity apply in any stage or depend on stage-specific attributes. Existing evidence is predominantly based on the examination of signals at one point in time, mostly start-up or at IPO (see Higgins and Gulati, 2006; Jain *et al*., 2008; Plummer *et al*., 2016), providing only a snapshot of the equity finance acquisition process (Gompers, 1995). We are not aware of any research that attempts to disentangle the changing nature of the determinants of equity by examining potential determinants over different stages. Recently, researchers have begun to explore temporal issues through analysis of the evolution of signals across rounds of funding by repeat investors (see Hsu and Ziedonis, 2013; Hoenen *et al*., 2014; Ko and McKelvie, 2018). These studies, however, neglect to consider how the signals significant in obtaining new equity funding differ as the firm develops over distinct stages in the lifecycle. This is a notable gap as signals that are significant determinants of equity finance in one stage may be less relevant in others. Offering a unique insight into the changing nature of signals over the lifecycle, our second question is: ***"How do the determinants of equity financing vary across the stages (seed, early-growth, expansion) in the firm's lifecycle?"***

Last, inherent in the financial lifecycle is the implication that financing across the stages is potentially dependent on prior financing decisions (Berger and Udell, 1998). Within this context, a number of studies have examined the relationship between initial angel financing and subsequent venture capital funding, although the resulting evidence is mixed. While some report that venture capitalists are more likely to invest in firms that have raised an initial round of finance from angels (see Madill *et al*., 2005; Croce *et al*., 2018a), Hellmann *et al*. (2015) report that the sources are substitutes. To the best of our knowledge, no evidence exists on the impact of affiliation with venture capitalists, business angels and government-managed funds on subsequent equity financing acquisition or indeed on the determinants of equity financing. Feasibly, relationships with investors not only play an important role in signalling prospects and capabilities (Baum and Oliver, 1991) but can also improve legitimacy (see Plummer *et al*., 2016; Fisher *et al*., 2017). This brings us to our final research question: "***Do the sources of equity substitute or complement each other in the financing of technology-based firms over the lifecycle?***"

In testing these hypotheses, we employ a multivariate framework, using multivariate probit (MVP) estimations to explore the determinants according to source and stage along with the relationship between these sources. The MVP is one form of a correlated binary response model that simultaneously estimates the influence of independent variables on – more than one – dependent variable, and allows for the error terms to be freely correlated (Milioti *et al*., 2015). The main advantage of this method is that it does not require us to formulate an *a priori* assumption regarding equity financing patterns (Calia and Ferrante, 2013). This is particularly beneficial to our econometric analysis given that firms could simultaneously obtain more than one source of equity at each stage. Lastly, as analysis is based solely on equity financed firms, we take account, in the spirit of Heckman (1979), of the non-randomness of being equity financed. As such, we include a Heckman correction term to take into account sample (self-) selection in each estimation.

This Chapter proceeds as follows: Section 6.2 considers the extant literature and develops associated hypotheses; Section 6.3 outlines the data, methods and variables employed in econometric analysis; in Section 6.4 the results are presented and discussed; and, finally, Section 6.5 summarises the findings and suggests potential implications and limitations of this analysis.

6.2 Related Literature

The aim of empirical analysis herein is to explore how the determinants of equity financing vary when examined by source of equity, across distinct stages in the lifecycle, and given the relationship between the equity investors. As a starting point, let us briefly consider why determinants of equity financing may differ according to source. Agency theory once again provides our theoretical basis. The point of departure from Chapter 5 is as follows: within Jensen and Meckling's (1976) theory, while agency issues should always rise as the entrepreneur's relative ownership stake decreases (Bitler *et al*., 2005), the nature of the agency problem likely differs by investor type (Bonnet and Wirtz, 2012).[108]

As discussed in Chapter 1 (Section 1.2), informal angels and formal (independent, corporate, government-sponsored) venture capitalists are two very different categories of equity investor. Venture capitalists are finance professionals who manage funds raised from third parties (limited partners, corporations, government) (see Gompers and Lerner, 2000; Block *et al*., 2018). As such, they are accountable to others for their decisions (Maxwell, 2016). Angel investors are usually actual or former entrepreneurs who invest their own money and, as such, are accountable only to themselves (see Freear *et al*., 2002; Morrissette, 2007). As a result of this difference there is also a difference in agency risk (Fiet, 1995). Angels tend to experience more severe informational problems, mainly due to difficulties obtaining, assessing and verifying information (see Kelly and Hay, 2003; Morrissette, 2007), leading to agency problems primarily based on information asymmetries (Fiet, 1995). For venture capitalists,

[108] To recap, agency costs derive from information asymmetry and potentially conflicting goals and interests (Jensen and Meckling, 1976). Agency theory suggests that agency problems occur when: one party (principal) delegates work to another (agent); the goals of the principal conflict with those of the agent; information asymmetries between the principal and agent result in difficulty for the principal to monitor the agent (see Jensen and Meckling, 1976; Eisenhardt, 1989). Underlying agency theory is the assumption that the principal will attempt to minimise the goal difference with the agent or set up beforehand control mechanisms to verify the information provided by the agent and also ensure that the agent will complete delegated work (Eisenhardt, 1989). The control mechanism may thus be focused on the agent's behaviour or the outcomes of the agent's behaviour (Eisenhardt, 1989). That is, the principal may attempt to use mechanisms that allow them to closely monitor the agent's behaviour (i.e. behaviour-oriented) or mechanisms that provide the agent with incentives based on the agent's behaviour (i.e. outcome-oriented) (Hsu *et al*., 2014).

while problems associated with information asymmetries may be less severe, agency costs arising from conflicting interests are likely to be greater than with angels (Bonnet and Writz, 2012). The goals of venture capitalists are predominantly focused on the outcome of the investment (Arthurs and Busenitz, 2003). In contrast, angels must only meet their own needs, and generally value benefits that go beyond financial returns (Van Osnabrugge and Robinson, 2000). Not only is the angel's knowledge base and cognitive process closer to the entrepreneur's (Bonnet and Wirtz, 2012) but their goals, compared to venture capital, are closer to the entrepreneur's goals (Arthurs and Busenitz, 2003). Consequently, venture capitalists usually emphasise outcome-oriented control mechanisms (for example, setting milestones, staging capital infusions), as these can efficiently reduce goal conflict (Hsu *et al*., 2014). In comparison, facing more severe informational issues (Morrissette, 2007), angels tend to select investees based on the attributes of the entrepreneur, as an *ex-ante* approach to reducing potential information asymmetries that may arise after the investment (see Fiet, 1995; Hsu *et al*., 2014). Due to these differences, formal and informal equity investors tend to differ with respect to the factors they are attracted to in selecting investees (Mason and Stark, 2004). It follows then that the determinants of equity may differ by source.

The attributes of the firm and entrepreneur that represent potential determinants of external equity have been identified and discussed in detail in Chapter 5 (Section 5.2). These range from the firm's market and product, through innovation activity, to human capital and financing-related aspects.[109] The way in which these factors act as signals to external investors, along with the hypothesised effect (see Table 5.1), has been established. In approaching analysis herein, we begin by assuming that, from the demand-side, which is where this study sits, entrepreneurs will attempt to convey all signals pertaining to their market, product,

[109] To recap, the determinants in Chapter 5 were grouped within categories as follows: **Market and Product** (Rivalry, Exports, Product Differentiation); **Incubation**; **Innovation Activity** (Frequency of Innovation; R&D Expenditure; Patents); **Human Capital** (Founder-CEO education and experience, Workforce Qualification); and **Financing-related** (Financing preferences, Personal Investment, F-Connection and Debt Funding).

innovation and human capital in attempting to raise external equity, regardless of the source of equity targeted. We posit further that these signalling mechanisms are rather stable and persistent across the stages. Thus, they are included as control variables in our estimations (Section 6.3) and, as such, we do not derive new hypotheses herein. This brings us to the financing-related variables. Financing preferences of the entrepreneur are unlikely to differ by source or stage and, as such, is also classified as a control variable for analysis. The same cannot be said for the remaining factors – sources of finance (personal, f-connection, and debt).

In short, the firm's financial attributes evolve and change over time. According to the financial lifecycle (see Roberts, 1991; Berger and Udell, 1998) the firm's stage plays a crucial role in capital structure.[110] Throughout the lifecycle, the financing of the firm changes according to the availability of information (La Rocca *et al.*, 2011). First is the seed stage, when a concept has still to be proven[111] and information opacity problems are most severe. The firm is typically considered too risky for formal debt or equity finance (Huyghebaert and Van de Gucht, 2007). Initially, the likely source of funding is personal investment by the founder(s), followed by investment from f-connections and then angels (Berger and Udell, 1998). Moving through the early-growth stage, products are developed and launched, and initial marketing takes place (Kazanjian, 1988). Formal equity finance becomes more obtainable, although angels remain important in formative years.[112] As firms mature into the expansion stage, the focus is on commercialisation and cementing its foothold in the market. The sources of financing do not differ substantially from the previous stage, although larger scale private/corporate venture capital and debt may be accessed (North *et al.*, 2013). Finally, the

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[110] The financial lifecycle model finds its basis in organisational lifecycle theory which depicts firms, like living organisms, as passing through a series of predictable patterns of development wherein resources, finance, capabilities, strategies, management priorities and structures vary with the corresponding stage of development (see Quinn and Cameron, 1983; Miller and Friesen, 1984; Kazanjian, 1988). The reader is referred to Chapter 2 (Section 2.3) for an in-depth discussion.
[111] Indeed, at this point the firm may not have an actual product or output to sell and so the purpose of financing is typically to transform R&D projects into successful enterprises (Caselli and Negri, 2018).
[112] Angels typically provide small-scale start-up and early stage capital, and the formal venture capital industry provides larger-scale subsequent capital (see Roberts, 1991; Harrison and Mason, 2000).

firm reaches the later stage, having diversified its products, established its reputation along with a proven market (Hogan and Hutson, 2010). At this point public equity markets may be accessed to raise larger amounts (Mason *et al*., 2010). It follows then that the financial information available to the entrepreneur in signalling to external equity investors may be transitory and stage-dependent.

Thus, the focal point for hypotheses development is primarily the role of the firm's financing as a determinant of angel, venture capital and government-sponsored equity at distinct stages in the lifecycle. This is an unexplored area in the existing literature and, as such, present an interesting topic for investigation. The discussion herein proceeds as follows: we begin with an examination of the impact of non-equity sources of financing as signals for angel, venture capital and government-sponsored equity at the seed, early-growth and expansion stages (Subsection 6.2.1); following this, we form our expectations concerning the relationship (i.e. complements or substitutes) between the sources of equity (Subsection 6.2.2).

6.2.1 Financial Signals across Sources of Equity and Stage of Lifecycle

Agency research, and the related 'certification' hypothesis, suggests that entrepreneurs can signal expected value by who has invested in their firm (see Black and Gilson, 1998; Drover *et al*., 2017). First, entrepreneurs themselves, through their own personal investment, can provide signals that are difficult to imitate and provide an indication of the firm's value (Leland and Pyle, 1977). Essentially, high levels of ownership by the entrepreneur signals that he/she believes there is value in the venture and this signal in turn reduces the adverse selection problem for external equity investors (Prasad *et al*., 2000). Personal ownership will also lead to greater alignment of interests with other investors, and signal that the entrepreneur will seek to make decisions that maximise the value of the venture (Jensen and Meckling, 1976). However, the existing evidence suggests that the signal from the founder's personal investment may be interpreted somewhat differently by external equity investors. In a recent study, Conti *et al*. (2013) show how the signal from founder, family and friends' investment (as a signal of commitment) has a positive and significant impact on angel funding, both for the likelihood of obtaining and the amount obtained, but does not have a significant effect on venture capital (their results show that patents represent the significant signal for venture capital). The authors conclude that angels are more concerned with signals of commitment than those pertaining to the firm's technology. This conclusion echoes Van Osnabrugge and Robinson (2000) and DeGennaro (2010) who show that angels tend to emphasise characteristics such as commitment, trust and enthusiasm more than venture capitalists. Similarly, Busenitz *et al*. (2005) find that high levels of ownership and personal net worth invested in a venture by the founding team does not provide a valid signal of actual success to venture capitalists. By way of explanation, the authors suggest that, by the time investment has been made, the venture capitalist has undertaken extensive due diligence and knows so much about the business that the information gap becomes relatively small. Thus, this financial signal may not be of much assistance. Nevertheless, although Conti *et al*. (2013) and Busenitz *et al*. (2005) found the signal to be insignificant, entrepreneur ownership has long been considered to be positively linked to firm value (Downes and Heinkel, 1982) and, as such, we conjecture that personal investment will be construed in a positive light by venture capitalists. Lastly, to government-sponsored equity. Although there exists, to the best of the author's knowledge, no empirical evidence as regards government-sponsored equity, given the fact that Enterprise Ireland require matched (private) funding, we posit that personal investment would be an important positive factor for successfully obtaining government-sponsored investment. Thus:

***Hypothesis 1**: Personal investment represents a positive signal for angel, venture capital and government-sponsored equity financing.*

Second, the entrepreneurs social circle is considered the most accessible form of funding for young firms (Bygrave and Quill, 2007). Social and physical proximity to the entrepreneur provides these funders with superior information and lower monitoring costs as compared to other financial intermediaries (Stiglitz, 1990). As discussed in Chapter 5 (Section 5.2), family and friends' (i.e. f-connection) investment can represent a signal to external equity investors. However, although f-connections are a vital (cheaper) source of capital for nascent firms (Berger and Udell, 1998), such investment may create corporate governance issues that deter professional investors from participating in future rounds. Venture capitalists typically require extensive control rights over investee firms, including the right to fire entrepreneurs (Hellmann, 1998), which can compensate for the risk associated with moral hazards and potential disagreements (Goldfarb *et al*., 2009). Control is not usually emphasised to the same extent by angels, who commonly employ mechanisms such as geographic proximity and higher equity stake left to founders to allow for lower levels of monitoring (Wong *et al*., 2009). The most direct way to control an investee firm is through board seats or to replace founders in the management team (Wasserman, 2012). Founders with a pronounced desire for control are likely to resist this change and resistance can be difficult to overcome should f-connection stakeholders decide to side with the founder and attempt to retain control within this close social circle (Zaccaria, 2015). The expectation of a costly or time-consuming negotiation over control with this informal coalition can discourage venture capitalists. To illustrate, in a study of young U.S. firms, Zaccaria (2015) finds that, due to conflicts of interest between informal stakeholders and professional venture capitalists, f-connection funding reduces the probability of future venture capital financing. Finally, again lacking evidence pertaining to government-sponsored equity, given the requirement for matched (private) funding, we posit that f-connection investment would represent a positive signal for obtaining government-sponsored funding. Given these considerations:

Hypothesis 2: *F-Connection investment represents a positive signal for angel and government-sponsored funding but a negative signal for venture capital.*

According to Ross (1977), firms can convey private information through the proportion of debt in their capital structure. In short, debt constitutes a costly signal in distinguishing high-quality from low-quality firms as only successful firms with higher revenues can support greater leverage. As outlined in Chapter 5 (Section 5.2), debt can also be a reliable signal due to its effective governance role (Epure and Guasch, 2019). In short, by commanding greater accountability, debt directs firms towards more professional management practices, ties control rights to cash flow monitoring by lenders, and institutes penalties that go as far as fully shifting control of the firm (see Jensen, 1986; Grossman and Hart, 1982). Given these considerations, it is feasible to expect that debt can be a reliable signal to external equity investors. Corroborating this, Epure and Guasch (2019), based on data gathered through the Kauffman Firm Survey, find that business debt serves as a reliable positive signal for external equity investors. Unfortunately, the authors do not distinguish by source of equity in their analysis. Audretsch and Lehmann (2004), on the other hand, report that the likelihood of obtaining venture capital is inversely related to the extent to which the firm is financed by debt. This finding, however, could simply indicate that excessive debt is a negative signal, rather than the signal from successfully obtaining debt finance. In line with this, the accounting literature indicates that high debt could be informative of financial distress (see Jones and Hensher, 2004; Caskey *et al*., 2012). The analysis herein is interested in examining the impact of the signal that arises from the firm receiving debt financing. Debt not only signals quality (Ross, 1977) but can also act as a governance mechanism that can help to mitigate potential agency conflicts by imposing a disciplining governance mechanism (see Jensen, 1986; Epure and Guasch, 2019). Unfortunately, to the best of the author's knowledge, no evidence exists regarding the signalling effect of debt according to the different sources of equity financing. If we once again assume that supplementary sources of financing are an important factor for government-sponsored equity funding and that debt, overall (i.e. to all external investors), can be considered a reliable signal then we can posit that:

Hypothesis 3: *Debt finance represents a positive signal for angel, venture capital and government-sponsored funding*.

Now, let us consider the '*when*' aspect of these financial signals. The personal funds of founders and investment from family and friends are widely recognised as vital sources of financing for nascent and young firms (see Berger and Udell, 1998; Ullah and Taylor, 2007). Effectively, during the seed and early years of development, when the firm lacks a track record and informational opacity is most severe, entrepreneurs usually depend on capital not only from themselves but also from their f-connections. These investors know the entrepreneur, and thus the information asymmetries faced are lower than those faced by other external sources (Cumming and Johan, 2009). Conti *et al*. (2013) show that founder, family and friends' investment represents an important signal of commitment for start-up companies. However, moving through the lifecycle, the capital required for sustained growth usually outstrips the abilities of this group (Cassar, 2004). Consequently, we argue that signals from founder and f-connection investments are most likely available during the seed and early-growth stages, given these are the stages in which investment from this group is obtained. Thus,

Hypothesis 4: *Personal investment represents a positive signal for equity financing during the seed and early-growth stages*.

Hypothesis 5: *F-Connection investment represents a positive signal for equity financing during the seed and early-growth stages*.

As regards the signalling role of debt financing, empirical evidence is, to the best of the author's knowledge, non-existent. Within the financial lifecycle, debt is typically only available once the firm becomes established, with a proven track record, and advances into expansion and later stages of development (Berger and Udell, 1998). This would suggest that:

Hypothesis 6: *Debt finance represents a positive signal for equity financing at the expansion stage.*

6.2.2 Relationships between the Sources of Equity Financing

Inherent in the financial lifecycle (see Roberts, 1991; Berger and Udell, 1998) is the notion that financing choices are intrinsically sequential and, as such, dependent on prior financing decisions (see Mayer, 2002; Hirsch and Walz, 2011). Indeed, a central tenet of Berger and Udell's (1998) financial lifecycle model is that the inter-connectedness and substitutability between different financiers is crucial to funding the continuous development of the firm. The authors illustrate this using the example of contracts between entrepreneurs and angels being made in anticipation of future venture capital to reduce the risks associated with information asymmetry. Moreover, applying signalling theory (Spence, 1973, 1974), research suggests that the endorsement offered by investments from external investors can be an important signal in obtaining future investment (see Stuart *et al*., 1999; Ko and McKelvie, 2018). Essentially, because of the irreversibility of financial relationships (Janney and Folta, 2006) a relationship with external investors might be the hardest to achieve but have the strongest effect when acquired (Sorenson and Stuart, 2001). Indeed, evidence shows that endorsement through financial commitment has a stronger signalling effect than other types of relationships (see Stuart *et al*., 1999; Hsu, 2004). This motivates the second element in the analysis of the determinants of equity – do the sources of equity substitute or complement each other in financing technology-based firms?

In short, there are two opposing assessments of the relationship between formal and informal equity investors. The first, and probably dominant, view sees these investors as synergistic members of a tightly knit ecosystem (Hellmann *et al*., 2015). Within this relationship, angels provide initial funding before venture capitalists provide follow-on finance (Harrison and Mason, 2000). Essentially, angels are a prelude to venture capital, running the critical first leg of the relay race and passing the baton to venture capitalists once the firm has begun to find its stride (Benjamin and Margulis, 2001). The second viewpoint sees these investors as substitutes, rarely interacting with each other (Hellmann and Thiele, 2015). They are alternative financing modes and those that obtain funding from one source are more likely to stick to that source in the future (Hellmann *et al*., 2015). Let us now consider both sides.

For the most part, researchers assert that angels and venture capitalists are complementary sources of funding, whereby those obtaining angel investment are relatively more likely to access venture capital (see Freear and Wetzel, 1990; Van Osnabrugge and Robinson, 2000; Heukamp *et al*., 2007). Essentially, angels play a specific role at very early stages of development, not only providing initial funding but, by serving a screening and signalling role, can open the field to venture capitalists (see Harrison and Mason, 2000; Freear *et al*., 2002; Schmidt, 2014). Bonnet and Wirtz (2012) show that, while angels play a strong role at the earliest stage of the funding process and venture capitalists take the lead in the deal structuring phase, both investor categories play important complementary roles during the post-investment phase. Madill *et al*. (2005), based on their analysis of angel financed firms in Canada, find that having received angel investment is significantly associated with receipt of venture capital. The authors ascertain that 57% of the firms in their sample which had received initial angel funding went on to obtain venture capital investment whereas only 10% of firms without initial angel funding subsequently received venture capital finance. In their examination of US-based angels, Kerr *et al*. (2014) find that angel funded firms are 70% more likely to receive venture capital investment than firms who are rejected by angels. Croce *et al*. (2017), in their analysis of Italian angels, report that business proposals brought to the attention of angels by venture capitalists are more likely to get through the pre-screening stage.

Chemmanur and Chen (2014), in their theoretical analysis of the different roles played by venture capitalists and angels in funding private firms, also imply a complementary relationship. If venture capitalists add value but angels don't, their model explains why, in choosing the optimal financing path, entrepreneurs first obtain angel funding and then switch to venture capital.

Hellmann and Thiele (2015) model the interaction between angels and venture capitalists, where companies want to proceed from angel to venture capital funding. A key insight from this model is that the bargaining dynamic between the two sources of equity funding may determine whether the relationship is one of complements or substitutes. Using a costly search model which assumes that entrepreneurs receive initial funding from angels but follow-on investment from venture capitalists, Hellmann and Thiele (2015) highlight two dimensions of the relationship between the investors: on the one hand, the two investor types are 'friends', relying on one another for investments; on the other, they are 'foes', as angels are no longer required by venture capitalists once their follow-on investment is made. In this scenario, the authors posit that the strength of the venture capitalists' bargaining power depends on both the competitiveness in equity markets and legal protection for angel investors.

Conversely, others report evidence of a substitute relationship. Hellmann *et al*. (2015) examine the extent to which angel investors and venture capitalists complement or substitute each other. Based on Canadian data, their OLS regression reveals a negative relationship between the two sources. The authors conclude that angel and venture capital financing are dynamic substitutes, with companies who have obtained venture capital being less likely to subsequently obtain angel financing, and vice versa. In other words, once the company obtains funding from one source, they are less likely to switch to another type of investor in the future. In line with this, Goldfarb *et al*. (2009) also report a negative effect of mixing these two sources of equity capital, suggesting that the sources are substitutes.

Unfortunately, there exists, to the best of the author's knowledge, no evidence for the role of such signals for obtaining government-sponsored equity funding. Conceptually, however, there is reason to believe that a complementary relationship will exist between public sources and private investors (venture capitalists and angels). The notion that public sector money follows private sector investors, who invest alongside government-sponsored funds in co-investment deals (Owen and Mason, 2017), embodies the very delineation of a complementary relationship. A frequently cited justification for government involvement in the equity market is the certification role played by the allocation of public funding. Referred to as the seeding hypothesis (Leleux and Surlemont, 2003), the presence of the public investor should enhance the capacity to attract private sector investment by lowering information asymmetries which might otherwise preclude private involvement (Buzzacchi *et al*., 2013). Essentially, public investment acts as a signal to private investors, fostering the provision of subsequent equity funding (see Lerner, 1999; Colombo *et al*., 2016; Minola *et al*., 2017). To illustrate, Brander *et al*. (2015) find that markets with higher levels of government-sponsored equity have more venture capital funding per enterprise and more venture capital funded firms, suggesting that public equity largely augments the private venture capital industry. The authors also report that firms funded by both government-sponsored and private venture capital obtain more investment than those funded solely by one source, suggesting an apparent complementarity between government and private sector equity financing. Similarly, for European technology-based companies, Guerini and Quas (2016) find that the receipt of government-sponsored equity significantly increases likelihood of receiving private venture capital at least threefold.

Although the existing evidence is mixed, applying a signalling perspective we can argue that endorsement through equity investment will have a positive impact on subsequent equity acquisition for several reasons. Financial investment typically triggers the first business relationship formed by many ventures (Hallen, 2008) and insinuates a level of confidence in the venture (Stuart *et al*., 1999). Furthermore, investors improve the venture's networks (Milanov and Fernhaber, 2009), as a noted non-financial value-added benefit of equity investment is access to the investor's network contacts and support resources (Arthurs and Busenitz, 2006). Additionally, endorsements from equity investors can enhance the firm's visibility in the market (Pollock and Gulati, 2007), prompting audiences to categorise these ventures as higher status compared to similar-appearing peers (Fombrun and Shanley, 1990) and helping them gain exposure to subsequent investors (Ko and McKelvie, 2018).

These considerations lead to the following:

Hypothesis 7: *Seed stage equity financing (angel, venture capital, government-sponsored) represents a positive signal for equity investors at the early-growth stage.*

Hypothesis 8: *Seed and early-growth stage equity financing (angel, venture capital, government-sponsored) represents a positive signal for equity investors at the expansion stage.*

6.2.3 Conclusions

The main themes of this Chapter have now been sketched. They explore the role of the firm's financing information on the source of equity obtained over the lifecycle, along with the relationship between equity investors. As a theoretical framework, agency theory (Jensen and Meckling, 1976) provides insight into differences in the investment strategies of equity investors while the financial lifecycle paradigm (see Roberts, 1991; Berger and Udell, 1998) illustrates how the determinants of equity are nuanced and potentially depends upon the attributes of the firm at distinct stages. Building on the sequential aspect of the financial lifecycle, we also considered the impact of initial financing decisions on future acquisition of equity funding. Although the evidence in this area is mixed and focused solely on the relationship between angel and venture capital financing, relationships with equity investors are argued to represent an important signal which can positively impact on acquisition of equity financing during subsequent stages.

6.3 Data and Methods

This Section outlines the data, methodology and variables used in econometric analysis. Discussion begins with a brief overview of the data employed (Subsection 6.3.1). This is followed by a discussion of the multivariate probit model used to examine the determinants of and relationship between the sources of equity financing over the lifecycle (Subsection 6.3.2). Analysis takes account, in the spirit of Heckman (1979), of the non-randomness of being equity financed and this is also detailed herein. Finally, the variables included in econometric estimations are summarised (Subsection 6.3.3).

6.3.1 Data

Given the focus of this Chapter, analysis is based solely on data from equity financed firms. From a sampling frame of 313 firms, 153 interviews were conducted (response rate 49%) with the founder-CEOs of equity financed technology-based firms. For these firms, the proportions between technology-based manufacturing and knowledge-intensive service sectors were 15% and 85% respectively. Most of these firms (89%) are classified as micro or small enterprises. The reader is referred to Chapter 4 for an in-depth profile of this firms.

For the purposes of analysis, firms are categorised according to stage in the lifecycle as follows: seed (first year of operation); early-growth (2-5 years); and expansion (6-10 years).[113] However, the sample size at each stage is not consistent. Specifically, all firms (N=153) had gone through the seed stage at the time of data collection. Two firms were nearing the end of their seed year at the time of interview; hence data is only available for this stage. Moving into the early-growth stage, therefore, we have data for a total of 151 firms (the two seed stage firms having been dropped). Of these, a total of 65 (43%) were in the early-growth stage at the time

[113] The later stage is dropped due to a lack of respondents (N = 33).

of interview and, as such, drop from the sample moving into the expansion stage. This leaves a total of 86 firms for which data is available for the expansion stage.

As regards sources of equity financing, all 153 firms had obtained equity financing (independent, corporate, or government-sponsored venture capital or angel funding) at some point in their lifecycle. Summary statistics are provided in Table 6.1. We see that firms used an assortment of sources of equity at each stage and in different combinations (see Chapter 4, Section 4.3 for in-depth discussion). Consistent with evidence (see Mason, 2006; Hsu *et al*., 2014) the main source at seed is angel financing. Moving into early-growth, sources are comparable – in fact, almost a quarter (21.2%) received funding from all three investor categories, while almost half (42.4%) obtained finance from two sources. During expansion years, venture capital is the most common source. Overall, equity appears to be clustered at the early-growth stage and, consistent with evidence, firms obtain a variety of sources, either through co-investment or multiple independent investments at the same stage (see Grilli and Murtinu, 2014b; Owen and Mason, 2017).

Table 6.1. Sources of Equity Financing by Stage of Lifecycle

	Seed (N = 153)	**Early-growth (N = 151)**	**Expansion (N = 86)**
Angel	44 (28.8%)	90 (59.6%)	16 (18.6%)
Venture Capital	18 (11.8%)	83 (55%)	35 (40.7%)
Government-sponsored Equity	24 (15.7%)	87 (57.6%)	18 (20.9%)

Source: Survey Data

6.3.2 Methods

In most general terms, analysis undertaken in this Chapter aims to test the determinants of each source of equity at distinct stages in the lifecycle (i.e. seed, early-growth and expansion). Such an empirical examination can be modelled in two ways, through multinomial or multivariate regression. One of the underlying assumptions of multinomial models is the independence of irrelevant alternatives (error terms are mutually exclusive) (Grenne, 2003). The survey instrument designed for this study allowed respondents to specify numerous sources of equity at each applicable lifecycle stage (see Chapter 3, Subsection 3.2.2). Thus, categories are not mutually exclusive. Given that the random error components of the categories may be correlated, analysis employs the multivariate probit (MVP), which allows for contemporaneous correlation in the use of different sources simultaneously. This model is considered appropriate when the binary dependent variables are very closely linked and seem to be influenced by the same factors (Castillo-Manzano, 2010). The main advantage of the multivariate probit approach is that multiple correlated binary choices are modelled simultaneously, capturing the influence of the set of explanatory variables on each source while accounting for correlations in the error terms between the individual outcomes (Greene, 2012) rather than explicitly modelling each combination of outcomes as in the multinomial case (Becker *et al*., 2017). Essentially, within the MVP, it is assumed that choices are made simultaneously and, as such, may share common underlying unobserved factors, whereby one outcome may be an endogenous factor in another (Becker *et al*., 2017).

In the MVP, each source of equity corresponds to a binary choice (*yes/no*) equation, and these are modelled jointly using correlations among disturbances. Essentially, the MVP extends the probit regression to accommodate more than two outcome variables by simply adding equations. If Y_j (j=1, 2,…, j) is a binary variable, then the general specification for a *k*-equation model for ($Y_1, Y_2,\ldots,Yj$) is:

$$
\begin{array}{ll}
Y_{1i}^{*} = \beta_1' x_{1i} + \varepsilon_{1i} & Y_{1i} = 1 \text{ if } Y_{1i}^{*} > 0 \text{ and 0 otherwise} \\
Y_{2i}^{*} = \beta_2' x_{2i} + \varepsilon_{2i} & Y_{2i} = 1 \text{ if } Y_{2i}^{*} > 0 \text{ and 0 otherwise} \\
 & \cdot \\
 & \cdot \\
 & \cdot \\
Y_{ji}^{*} = \beta_j' x_{ji} + \varepsilon_{ji} & Y_{ji} = 1 \text{ if } Y_{ji}^{*} > 0 \text{ and 0 otherwise}
\end{array} \tag{6.1}
$$

where x_k is a vector of observed characteristics determining choice alternative i (e.g. supplementary sources of financing, entrepreneurial preferences, firm-specific attributes, human capital, etc.) the j^{th} equation (j=1,…, J); β_j' is the corresponding vector of parameters; and ε_k is an error term distributed as multivariate normal, with a mean of zero and variance-covariance matrix V. If we assume that ε_m are distributed independently and identically with a univariate normal distribution, equation (6.1) defines J univariate probit models (Calia and Ferrante, 2013). The model estimated herein consists of three equations, capturing the three sources of equity financing of interest (angel, venture capital, government-sponsored).

In total, five specifications of the MVP are estimated. First, in testing the determinants of the sources of equity obtained over the lifecycle, three MVP models are estimated, one for each stage (seed, early-growth, expansion). Within these models, an equation is specified for each source (venture capital, angel, government-sponsored) obtained during the specified stage. In this way, the simultaneous choice of some sources can be addressed through joint probabilities (Calia and Ferrante, 2013). The covariates are the same across each equation, and these are discussed next (Subsection 6.3.2). Second, in investigating the relationship between the sources of equity, and the impact existing investors have on the determinants of equity, two MVP models are estimated – one for the early-growth and one for the expansion stage. Clearly, at the seed stage (the first year of operation) prior equity investment is non-existent, so analysis effectively begins with the early-growth stage. Once again, within each model, a binary indicator corresponds to the source(s) of equity obtained during that stage and an equation is specified for each. As the point of departure from the first phase of analysis, these models include covariates which capture sources of financing obtained in previous stages. In this context, in addition to extending our exploration of the determinants of equity financing we also examine the complementarity/substitutability relationships between the different sources.

One key hypothesis to test is that all cross-equation correlation coefficients are simultaneously equal to zero. If this is the case, one could equivalently fit *M* independent univariate probit models for each source of equity. The assumption of the independence in the error terms means that information regarding the firm's choice of equity investor does not affect the prediction of the probability of choosing another source for that firm. If the unobserved correlations among outcomes are ignored, each of the *M* equations in (6.1) could be estimated separately by a univariate probit. In principal, the MVP is an extension of the standard bivariate probit to more than two outcome variables, and the practical obstacle to this extension is the evaluation of higher-order multivariate normal integrals, an *M*-dimensional integral without a closed analytical form (Greene, 2003).

Finally, because analysis is based solely on equity financed firms, each MVP model includes a correction for sample selection bias. In short, selection occurs when observations are non-randomly sorted into discrete groups, resulting in the potential for coefficient bias in estimation procedures (Maddala, 1991). Consequently, it is necessary to control for bias due to unobservable factors to minimise the possibility of biased parameter estimates (Eckhardt *et al*., 2006). Thus, a two-step Heckman selection model (Heckman, 1979) is utilised to address bias that may arise due to unobservable factors that affect both the probability of a firm self-selecting its treatment (i.e. choice to seek equity finance) and the treatment outcome (i.e. being equity financed). In the first step, a correction term (Inverse Mills' Ratio (IMR)) is estimated through a choice model and, in the second, added as a regressor in estimations based solely on equity financed firms. The binary probit of the likelihood of being equity financed estimated in Chapter 5 was used to calculate an IMR.

Empirically, a treatment-effects model estimates the effect of an endogenous binary treatment (i.e. equity financed), T_i, conditional on the independent variables X_i and Z_i such that:

$$Y_i = X_i\beta + \delta T_i + \epsilon_i, \tag{6.2}$$

where T_i is an endogenous dummy variable indicating whether the treatment is assigned or not. The binary decision to obtain the treatment T_i is modelled as the outcome of a latent variable, T_i^* where $T_i^* = Z_i\gamma + \upsilon_i$ and the observed decision is made such that:

$$T_i \begin{cases} 1 & \text{if } T_i^* > \\ 0 & \text{otherwise} \end{cases} \tag{6.3}$$

where ϵ_i and υ_i are bivariate normal with mean zero and covariance ρ. Maddala (1986) provides details of a two-step estimator for computing the IMR (see also Greene, 2003). At the first step, probit estimates of γ are obtained from the treatment equation (6.1), where:

$$Pr\ (T_i = 1 \mid Z_i) = \Phi(Z_i\gamma) \tag{6.4}$$

From this estimation, the inverse Mills ratio, IMR_i, for each observation i is computed as:

$$IMR_i = \begin{cases} \dfrac{\emptyset(Z_{i\hat{\gamma}})}{\Phi(Z_{i\hat{\gamma}})} & T_i = 1 \\ \dfrac{-\emptyset(Z_{i\hat{\gamma}})}{(1 - \Phi(Z_{i\hat{\gamma}}))} & T_i = 0 \end{cases} \tag{6.5}$$

where $\emptyset$ is the standard normal density function; Φ is the normal cumulative distribution function. Two-step parameter estimates of β and δ in equation (6.1) are obtained by augmenting regression equations with the inverse Mills ratio (IMR_i) obtained from equation (6.4) (this Mills ratio is included in all estimations based solely on equity financed firms).

6.3.3 Variables

Descriptive statistics for dependent and independent variables are provided in Tables 6.2 and 6.3 respectively. Because these are largely the same as those applied in Chapter 5 (Subsection 5.3.3), only a brief synopsis is presented here. The point of departure is that, for the analysis undertaken herein, variables are defined by stage.[114]

The dependent variables in all MVP models are binary indicators corresponding to each source of equity, with three[115] categories defined as follows:

- ***Business Angel*** **–** investment by high-net worth individuals, acting alone or as part a group (see Landström, 1993; Drover *et al*., 2017);
- ***Venture Capital*** – investment by private (independent) or corporate professional entities (see McNally; 1997; Tykvová *et al*., 2012);
- ***Government-sponsored Equity*** - investment provided through publicly funded schemes of Government agencies (see Guerini and Quas, 2016; IVCA, 2018).

As discussed above, the MVP is estimated by lifecycle stage, namely: seed (first year of operation); early-growth (years 2–5); and expansion (years 6-9).[116] This classification is in line with those applied in the literature (see Roberts, 1991; Mayer, 2002). It should be noted that dependent variables in all models take account only of new sources received during the stated stage (i.e. reinvestment from those who participated previously are excluded). Results are most convincing when focusing only on new investors, as existing investors who may decide to make follow-on investments face a different decision problem in comparison to new investors (Hellmann *et al*., 2015).

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[114] It should be noted that differences in summary statistics between stages is due to cases dropping out of consecutive stages rather than new cases entering (i.e. firms progress through the lifecycle until they are dropped from the database after their current stage).
[115] Venture Capital is collapsed into one category incorporating both independent and corporate as the number of firms in the corporate venture capital (N = 22) category is quite small.
[116] The later stage is dropped due to a lack of respondents (N = 33).

Table 6.2. Description of Variables

Variable	Definition	Seed (N= 153)	Early (N= 151)	Expansion (N= 86)
Financing		Number (%) [a] / Mean (Std. Dev.) [b]		
PersInvest	= ‘1’ if firm used personal capital of founder(s) during stage; = ‘0’ otherwise	143 (93.5%)	88 (58.3%)	22 (25.6%)
FConnections	= ‘1’ if firm received f-connection funding during stage; = ‘0’ otherwise	37 (24%)	40 (26.5%)	7 (8.1%)
Debt	= ‘1’ if firm obtained debt financing during stage; ‘0’ otherwise	15 (9.8%)	29 (19.2%)	20 (23.3%)
Entrepreneurial Perspective				
FinancingPref	= ‘1’ if entrepreneur prefers to utilise internal finance; = ‘0’ otherwise	106 (68.8%)	105 (69.5%)	58 (67.4%)
Control	= ‘1’ (unimportant); = 2 (slightly important); = 3 (important); = 4 (very important)	1.9 (0.9)	1.9 (0.9)	2.0 (1.0)
Monitoring	= ‘1’ (unimportant); = 2 (slightly important); = 3 (important); = 4 (very important)	2.8 (0.9)	2.8 (1.0)	2.8 (1.1)
RiskSharing	Average importance of risk sharing with investors, where 1 is the lowest and 5 the highest	2.1 (1.0)	2.1 (1.1)	1.0 (1.3)
Firm-specific				
SizeStage	Number of full-time equivalent employees at beginning of stage	5.6 (6.6)	15.9 (26.9)	35.1 (61.0)
ServiceFirm	= ‘1’ knowledge-intensive service firm (SIC 58-63, 66, 69-75, 78, 79, 82); = ‘0’ otherwise	130 (85%)	128 (84.8%)	67 (77.9%)
Incubation				
IncCentre	= ‘1’ if located in an incubation centre; = ‘0’ otherwise	25 (16.3%)	24 (15.9%)	10 (11.6%)
Market and Product				
Rivalry	Number of major rivals the firm faces in its main market	4.6 (5.2)	4.6 (5.2)	6.2 (11.67
Exports	International (export) sales as a percentage of total sales for the last fiscal year	68.2 (35.5)	68.5 (35.3)	71.4 (34)
ProdDiff	= ‘1’ (very similar); = ‘2’ (similar); = ‘3’ (different); = ‘4’ (very different)	2.2 (0.7)	2.2 (0.7)	2.1 (0.8)
Human Capital				
FoundEdu	= ‘1’ (up to Degree); = ‘2’ (Masters); = ‘3’ (Ph.D.)	1.66 (0.63)	1.66 (0.63)	1.69 (0.69)
FoundIndExp	Number of years’ experience working in the firm’s industrial sector at beginning of stage	12.0 (7.2)	13.1 (7.3)	15.5 (6.7)
FoundIntExp	= ‘1’ if experience working abroad prior to current role; = ‘0’ otherwise	123 (79.9%)	121 (80%)	70 (81.4%)
WorkQual	Percentage of employees who possess a third level or equivalent qualification	90.7 (13.5)	90.6 (13.5)	88.8 (13.7)
Innovation				
TotalInno	Sum of product and process innovation during stage, where 2 is the lowest and 8 the highest	7.4 (0.9)	7.5 (0.9)	7.2 (1.0)
FreqR&D	= ‘1’ (longer); = ‘2’ (weekly); = ‘3’ (daily)	2.5 (0.7)	2.5 (0.7)	2.4 (0.8)
Patent	= ‘1’ patent holder; = ‘0’ otherwise	13 (8.5%)	46 (30.5%)	43 (50%)

Note: [a] Number (percentage) reported for dummy variables; [b] Mean (standard deviation) reported for ordinal and scale variables

The main independent variables of interest in our analysis are those within the '*Financing*' group. For the first phase of analysis the variables (personal investment, f-connection funding and debt) capture use of non-equity sources during the specified stage. These variables take a value of '*1*' if the source was obtained during the stage in question, '*0*' otherwise. For the second phase, where analysis is focused on testing the impact of existing equity investors on sources of equity obtained, explanatory variables capture sources obtained at the prior stage (seed for the early-growth estimation, seed and early-growth for the expansion). For the early-growth stage, (dummy) variables capture sources of equity (angel, venture capital, government-sponsored) and non-equity (personal, f-connection, debt) financing obtained during the seed stage. For the expansion stage, variables capture sources of finance obtained at the seed and early-growth stages. Summary statistics for these variables are provided in Table 6.3 below.

Table 6.3. Description of Variables in the '*Financing*' Category for Phase II of Analysis

Variable	**Definition**	**Early-growth (N = 151)**	**Expansion (N = 86)**
AngelSeed	= '1' angel at seed; = '0' otherwise	42 (27.8%)	24 (28%)
AngelEarly	= '1' angel at early-growth; = '0' otherwise		49 (57%)
VCSeed	= '1' venture capital at seed; = '0' otherwise	18 (11.9%)	15 (17.4%)
VCEarly	= '1' venture capital at early-growth; = '0' otherwise		48 (55.8%)
GovSponSeed	= '1' gov.-sponsored at seed; = '0' otherwise	20 (13.2%)	11 (12.8%)
GovSponEarly	= '1' gov.-sponsored at early-growth; = '0' otherwise		47 (54.7%)
PersInvestSeed	= '1' personal investment at seed; = '0' otherwise	141 (93.4%)	80 (93%)
PersInvestEarly	= '1' personal investment at early-growth; = '0' otherwise		50 (58%)
FConnSeed	= '1' f-connection funding at seed; = '0' otherwise	35 (23.2%)	16 (18.6%)
FConnEarly	= '1' f-connection funding at early-growth; = '0' otherwise		22 (25.6%)
DebtSeed	= '1' debt finance at seed; = '0' otherwise	14 (9.3%)	8 (9.3%)
DebtEarly	= '1' debt finance at early-growth; = '0' otherwise		17 (19.8%)

Source: Survey Data

In most general terms, the remaining explanatory variables largely follow those identified as potential determinants of equity financing in Chapter 5. In keeping the financing variables separate, the variable *FinancingPref* is moved to a new group, '*Entrepreneurial Perspective*', and three additions are made to this, capturing perspectives regarding aspects relating to use of equity. As outlined in Chapter 4 (Section 4.7), to examine the importance of concerns relating to control, respondents were asked to rate the consideration of loss of control in their decision to seek equity financing on a scale from 1 to 4, where 1 is '*not important at all*' and 4 is '*very important*', implying that the higher the response number, the more control-oriented the respondent. Among the 153 founder-CEOs interviewed, most were concerned about retaining control, with a very close split between those rating the concern as very important (43.8%) or important (35.3%) in their decision to engage with equity investors. Similarly, to capture the significance of concerns relating to monitoring, respondents were asked to rate the consideration of being monitored by equity investors in their decision to seek equity finance on a scale from 1 to 4, where 1 is '*not important at all*' and 4 is '*very important*', implying that the higher the response number, the more concerned the respondent is with scrutiny by investors. Among those interviewed, there was an almost equal split between those rating the possibility of increased monitoring as an important (34.6%) or moderately important (39.9%) issue. Respondents were also asked to rate the importance of risk sharing with equity investors on a similar scale (from '*unimportant*' through '*moderately important*' to '*very important*') for each source of equity obtained and the variable *RiskSharing* is calculated as the average across all investors for the specified stage.

Within the firm-specific control variables, *SizeStage* now measures firm size at the beginning of the stated stage. It should be noted that, because initial and current employee numbers were requested in the questionnaire, size measures for the early and expansion stages were calculated as an average, assuming linear growth from start-up to the beginning of the early (year 2) and expansion (year 6) phases. Firm age is excluded given that analysis is carried out by stage. Finally, *ServiceFirm* remains unchanged.

Variables in the '*Affiliation*' and '*Market and Product*' groups remain unchanged. Moving to innovation activity, frequency of innovation is again calibrated as the sum of the frequency of product and process innovation although here the measure is calculated by lifecycle stage (i.e. sum of frequency of innovation during the specified stage). The variable *Patent* now takes a value of '*1*' if the firm possesses a patent during the specified stage ('*0*' otherwise). The R&D indicator switches to a self-appraised measure of intensity of activities. Respondents were asked how they would describe frequency of R&D within their firm and were given qualitative descriptions ranging from 'daily' through 'monthly' to 'twice yearly' and 'yearly'. The variable was coded so that low values denote less R&D-intensity and high denote intense R&D activity. This is an alternative to the measure based on expenditure on R&D utilised in the previous chapter, which is excluded here due to high correlation with the Mills Ratio[117]. Almost two-thirds (60.1%) rated R&D-activity as a daily endeavour.

Variables within the '*Human Capital*' group mostly remain unchanged. The two measures of educational attainment (founder-CEO and workforce) are as defined in the previous chapter. Industry-specific experience is now measured as experience amassed to the beginning of the specified stage to capture the impact of accumulation of experience. To recall from Chapter 5, international experience measures experience working abroad prior to involvement in the current firm and, as such, this form of experience is not stage-specific.

To conclude, the correlation matrix for each stage (seed, early-growth and expansion) are presented in Tables 6.6 to 6.8 below. In general, correlations among the variables at each stage are mostly moderate to low (no correlation is above 0.5) suggesting limited potential for

[117] This is particularly the case for the seed (r=-0.594, n=153, p-value=0.000) and early (r=-0.578, n=151, p-value=0.000) stages. Although lower in the expansion stage (r=-0.426, n=86, p-value=0.000) the self-appraised measure is utilised throughout all regressions herein to maintain consistency.

distortions. Specifically, the highest significant correlation at the seed stage (0.5100) is between market rivalry and product differentiation (significant at p-value<0.01). At the early-growth stage, the highest significant correlation (-0.4339) is also between rivalry and product differentiation (significant at p-value<0.01) while at the expansion stage the highest (-0.4797) is between monitoring and control (p-value<0.01).

Table 6.4. Correlation Matrix – Seed Stage

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1)	Angel	1.0000											
(2)	VC	0.2862*	1.0000										
(3)	GovSpon	0.3215*	0.1101	1.0000									
(4)	IncCentre	-0.0465	-0.0056	-0.0934	1.0000								
(5)	Rivalry	-0.1680	0.2134**	-0.0913	0.0004	1.0000							
(6)	Exports	0.0261	0.0966	0.1160*	-0.0008	-0.0046	1.0000						
(7)	ProdDiff	0.0559	-0.1335	0.0721	0.0646	-0.5100*	0.0218	1.0000					
(8)	TotalInno	-0.0654**	0.0188	-0.0174	0.1402*	-0.1068	0.0932	0.3046*	1.0000				
(9)	FreqR&D	0.0715	0.0872	0.0711	0.1075	-0.1943**	0.1008	0.2627*	0.3966*	1.0000			
(10)	Patent	0.0900*	0.0985	0.1264	-0.0079	-0.0804	0.2500*	0.1202	0.1247*	0.0962	1.0000		
(11)	FoundEdu	-0.0470	-0.0802	-0.0814	0.1266	-0.0444	0.1083	0.0471	0.0792	0.1314***	-0.0217	1.0000	
(12)	FoundIndExp	0.0889**	0.0131	-0.0706	-0.0498	-0.1038	-0.0287	0.0889	0.1283	0.2131**	0.0905	-0.0264	1.0000
(13)	FoundIntExp	0.0329	0.0912	0.0386	-0.0851	-0.0112***	0.0380	-0.0022	-0.0914	0.0986	0.0953	0.0120	0.1114
(14)	WorkQual	0.0511	0.0236**	0.0901	0.2128*	-0.0962	0.0781	0.1688*	0.2326*	0.3337*	0.0182	0.2004*	0.0219
(15)	FinancingPref	0.0162	-0.0500	0.1314***	0.0260	-0.0111	-0.0714	-0.1778*	-0.0802***	-0.0233	-0.0003	-0.0220	-0.0636
(16)	PersInvest	-0.1241	-0.2212*	0.0413	0.0453	0.0253	-0.1211***	0.0570	-0.0348	0.0234	-0.0143	0.0253	0.1288
(17)	FConnections	0.2145*	-0.0738	0.0502	-0.0845	-0.0856	-0.1232	0.0758	0.0191	-0.0247	-0.0079	-0.0833	0.1429
(18)	Debt	0.0819	-0.0575	0.0995	-0.0268	-0.0422	-0.1544	0.0360	-0.0587	-0.0900	-0.1005	-0.1016	-0.0859
(19)	LossControl	0.1631**	0.0961	-0.0023	0.0375	-0.0708	-0.0981	-0.1370	-0.1423**	-0.0823	-0.2021*	-0.0121	-0.0233
(20)	Monitoring	-0.0270	0.0175	-0.0166	0.0069	0.0599*	0.0269	-0.1055	-0.1589	-0.0749	-0.0415	-0.0683	-0.0299
(21)	RiskSharing	-0.1052	0.0040	0.1538	0.0043	0.0458	0.0671	0.0021	0.0205	-0.0751	0.1080*	-0.0879***	0.0457
(22)	Size	0.1205	0.1383**	-0.0520	-0.1684*	0.0369	-0.0167	-0.0678	-0.1957*	-0.1829	-0.0654	-0.0163***	-0.0190
(23)	ServiceFirm	0.0652	0.0475	-0.0197	-0.0120	-0.2204**	-0.1208	0.1492**	0.1617***	0.1182	-0.1998*	0.0053	0.0743

		(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	
(13)	FoundIntExp	1.0000											
(14)	WorkQual	-0.0207	1.0000										
(15)	FinancingPref	-0.0537	0.0472	1.0000									
(16)	PersInvest	-0.0017	-0.0446	-0.0041	1.0000								
(17)	FConnections	-0.1330	0.0144	-0.0872	0.0876	1.0000							
(18)	Debt	0.0568	-0.0918*	-0.0663	-0.0017	-0.0322	1.0000						
(19)	LossControl	0.0100	-0.0385***	0.1120	0.0062	-0.0016	0.1704**	1.0000					
(20)	Monitoring	0.0358	-0.1028	0.0597	-0.0430	-0.0251	0.0190	0.4292	1.0000				
(21)	RiskSharing	0.0186	-0.0663	-0.0500	-0.0980**	0.0472	-0.0337	0.0285	0.0623	1.0000			
(22)	SizeStage	0.0134	-0.2348*	-0.0347	0.0508	0.0760	0.0304	0.2218	0.0417	-0.0254	1.0000		
(23)	ServiceFirm	-0.0755	0.1281***	-0.1612	-0.0372	0.0667	-0.0458	0.0434	-0.1125	-0.0661	0.0527	1.0000	

Diagnostics: * significant at p< 0.1, ** significant at p< 0.05, *** significant at p< 0.01

Table 6.5. Correlation Matrix – Early-growth Stage

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1)	Angel	1.0000											
(2)	VC	-0.0399	1.0000										
(3)	GovSpon	0.1952*	0.1395***	1.0000									
(4)	IncCentre	-0.1589**	0.0294	-0.0303	1.0000								
(5)	MktRivalry	-0.0349	-0.1132	-0.0454	0.0077	1.0000							
(6)	IntSales	-0.0676	0.2307*	0.1073	0.0305	-0.0033	1.0000						
(7)	ProdDiff	-0.0452	0.1126	-0.0135	0.0562	-0.4339*	0.0624	1.0000					
(8)	TotalInno	-0.0202	0.1052	0.1381***	0.0968	-0.1240	0.1791	0.2767**	1.0000				
(9)	FreqR&D	0.0842	0.1308	0.1709***	0.1072	-0.1688**	0.0968	0.2894*	0.3563*	1.0000			
(10)	Patent	0.1930*	0.2231*	0.1018	0.1452***	-0.0952	0.2200*	0.1770**	0.1691**	0.1493***	1.0000		
(11)	FoundEdu	-0.1416	0.0642	0.0508	0.1470***	-0.0397	0.0946	0.0596	0.0594	0.1425***	0.1037	1.0000	
(12)	FoundIndExp	0.0674	-0.0485	-0.0122	-0.0456	-0.1005	-0.0328	0.0822	0.0903	0.1776	0.1281	-0.0280	1.0000
(13)	FoundIntExp	0.0298	0.0163	0.0767	-0.1013	0.0079	0.0560	0.0034	-0.0356	0.0698***	0.0411	0.0229	0.1066
(14)	WorkQual	-0.1858**	0.0661	0.1587**	0.2088*	-0.0958	0.0855	0.1948**	0.2476*	0.3330*	0.1973*	0.2043*	0.0258
(15)	FinancingPref	0.0416	-0.0785	-0.0436	0.0516	-0.0934	0.0555	0.0581	-0.0387	-0.0658	0.0004	-0.1037	-0.0130
(16)	PersInvest	0.0698	-0.0910	0.0896	0.1842**	-0.0186	0.0397	0.0918	-0.0057	0.0057	-0.0236	-0.0273	0.0784
(17)	FConnections	0.1578**	0.0306	0.2415*	-0.0968	-0.0684	0.0023	-0.0110	0.0373	-0.0842	0.0266	0.0360	0.0660
(18)	Debt	-0.0098	0.0020	0.0780	-0.0280	-0.0319	-0.0513	0.0478	0.0641	0.0633	0.0060	0.0747	0.1263
(19)	LossControl	-0.0123	0.0800	-0.0012	0.0371	-0.0789	-0.0987	-0.1175	-0.1962***	-0.0417	-0.1134	-0.0119	-0.0229
(20)	Monitoring	0.0572	0.0047	-0.0937	0.0167	0.0598	0.0205	-0.0866	-0.2638	-0.0766	0.0191	-0.0715	-0.0344
(21)	RiskSharing	0.0180	0.0604	-0.0163	0.0208	0.0261*	0.0545	-0.0162	0.0140***	-0.0438	0.0744	-0.0960***	0.0426
(22)	Size Stage	-0.0560	0.2270*	-0.0730**	-0.1786	0.0868	0.1308***	-0.0536	-0.0213	-0.1691	0.0452	-0.0688	0.0490
(23)	ServiceFirm	-0.0485	0.0608	0.0467	0.0835	-0.1983**	-0.0989	0.0874	0.1214	0.1718**	-0.1199*	0.0068	0.0666

		(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	
(13)	FoundIntExp	1.0000											
(14)	WorkQual	-0.0142	1.0000										
(15)	FinancingPref	0.1032	0.0591	1.0000									
(16)	PersInvest	0.0163	-0.0441	0.0528*	1.0000								
(17)	FConnections	-0.1148	0.0227	-0.0918	0.1427***	1.0000							
(18)	Debt	-0.0522	0.0838	-0.0426	0.1057	0.0502	1.0000						
(19)	LossControl	0.0110	-0.0394***	-0.3190	0.0432	0.0029	0.0596	1.0000					
(20)	Monitoring	0.0286	-0.0963	-0.1095	0.1063	0.0911	-0.1037***	0.4318*	1.0000				
(21)	RiskSharing	0.0547	-0.0613	0.0340	-0.0593	-0.1108	-0.0031	0.0293	0.0566	1.0000			
(22)	SizeStage	0.0759	-0.1747**	-0.0222	0.0065	-0.0151	-0.0570	0.0388	0.0477	-0.0590	1.0000		
(23)	ServiceFirm	-0.1187	0.1512***	-0.0003	-0.0223	0.1292	-0.0741	0.0232	-0.0701	-0.0322	0.0532	1.0000	

Diagnostics: * significant at p< 0.1, ** significant at p< 0.05, *** significant at p< 0.01

Table 6.6. Correlation Matrix – Expansion Stage

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1)	Angel	1.0000											
(2)	VC	0.2000***	1.0000										
(3)	GovSpon	0.1947***	0.2587*	1.0000									
(4)	IncCentre	0.1062	-0.0872	0.2592*	1.0000								
(5)	MktRivalry	-0.0664	-0.0534	0.0456	0.0321	1.0000							
(6)	IntSales	0.0234	0.0213	-0.0595	-0.0478	-0.1847***	1.0000						
(7)	ProdDiff	0.0027	0.2120	-0.0017	-0.0275	-0.3262*	-0.0434***	1.0000					
(8)	TotalInno	0.0878	0.0986***	-0.0930	0.2165*	-0.3038*	0.1789***	0.1924***	1.0000				
(9)	FreqR&D	0.1976	0.0603	-0.1983	0.1098	-0.2907*	0.0367	0.3292*	0.4448*	1.0000			
(10)	Patent	0.1195	0.3771*	0.1143	0.1451	-0.1073	0.1467	0.0757	0.2034***	0.1029	1.0000		
(11)	FoundEdu	0.0445	0.0104	0.0688	0.1659	0.1471	0.1292	0.0787	0.0992	0.1870***	0.1525	1.0000	
(12)	FoundIndExp	0.0578	0.1230	-0.1260	-0.0171	-0.0081	0.0576	0.0421	0.1327	0.2642**	0.1684	-0.0490	1.0000
(13)	FoundIntExp	-0.0786	0.1028	-0.1213	-0.0130	-0.2504*	0.1430	0.0751	-0.0588	0.0290	0.2390**	0.1296	-0.0983
(14)	WorkQual	0.1756**	0.0568	0.1627**	0.2199	-0.1413	0.0970	0.2441***	0.2492**	0.3529*	0.2676*	0.2260*	0.1183
(15)	FinancingPref	-0.1142	-0.1146	0.0525	0.0198	-0.1628*	-0.0002	-0.0443	-0.0914	-0.0912	0.0000	-0.1009	0.0050***
(16)	PersInvest	0.0621	-0.0653	-0.1051	-0.1295	-0.0410	0.1645*	-0.1138	0.0753	-0.0650	-0.0533	-0.0424	0.0271
(17)	FConnections	-0.0991	-0.0276	-0.0167	-0.1133	0.1215***	-0.0437	-0.0872	-0.1798**	-0.1485	-0.0976	0.0149	0.0171
(18)	Debt	-0.0510	0.0350	0.1227	-0.1997***	-0.0795	0.0449	-0.0775	-0.0995	-0.1117	-0.0550	-0.0690	0.0447
(19)	LossControl	0.0057	-0.0384	0.0651	-0.1078	0.1407	-0.1262	-0.0927	-0.1958*	-0.1460	-0.1078	-0.1277	-0.0117
(20)	Monitoring	0.0186	0.0692	0.0566	0.0606	0.0611	-0.0202	-0.0184	-0.0626	-0.1350	0.0477	-0.1285	0.0237
(21)	RiskSharing	0.1856	0.1327*	-0.0012	-0.1301	-0.1112	-0.0028	0.0743	0.0007	-0.0346	0.0332*	-0.1943	-0.0413
(22)	Size Stage	-0.0787	0.2273*	0.0207	-0.1787**	0.0836	0.1413	0.0082	0.0408	-0.1321	0.2720*	-0.0969	0.1090
(23)	ServiceFirm	-0.2496**	-0.2867*	0.0673	0.0183	-0.0693	-0.1797	0.1498	0.0691	0.1718	-0.1401	-0.0802	0.1299

		(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	
(13)	FoundIntExp	1.0000											
(14)	WorkQual	0.0441	1.0000										
(15)	FinancingPref	0.1142	-0.0052	1.0000									
(16)	PersInvest	0.0064	0.0144	0.0661	1.0000								
(17)	FConnections	-0.0889	-0.0443	-0.1162	-0.0377	1.0000							
(18)	Debt	-0.0197	-0.1723	-0.0287	0.1819***	0.0591	1.0000						
(19)	LossControl	0.0251	-0.0117	-0.3663	-0.0479	0.0842	0.0917	1.0000					
(20)	Monitoring	0.0734	-0.0854	-0.0906	0.0706	0.0471	0.0072	0.4797*	1.0000				
(21)	RiskSharing	0.1557	0.0065	0.1881	-0.1529	0.1448	0.0928	-0.0481	0.0793	1.0000			
(22)	SizeStage	0.0725	-0.1700	-0.0426	-0.0791	-0.0383	0.0116	0.0434	0.0395	-0.0364	1.0000		
(23)	ServiceFirm	-0.1105	0.2336*	0.0487	-0.2017***	0.0369	-0.1049	0.0225	-0.0889	-0.0928**	0.1056**	1.0000	

Diagnostics: * significant at p< 0.1, ** significant at p< 0.05, *** significant at p< 0.01

6.4 Results

This Section presents the results from empirical analysis. We begin with the findings of MVP models that test the determinants of the three sources of equity at the seed, early-growth and expansion stages, taking into account the role of supplementary sources of non-equity financing obtained during the specified stage (Subsection 6.4.1). Following this, attention turns to the results of MVP estimations that test the signalling impact of prior (equity and non-equity) financing on the acquisition of subsequent equity funding (Subsection 6.4.2). In correcting for sample selection bias, the inverse Mills ratio calculated from the probit of Chapter 5 is included as a regressor in all estimations. Discussion now continues with consideration of key findings.

6.4.1 Determinants of Equity Financing by Source and Stage

In exploring the determinants of the three sources of equity (angel, venture capital, government-sponsored) at the different stages of the lifecycle, three MVPs were estimated, one each for the seed, early-growth and expansion stages. Results are reported in Tables 6.7 to 6.9. Let us now consider the findings for each stage in turn.

Seed Stage

Results for the MVP estimated for the seed stage are presented in Table 6.7, along with associated marginal effects. The hypothesis that the correlations between the error terms of the equations are all zero can be rejected at a high level of significance (Wald Chi^2=177.64, $p<0.01$). We can thus have confidence in our findings. This also confirms that the MVP model fits the data for the seed stage better than three univariate probit models.

Looking at the results for the impact of other sources of (non-equity) financing also obtained during the seed stage, we see that *PersInvest* is significant for all three sources of equity. Looking at the signs on the coefficients, the founder's personal investment is positive and significant for angel (Column I) and government-sponsored (Column V) funding but negative for venture capital (Column III). Thus, while we find support for Hypothesis 1 for both angel and government-sponsored equity, the impact on venture capital is contrary to our expectations. Interestingly, looking at the magnitude of the marginal effects across the sources, the impact of personal investment is largest for venture capital (Column IV), followed by government-sponsored equity (Column VI). A possible explanation for our findings is simply that those entrepreneurs that obtain venture capital at seed have less recourse to their own financial resources. Angels tend to invest much smaller amounts of capital than venture capital funds (Chemmanur and Chen, 2014) and thus it is plausible to postulate than entrepreneurs have greater dependence on their own funding when obtaining angel finance. Moreover, as noted previously, an important factor to consider in the context of this study is that the main publicly-managed funds in Ireland, namely Enterprise Ireland's Seed and Venture Capital Scheme and Innovative High-Potential Start-up (HPSU) Scheme, operate on a co-investment or matching basis. This requires the investee firm to provide (private) funding that will at least match the commitment from public equity (IVCA, 2012). Thus, entrepreneurs may utilise personal capital in their attempt to obtain investment from the government-sponsored fund. Overall, our results show that personal funding is a significant determinant for all three sources of equity at seed, confirming Hypothesis 4 although these funds appear to substitute venture capital financing at seed while complementing government-sponsored and angel financing.

Next, *FConn*, is positive and significant for angel at seed (Column I). Consistent with both the source (Hypothesis 2) and stage-specific (Hypothesis 5) hypothesised impacts, it appears that, as in Conti *et al*. (2013), f-connection investment represents an important signal for angel investors. In terms of magnitude, this is the second largest marginal effect observed for angel financing at the seed stage (Column II). Overall, this suggests that family and friends' investment and angel financing play a complementary role in funding technology-based firms during the seed stage. F-connection funding is not statistically significant for either government-sponsored or venture capital financing at the seed stage. Thus, we only find partial support for Hypotheses 2 and 5 (i.e. only for angel financing at seed).

Looking at the impact of the entrepreneur's perspective on use of the sources of equity at seed, the positive and significant coefficient on *FinancingPref* suggests that those entrepreneurs with a preference for using internal funding, where possible, are more likely to use government-sponsored funding at seed (Column V). Moreover, looking at the marginal effects, we see that this preference has the second largest impact for government-sponsored equity (Column VI). This finding highlights the role of the demand-side perspective in impacting on the firm's financing decisions. We need to ask why entrepreneurs with a preference for internal funding may choose government-sponsored equity when external funding is required. In a nutshell, it is highly likely that public investors will interfere less in the operation of portfolio firms than their private counterparts (i.e. venture capitalists and angels). Those from public funds are less able to closely monitor portfolio firms (Secrieru and Vigneault, 2004), use less sophisticated corporate governance mechanisms and have fewer voting rights (Hirsch and Walz, 2013). Moreover, quite often they lack the experience and skills necessary to sufficiently participate in and support technology firms, or to offer the expertise and advice that specialised independent investors offer (see Lerner, 2002; Leleux and Surlemont, 2003).

For angel financing (Column I), concerns regarding control are positive and significant for angel financing.[118] In terms of magnitude, the marginal effect is the second largest observed in the angel equation for the seed stage (Column II). It is widely believed that business owners value independence and control, with the penchant for autonomy being a major motive for

[118] To recall from Subsection 6.3.3, this variable is measured on a scale where '*1*' donates that the respondent is '*not at all*' concerned with potential loss of control in their decision to seek external equity financing and '*5*' denotes that they consider this a '*very important*' issue. As such, lower values imply that the entrepreneur is more willing to cede control.

business ownership (see Cressy and Olofsson, 1997; Riding *et al*., 2012a). They must, however, be prepared to relinquish a certain degree of control in order to obtain equity investment (Kaplan and Strömberg, 2000). The degree of control may vary depending on the source of equity. Previous reports assert that angels normally allow entrepreneurs to maintain more control over their business than venture capitalists (see Wasserman, 2008; Wong *et al*., 2009). Goldfarb *et al*. (2007) report that angels forgo strong control rights as they are less cost efficient for smaller deals. The positive coefficient here suggests that maintaining control is an important factor for entrepreneurs in their decision to use angel financing at seed.

Additionally, we see that the potential to share risk is significant and negative for angel financing (Column I) but positive for government-sponsored equity (Column V). In brief, as considered in Chapter 4 (Section 4.7), because the risk of failure is exacerbated in technology-based firms (Giudici and Paleari, 2000) and failure can lead to financial loss or ruin at the personal level for the entrepreneur (Ang *et al*., 2010) the prospect of sharing risk can impact the financing decisions of entrepreneurs (see Reid, 1998; Coleman *et al*., 2016). These investors take a stake in the firm, sharing upside and downside risks (Pfirrmann *et al*., 2012). We see from the marginal effects that risk sharing is more important for government-sponsored funding (Column VI) than for angel (Column II). As way of explanation, given that angels typically make smaller investments than formal equity investors (Prasad *et al*., 2000), the entrepreneur retains a larger stake in their business and, thus, the potential for risk sharing might not be as pronounced with these investors.

Turning next to the control variables within the *Firm-specific* group, the only significant coefficient is firm size, which positively impacts on venture capital financing (Column II). Specifically, the probability of being venture capital financed during the seed year increases with size, consistent with the existing evidence. Both Colombo and Grilli (2005b), for Italian firms, and Engel and Keilbach (2007), for German firms, find that firm size has a positive influence on the probability of being venture capital funded. For the US, Chemmanur *et al*. (2011) report that venture capital financed firms are larger than non-venture capital financed.

Moving on to market and product attributes, the negative and significant coefficient on *Rivalry* for both angel (Column I) and venture capital (Column III) indicates that intensity of competition is a signal for both sources of equity at the seed stage. In terms of magnitude, this factor has a larger impact for venture capital financing (Column IV) than for angel (Column II). At the seed stage, when the focus is typically on establishing proof of concept and product development, the firm likely lacks sales revenue or a finished product (Hogan and Hutson, 2010). It follows then that occupying a competitive market position, or a niche, would be an accessible signal of market potential in attracting external investors. Somewhat consistent with this argument, existing supply-side evidence shows that, even prior to making the investment, venture capitals and angels commonly reject investment proposals at the screening stage if the venture's market is deemed too crowded or competitive (see Petty and Gruber, 2011; Carpentier and Suret, 2015).

Next to innovation activity. First, we see that frequency of innovation is positive and significant for venture capital financing (Column III). In fact, in terms of magnitude, it has the second largest effect on venture capital at seed (Column IV). This finding is in line with evidence provided by Hellmann and Puri (2000), Peneder (2010) and Mina *et al*. (2013) who show that innovative firms are more likely to obtain venture capital. Moreover, patenting also represents a positive and significant signal for venture capital financing and is the largest marginal effect observed (Column IV). Increasingly, patent protection is noted as a primary factor for venture capitalists in making the decision of whether to invest in nascent firms (see Hayes, 1999; Audretsch *et al*., 2012). The existing evidence shows a positive relationship between patenting and venture capital financing for start-ups (see Baum and Silverman, 2004; Haeussler *et al*., 2009; Conti *et al*., 2013). Our findings here serve to confirm the importance of venture capital financing for innovation activities among nascent firms. Furthermore, we see that expenditure on R&D has a significant and positive impact on government-sponsored equity (Column V). That equity funding is important for R&D activities is noted in the existing literature (see Hall and Lerner, 2010; Brown *et al*., 2012).

Finally, we see that human capital attributes impact on the sources in different ways. First, the positive and significant coefficient on *FoundIndExp* suggests that those entrepreneurs with greater industry-specific experience are more likely to obtain angel funding during the seed year (Column I). Assuming that industry-specific experience can signal not only knowledge of how to reduce uncertainty when identifying and evaluating business opportunities but also awareness of threats to feasibility (Cassar, 2014), necessary resources and the sources through which they can be secured (Hellmann and Puri, 2002), and ways to cope with the changing needs of the new enterprise (Boeker and Wiltbank, 2005), then it is feasible that angels, who typically depend on the entrepreneur to manage market risks (see Fiet, 1995; Hsu *et al*., 2014), would pay particular attention to founders' industry-specific experience when evaluating a new venture. Furthermore, this finding is well supported in the literature (see Haines *et al*., 2003; Mason and Stark, 2004; Clark, 2008), with Carpentier and Suret (2015) reporting a highly significant relationship between industry experience and the probability of successfully raising angel financing. Second, for venture capital at seed (Column III), the coefficient on *FoundEdu* is negative and significant. This suggests that those entrepreneurs with lower levels of educational attainment are more likely to obtain venture capital. However, this finding must be considered in context. Specifically, the variable was coded such that low values denoted a third-level degree (1) and high values a PhD (3). All those interviewed held at least a degree. This result simply indicates that those with venture capital at seed are more likely to hold a degree rather than a PhD qualification. This finding is consistent with the related literature. As Roberts (1991, page 253) notes "*the general temperament, attitude, and orientation of PhD recipients are usually out of line with those necessary for successful technical entrepreneurship*". Hsu (2007), based on his study of technology-based start-ups, reports a negative relationship between having a founder with a PhD and the receipt of venture capital financing. Third, and finally, organisational human capital exerts a positive significant impact on government-sponsored equity (Column V). Although, in terms of magnitude, this has the smallest impact observed in the government-sponsored estimation (Column VI), it nonetheless serves to emphasise the role of organisational human capital as a signal for equity financing.

To close, let us briefly summarise the findings. Technology-based firms operating in a niche market position, led by founder-CEOs with greater industry-specific experience, concerned with losing control of their business when bringing in outside equity investors but less so with the potential of risk sharing with said investors, are more likely to be angel financing during the seed stage. Moreover, these firms are also more likely to also use founder and f-connection funding along with angel investment. Larger firms, occupying a niche position, with a higher frequency of innovation and in possession of a patent, along with founder-CEOs educated to degree level have a higher probability of being venture capital financed at the seed stage. In contrast to angel funding, those with venture capital are less likely to use personal funding during the seed year. Finally, those entrepreneurs with a preference for internal sources of funding but who value risk sharing with external equity investors are more likely to have government-sponsored funding at seed. These firms have higher R&D expenditures, along with higher levels of organisational human capital. As with angel, those receiving government-sponsored equity at seed are also more likely to depend on the personal investment of the founders during this stage.

Table 6.7. Multivariate Probit – Determinants at Seed Stage (N=153)

	Angel		VC		GovSpon	
	I β (Std. Error)	II Marginal Effect	III β (Std. Error)	IV Marginal Effect	V β (Std. Error)	VI Marginal Effect
Financing:						
PersInvest	0.8869** (0.4746)	0.0269	-1.1875*** (0.4713)	-1.3878	1.2769** (0.5738)	1.1408
FConn	0.8415*** (0.2695)	0.7090	-0.4017 (0.3987)	-0.8090	0.3590 (0.3328)	0.2277
Debt	0.1789 (0.3820)	0.3217	0.1369 (0.4368)	0.1331	0.4385 (0.3859)	0.1728
Entrepreneur-specific:						
FinancingPref	-0.0235 (0.2732)	-0.2275	-0.2181 (0.3345)	-0.2895	0.6208** (0.3290)	0.4373
LossOfControl	0.2188* (0.1513)	0.1592	-0.2318 (0.1677)	-0.0705	0.1074 (0.1707)	0.0134
Monitoring	0.1517 (0.1469)	0.1396	-0.1210 (0.1552)	-0.0087	-0.1935 (0.1586)	-0.0835
RiskSharing	-0.2048* (0.1242)	-0.0187	0.0990 (0.1268)	0.1176	0.3245*** (0.1308)	0.2270
Firm-specific:						
SizeStage	0.0232 (0.0235)	0.0049	0.0424** (0.0194)	0.0372	-0.0348 (0.0338)	-0.0330
ServiceFirm	-0.0771 (0.3720)	-0.3569	0.4260 (0.3547)	0.6586	0.0892 (0.3718)	0.1689
Affiliation:						
IncCent	-0.1984 (0.3184)	-0.2577	0.3880 (0.4020)	0.5005	0.4671 (0.3714)	0.3938
Market and Product:						
Rivalry	-0.0834* (0.0474)	-0.0943	-0.1059*** (0.0412)	-0.1382	-0.0497 (0.0349)	-0.0496
IntSales	0.0063 (0.0044)	0.0063	0.0077 (0.0053)	0.0035	0.0100 (0.0051)	0.0053
ProductDiff	0.1631 (0.2491)	0.0434	0.1808 (0.2930)	0.0445	0.0400 (0.2203)	0.0771
Innovation:						
TotalInnov	0.1483 (0.1504)	0.1639	0.2078* (0.1329)	0.1312	0.0201 (0.1743)	0.0662
FreqRandD	0.2696 (0.2093)	0.3785	0.2942 (0.2665)	0.0458	0.3389** (0.1730)	0.1020
Patent	-0.5579 (0.4275)	-0.3730	1.2284** (0.4788)	0.8852	0.3505 (0.4589)	0.0269
Human Capital:						
FoundEdu	0.0440 (0.0207)	0.1255	-0.5396** (0.2455)	-0.3536	-0.1090 (0.2552)	-0.0802
FoundIndExp	0.0207* (0.0153)	0.0001	-0.0029 (0.0222)	-0.0070	-0.0194 (0.0212)	-0.0108
FoundIntExp	0.2178 (0.3423)	0.0347	0.7101 (0.5197)	0.7177	0.3542 (0.3137)	0.0427
WorkforceQual	0.0088 (0.0117)	0.0116	0.0064 (0.0103)	0.0141	0.0169* (0.0112)	0.0112
MillsRatio	-0.7397 (0.6376)	-0.8201	-1.1142 (0.7396)	-1.6224	-1.2018 (0.7299)	-0.9178
Constant	-0.4712 (2.2836)		-1.222 (2.2040)		-6.7372* (2.5047)	
Log Likelihood	-152.7534					
No. Observations	153					
Wald Chi-square	177.64					
Prob>Chi2	0.0000					

Notes: (1) Robust standard errors in parentheses; (2) Significance levels: * p<0.1; ** p<0.05; *** p-<0.01; (3) *MillsRatio* controls for sample self-selection.

Early-growth Stage

We now turn to the early-growth stage (Tables 6.8). Once again, the hypothesis that the correlations between the error terms of the equations are all zero can be rejected (Wald Chi^2=138.27, p<0.10). We can thus have confidence in our findings.

As regards the role of financial signals, personal investment has a significant and negative impact on venture capital (Column III) but a positive impact on government-sponsored equity (Column V) during the early-growth stage. The coefficient is not statistically significant in the angel estimation (Columns I and II). Thus, once again, we find partial support for Hypothesis 1 (for government-sponsored funding). In terms of magnitude, founder's investment has a larger effect for venture capital (Column IV) than government-sponsored funding (Column VI). As with the seed stage, a plausible explanation is simply that those entrepreneurs with funding from private investors (venture capitalists) have less recourse to their own financial resources. These results also provide partial support for Hypothesis 4 as regards stage of significance, with personal investment representing a significant determinant for both venture capital (negative) and government-sponsored (positive) funding at the early-growth stage.

Next, f-connection funding has a significant positive impact on angel funding (Column I). In terms of magnitude, it has the fourth largest effect on angel financing at the early-growth stage (Column II). Interestingly, f-connection funding is also positive and significant for government-sponsored funding at during this stage (Column V) and has the largest effect observed (Column VI). Comparing across the two sources, the signal from f-connection funding has the larger impact for government-sponsored funding. The coefficient is not statistically significant in the venture capital estimation (Columns III and IV). Thus, we find partial support for Hypotheses 2 and 5, with f-connection funding representing a positive signal for angel and government-sponsored equity during the early-growth stage. Overall, this serves to highlight the key role of family and friends' financial support in the early years for technology-based firms, in line with Conti *et al*. (2013).

Next to the control variables. Beginning with entrepreneur-specific issues, concerns regarding loss of control has a negative significant effect on venture capital at the early-growth stage (Column III). This suggests that founders who are concerned with maintaining control are less likely to use venture capital. As to magnitude, the marginal effect is the third largest observed in the venture capital estimation (Column IV). This is a plausible result in that entrepreneurs must give up a substantial equity stake in return for venture capital investment, often up to 50 percent (Kaplan and Strömberg, 2003). Analogous to this, researchers commonly explain the preference for debt over external equity in terms of the founder's desire to maintain independence and control (see Chittenden *et al*., 1996; Cosh and Hughes, 1994).

For government-sponsored funding, the coefficient on *IncreasedMonitoring* is negative and significant (Column V), suggesting that entrepreneurs less concerned with monitoring of their activities by investors are more likely to use government-sponsored funding. Although one of the weaker factors in terms of magnitude (Column VI), two explanations may be offered for this finding. First, entrepreneurs are simply unconcerned with the possibility of being closely monitored. Second, because this source of equity is reputed to be relatively unobtrusive, monitoring is likely not going to be a key feature. To illustrate, Knockaert *et al.* (2010) find that investment managers within public funds tend to be less involved in providing value-added activities than independent venture capitalists. Similarly, Luukkonen *et al*. (2013) reveal that publicly-backed investors are less engaged than private investors in professionalisation activities, including changing the management team, finding board members and initiating a trade sale.

Moving on, we see that firm size is significant and negative for angel (Column I) but positive for venture capital (Column III). The effect is larger for venture capital (Column IV) than angel (Column II) financing. Thus, while smaller firms are more likely to be financed by angels at the early-growth stage, as the firm gets bigger it is more likely to obtain venture capital. This finding is consistent with existing evidence (see Engel and Keilbach, 2007; Wong *et al*., 2009; Brush *et al*., 2012; Bertoni *et al*., 2015). Using data from the National Survey of Small Business Finance, Berger and Udell (1998) found that 3.59% of small businesses were funded by angels but only 1.85% by venture capitalists.

Incubation is significant but negatively related to angel financing (Column I). This is a somewhat surprising result. Although empirical evidence is lacking, it is generally believed that incubators play a positive role in facilitating access to entrepreneurial finance (see Hansen *et al*., 2000; Colombo and Delmastro, 2002; Scillitoe and Chakrabarti, 2010). The conflicting result here likely occurs because, of the 90 firms with angel finance at this stage, there is a greater representation of those located outside an incubator (80 firms).

Market and product attributes significantly impact on government-sponsored equity (Column V). First, the coefficient on exporting is positive and significant, suggesting that, as the firm increases turnover generated through international sales, *ceteris paribus*, the likelihood of obtaining finance from a government-managed fund at early-growth increases. Thus, it appears that an export orientation improves the firm's ability to obtain government-sponsored funding during early-growth years. Additionally, product differentiation is also positive and significant at this stage. In terms of magnitude, *ProdDiff* has the third largest effect on this source of equity (Column VI). Overall, these results suggest that, at early-growth, signals pertaining to the uniqueness of the product and the firm's export potential, which essentially provide the conditions for strong revenue growth and value creation (Petty and Gruber, 2011), are particularly important for attracting government-sponsored equity.

Turning to innovation, R&D activity has a positive and significant effect on both angel (Column I) and government-sponsored (Column V) funding. This is again consistent with evidence highlighting the role of equity in funding R&D activities, as reported by researchers including Hall and Lerner (2010) and Brown *et al*. (2012). As to magnitude, R&D has a larger effect on angel (Column II) than government-sponsored (Column VI) investment. Additionally, patents exert a positive and significant impact on both venture capital (Column III) and angel (Column I) financing. Correspondingly, the literature confirms that patents act as a signal of the firm's innovative capabilities and, as such, increase the likelihood of attracting equity financing (see Audretsch *et al*., 2012; Hsu and Ziedonis, 2013). In terms of magnitude, while the marginal effect is the largest observed in both equations, the signal from patenting has a larger impact for angel funding. This is contrary to the evidence provided by Conti *et al*. (2013) but nevertheless highlights the signalling role of patenting. In general, our findings demonstrate the role of proprietary protection as a signal to external investors, showing that patents do matter although, providing novel evidence in this area, we see that patents are more effective in attracting angels, at least at the early-growth stage.

Moving to human capital, founder-CEO educational attainment is positive and significant for angel financing (Column I). This suggests that founders' education level higher than a bachelor's degree significantly improves the firm's likelihood of obtaining angel funding. We also observe a positive and highly significant coefficient on *WorkforceQual* for angel funding at this stage. To the extent that education confers specific skills and knowledge, these results may be indicative of two qualities that potentially appeal to angel investors. The first is a straightforward scientific and/or specialised knowledge effect, which could be particularly valuable in the context of technologically-oriented new ventures (Colombo and Grilli, 2005a). Essentially, because the development of products in technology-intensive firms can be complex and intricate, the more the founder and workforce understand the scientific methods or devices necessary, the more likely they will be able to identify and allocate the resources necessary to successfully develop their product (Behrens *et al*., 2012). The second is that the mere presence of a PhD-trained individual on the founding team might also signal to outsiders that the concept is a viable one (Hsu, 2007). In essence, high academic status acts as a signal of quality to investors in highly uncertain markets (Gimmon and Levie, 2010). This appears to support Fiet's (1995) premise, whereby angels invest in businesses managed by competent entrepreneurs and depend on the ability of those individuals to manage market risk.

For venture capital, industry-specific experience is significant but the coefficient is negative (Column III). A possible explanation, as offered by Behrens *et al*. (2012), is that venture capitalists are less willing to invest in entrepreneurs who are competent enough to move their product to market and raise money from other sources, such as alliance partners. In contrast, those that lack such competencies and experience benefit from the knowledge offered by the venture capitalist. This line of reasoning ties in with the concept of venture capitalists as active investors (Hellmann and Puri, 2002), who not only provide financial capital to investees but also like to actively involve themselves in coaching and mentoring investees (see Davila *et al*., 2003; Busenitz *et al*., 2004; St-Pierre *et al*., 2011).

To close, let us briefly summarise the findings by source. Smaller firms, with higher levels of expenditure on R&D and in possession of a patent, have a higher probability of being angel financed during the early-growth stage. These firms are more likely to be run by founder-CEOs with a Masters or doctorate qualification, while also possessing higher levels of organisational human capital. Furthermore, those obtaining angel finance during the early-growth years are more likely to also use f-connection funding. In contrast, it is larger firms that are more likely to be venture capital financed during this stage. Like those with angel financing, those with a patent have a higher probability of being venture capital financed. The founder-CEOs within these firms are less concerned with potential loss of control to external equity investors, have lower levels of industry-specific experience, and are less likely to invest personal capital into the firm. Finally, firms with higher levels of turnover generated through exporting, with a unique product offering, greater expenditure on R&D activities, and having also obtained personal and f-connection investment during this stage have a higher probability of being funded by government-sponsored equity. The entrepreneurs within these firms are less concerned with the potential for increased monitoring by government-sponsored funders.

Table 6.8. Multivariate Probit – Determinants at Early-growth Stage (N=141)

	Angel		VC		GovSpon	
	I β (Std. Error)	II Marginal Effect	III β (Std. Error)	IV Marginal Effect	V β (Std. Error)	VI Marginal Effect
Financing:						
PersInvest	0.2302 (0.2369)	0.0595	-0.3467* (0.2394)	-0.1451	0.3512* (0.2323)	0.1075
FConn	0.5092* (0.2889)	0.1474	-0.1477 (0.2796)	-0.0413	0.8074*** (0.2814)	0.2534
Debt	0.0872 (0.2983)	-0.0124	0.2167 (0.2865)	0.0315	0.0144 (0.2899)	0.0605
Entrepreneur-specific:						
FinancingPref	-0.3753 (0.2759)	-0.1201	-0.0987 (0.2706)	-0.0846	0.0728 (0.2759)	0.0302
LossOfControl	0.0379 (0.1472)	0.0062	-0.1919* (0.1462)	-0.0400	0.1692 (0.1595)	0.0148
Monitoring	0.0142 (0.1354)	0.0230	-0.0701 (0.1404)	-0.0130	-0.2774* (0.1493)	-0.0741
RiskSharing	-0.0065 (0.1199)	-0.0169	0.1351 (0.1146)	0.0698	0.0018 (0.1157)	0.0026
Firm-specific:						
SizeStage	-0.0065* (0.0036)	-0.0009	0.0306*** (0.0111)	0.0113	-0.0044 (0.0038)	-0.0019
ServiceFirm	0.0236 (0.3868)	0.1125	0.3362 (0.3438)	0.3564	0.2335 (0.3629)	0.1946
Affiliation:						
IncCent	-0.4174** (0.3381)	-0.2394	0.3071 (0.3204)	0.1255	0.3258 (0.3279)	0.0576
Market and Product:						
Rivalry	-0.009 (0.0267)	-0.0062	-0.0161 (0.0276)	-0.0104	-0.0091 (0.0269)	-0.0034
IntSales	0.0026 (0.0042)	0.0019	0.0031 (0.0044)	0.0013	0.0800** (0.0044)	-0.0001
ProductDiff	0.2272 (0.1889)	0.0907	0.1056 (0.1953)	0.0311	0.2778* (0.1901)	-0.0834
Innovation:						
TotalInnov	0.0547 (0.1653)	0.0188	0.0766 (0.1601)	0.0205	0.0025 (0.1598)	0.0039
FreqRandD	0.4155** (0.2158)	0.1556	0.2037 (0.2069)	0.0913	0.2669* (0.2019)	0.0667
Patent	0.6177*** (0.2693)	0.3573	0.4920** (0.2679)	0.1932	0.1435 (0.2704)	0.0407
Human Capital:						
FoundEdu	0.2778* (0.1968)	0.0956	-0.1143 (0.2052)	-0.0339	-0.1705 (0.2048)	-0.0412
FoundIndExp	0.0037 (0.0171)	0.0007	-0.0296* (0.0173)	-0.0089	-0.0209 (0.0164)	-0.0063
FoundIntExp	0.0264 (0.2795)	0.0094	0.0098 (0.3017)	0.0017	0.3550 (0.2992)	0.1203
WorkforceQual	0.0319*** (0.0119)	0.0120	0.0044 (0.0097)	0.0015	0.0021 (0.0118)	0.0036
MillsRatio	-0.2862 (0.5956)	-0.0449	-0.7229 (0.6549)	-0.1252	-0.9668 (0.7026)	-0.2657
Constant	3.4174 (2.2615)		0.0764 (2.3344)		0.7272 (2.3624)	
Log Likelihood	-252.8369					
No. Observations	151					
Wald Chi-square	138.27					
Prob>Chi2	0.0856					

Notes: (1) Robust standard errors in parentheses; (2) Significance levels: * p<0.1; ** p<0.05; *** p-<0.01;
(3) *MillsRatio* controls for sample self-selection.

Expansion Stage

This brings us, finally, to the expansions stage, the results for which are presented in Table 6.9. As the sample size is reduced (N=86) it was necessary to also reduce the number of covariates in order to successfully run the MVP. As such, this estimation does not include the following variables: *ServiceFirm*; *LossOfControl;* and *RiskSharing*. We can reject the hypothesis that the correlation between the error terms of the equations are all zero (Chi^2=236.49, p<0.01) and thus can have confidence in our findings.

Interestingly, f-connection funding is again positive and significant for angel financing (Column I) although, in terms of magnitude (Column II), it has the smallest effect observed. Nevertheless, our finding serves to highlight the signalling role of investment from family and friends for angel financing. While contrary to Hypothesis 5 regarding stage of significance, this finding is in line with Hypothesis 2 and also with Conti *et al*. (2013). Furthermore, debt financing is positive and significant for government-sponsored funding (Column V), providing support for the predictions of Hypothesis 3. Moreover, debt has the largest effect observed for government-sponsored funding at the expansion stage (Column VI), also providing support for Hypothesis 6. As with the arguments advanced regarding our findings on the relationship between government-sponsored funding and founder, family and friends' investment, a possible explanation for this finding is the need for entrepreneurs to provide matched funding in order to obtain funding from government-managed funds. Regarding the lifecycle, as the firm moves through to expansion years, debt financing replaces personal and f-connection funding (Berger and Udell, 1998), thus the signalling role switches to debt financing.

We see that incubation has a significant positive effect on government-sponsored funding (Column V). We must consider the result in context. That is, of the eighteen firms that obtained government-sponsored funding at the expansion stage, half are located within an incubation centre. These results, nevertheless, point to the positive relationship between incubation and government-managed funding. Moreover, this is the second largest marginal effect observed in the government-sponsored equation (Column VI).

The relationship between market and product-related factors and venture capital financing at the expansion stage is particularly noticeable (Column III). In our estimate, all coefficients within this group are significant for venture capital, with *ProdDiff* (positive) and *Rivalry* (negative) having the second and third largest effects observed respectively (Column IV). These findings support the contention that market and product-related factors are vital signals for formal equity financing (Hsu *et al*., 2014). Petty and Gruber (2011) find that product and market-related factors play a primary role for European venture capitalists, who rate such factors over those associated with the management team. In short, moving through the lifecycle, the firm will diversify its product and market and become focused on scaling the offering, defending and winning market share, and internationalisation (Kazanjian, 1988). The expansion phase corresponds to affirmation of the firm's market entry and position (Hirsch and Walz, 2011). Faced with an increasingly hostile environment, the firm may expand their product/service base (Bonn and Pettigrew, 2009). At this stage, funding is usually intended to help further traction through, for example, large-scale marking initiatives, new product launches or internationalisation (see Tyebjee and Bruno, 1984; Jeng and Wells, 2000). Thus, it is feasible that the firm's market and product would represent valuable signals in attracting venture capitalists during the expansion stage.

Turning to innovation-specific factors, *Patent* has a positive and significant impact on venture capital (Column III), again highlighting the key role of patents in signalling to venture capitalists and corroborating existing evidence (see Audretsch *et al*., 2012; Hoenen *et al*., 2014). In fact, patenting has the largest effect on venture capital funding at expansion (Column IV). For government-sponsored funding, the coefficient on R&D is positive and significant (Column V), having the third largest marginal effect observed for the source (Column VI).

Once again, our findings serve to highlight the role of formal equity financing in funding innovation in technology-based firms.

Moving finally to human capital, founder-CEO education and international experience are both positive and significant for angel financing at this stage (Column I). Of these two factors, education has the larger effect (Column II). That the education and experience of the entrepreneur are key in attracting angel investors is consistent with the existing evidence, with scholars noting that angels have a tendency to assign a substantial weight to the entrepreneur's characteristics when assessing a deal (see Haines *et al*., 2013; Mason and Stark, 2004; Croce *et al*., 2017). Organisational human capital has a positive and significant coefficient for government-sponsored funding (Column V), suggesting that higher levels of organisational human capital represents a signal for government-sponsored funding during expansion years.

To summarise, the findings from the expansion stage offer the following insights. Technology-based firms who founder-CEOs have higher levels of educational attainment and international work experience have a higher probability of being angel financed during the expansion stage. These firms also obtain f-connection funding during the expansion stage. For venture capital, the emphasis is on the firm's product and market. Specifically, occupying a market niche, offering a unique product, possessing patent protection, and having higher levels of turnover generated through export activities increase the probability of obtaining venture capital during expansion. Finally, being located within an incubation centre, along with having higher levels of R&D expenditure and organisational human capital positively impact on the probability of being funded by government-sponsored equity at the expansion stage. Moreover, these firms are more likely to also use debt financing during expansion years.

Table 6.9. Multivariate Probit – Determinants at Expansion Stage (N=86)

	Angel		VC		GovSpon	
	I	II	III	IV	V	VI
	β (Std. Error)	Marginal Effect	β (Std. Error)	Marginal Effect	β (Std. Error)	Marginal Effect
Financing:						
PersInvest	0.3198	0.9800	-0.2048	-0.3743	0.4719	0.7309
	(0.4162)		(0.3369)		(0.4185)	
FConn	0.6032*	0.5357	-0.1829	0.0824	0.0943	0.2398
	(0.3773)		(0.3087)		(0.4166)	
Debt	0.0383	-1.1542	0.4228	0.6892	1.0447***	0.9885
	(0.4232)		(0.3632)		(0.3911)	
Entrepreneur-specific:						
FinancingPref	-0.3841	-0.7724	-0.0362	-0.1567	0.0742	0.3891
	(0.3682)		(0.3194)		(0.4320)	
Monitoring	0.1317	0.1632	-0.0672	-0.1364	-0.0432	0.1557
	(0.2354)		(0.149)		(0.2031)	
Firm specific:						
SizeStage	-0.0031	-0.0052	0.0005	0.0035	-0.0024	-0.0043
	(0.0033)		(0.0026)		(0.0027)	
Affiliation:						
IncCent	-0.5087	-0.6140	0.4833	0.6769	1.2775**	0.7093
	(0.4925)		(0.4834)		(0.5197)	
Market and Product:						
Rivalry	-0.0267	-0.0496	-0.0368*	-0.0104	-0.0023	-0.0197
	(0.0294)		(0.0165)		(0.0204)	
IntSales	-0.0099	-0.0023	0.0158**	0.0042	0.0004	0.0052
	(0.0073)		(0.0068)		(0.0080)	
ProductDiff	-0.3133	-0.5865	0.4435*	0.3909	0.2223	0.3626
	(0.2443)		(0.2375)		(0.2535)	
Innovation:						
TotalInnov	-0.2290	-0.0709	-0.0832	-0.1612	-0.2557	-0.0724
	(0.2068)		(0.2269)		(0.2454)	
FreqRandD	0.2144	0.9994	0.2168	0.4812	0.5814*	0.6808
	(0.2609)		(0.2839)		(0.3092)	
Patent	0.3599	0.3505	0.7403**	0.6128	0.4851	0.0831
	(0.4003)		(0.3643)		(0.4870)	
Human Capital:						
FoundEdu	0.4351*	0.6796	-0.3854	-0.2935	-0.2198	-0.5469
	(0.2757)		(0.2687)		(0.2934)	
FoundIndExp	0.0099	0.0381	-0.0054	-0.0210	-0.0280	-0.0256
	(0.0266)		(0.0234)		(0.0279)	
FoundIntExp	0.7718*	0.5686	-0.0822	-0.0529	-0.5572	-0.3393
	(0.5049)		(0.4142)		(0.5227)	
WorkforceQual	0.0003	0.0067	0.0205	0.0146	0.0284*	0.0199
	(0.0176)		(0.0153)		(0.0177)	
MillsRatio	-1.6531	-0.7112	-2.4024***	-0.4253	-0.1428	-0.8851
	(1.1388)		(0.8835)		(1.3387)	
Constant	3.6233		4.2305		-0.8106	
	(3.4192)		(3.0268)		(4.0033)	
Log Likelihood	-103.0542					
No. Observations	86					
Wald Chi-square	236.49					
Prob>Chi2	0.0006					

Notes: (1) Robust standard errors in parentheses; (2) Significance levels: * p<0.1; ** p<0.05; *** p-<0.01; (3) *MillsRatio* controls for sample self-selection.

6.4.2 Relationship between Sources of Equity

We turn now to the results from the second phase of empirical analysis, the aim of which is to examine the role existing sources of financing play in facilitating access to subsequent equity funding. In particular, we are interested in testing whether the sources of equity substitute or complement each other over the lifecycle. Similar models to those estimated in the first phase are used, but now the '*Financing*' category switches to capture sources of financing used in prior stages. In the ensuing discussion, we are explicitly interested in the direction and significance of the coefficients on these sources of financing, although results regarding other explanatory variables will also briefly be commented on. As such, positive (negative) coefficients (β) indicate that these sources are complements (substitutes). Discussion now turns to an assessment of key findings. Two MVPs are estimated, again corrected for sample self-selection bias, one for the early-growth stage and one for the expansion. We will now consider each of these in turn.

Beginning with the estimation for the early-growth stage, the results of which are presented in Table 6.10, with associated marginal effects, we can reject the hypothesis that the correlation between the error terms of the equations are all zero (Chi^2=215.06, $p<0.05$) and thus can have confidence in our findings. For those obtaining angel financing (Column I), the negative and significant coefficient on *AngelSeed* suggests that these firms do not have angel funding prior to the early-growth stage. Likewise, the negative significant coefficient on *GovSponSeed* suggests that these firms did not obtain government-sponsored funding at seed. In terms of magnitude, *GovSponSeed* has the larger effect and is, in fact, the second largest marginal effect observed in the angel estimate (Column II). Venture capital funding at the seed stage, although a negative coefficient, is not statistically significant. Overall, these findings are contrary to Hypothesis 7 and suggest a substitute relationship both within this source and with government-sponsored funding. Put another way, it appears that those technology-based firms obtaining angel funding during their early-growth stage are unlikely to have received angel or government-sponsored equity in the seed stage. The coefficients on all other explanatory variables, along with the signs and significance levels, are comparable to the specification discussed above in Subsection 6.4.1 (i.e. they do not vary when we take into consideration the relationship between prior sources of financing).

Moving to the findings for venture capital at early-growth (Column III), *AngelSeed* is negative and significant, suggesting that those obtaining venture capital during the early-growth stage are unlikely to have received angel finance at the seed stage. From Column IV, we see that, in terms of magnitude, this variable has the second largest marginal effect observed for venture capital. Although opposing our hypothesised effect (Hypothesis 7), this finding is consistent with the work of Hellmann *et al*. (2015), who also show such a substitution between these two investor categories. Thus, those technology-based firms that raise venture capital funds during their early-growth stage are unlikely to have received prior angel support. Aside from this, the findings are identical to those presented in Subsection 6.4.1.

Lastly, we turn to the results for government-sponsored equity (Column V). Those obtaining finance from a government-managed fund at the early-growth stage are unlikely to have received angel funding at seed. In fact, *AngelSeed* is the third largest marginal effect observed in the government-sponsored estimation (Column VI). Moreover, the negative and significant *GovSponSeed* suggests that these firms have not obtained financing from another government-managed equity fund. In this estimation, *GovSponSeed* had the largest marginal effect (Column VI). Given there is one primary fund in Ireland, Enterprise Ireland's Seed and Venture Capital scheme, this result is hardly surprising. Overall, these findings suggest that those obtaining government-sponsored equity at the early-growth stage are unlikely to have prior angel or government-sponsored funding, contrary to Hypothesis 7. Interestingly, personal investment and debt financing at seed both have a positive and significant impact on government-sponsored funding at the early-growth stage. The findings provide further support for the signal from personal investment (Hypothesis 1) and debt finance (Hypothesis 3). In terms of magnitude (Column VI), debt at seed has the second largest effect observed. This again points towards a complementary relationship between government-sponsored funding and non-equity sources of capital, consistent with our findings in the first phase of analysis and potentially indicative of the need for matched funding in accessing government-sponsored funds. As to the other explanatory variables, we find no differences in the signs of the coefficients although there are some differences in their significance. Specifically, we see that incubation, founder-CEO education and firm size now become significant. As such, when we take sources of financing into account, we see that smaller firms, located in an incubator, and whose founder-CEOs are educated to degree level are more likely to be financed by government-sponsored equity at the early-growth stage.

Overall, findings from the early-growth stage would suggest that the relationship between sources obtained at seed and early-growth stages is, predominantly, one of substitutes. Most strikingly, we see that prior angel finance exerts a negative significant impact on all sources of equity at the early-growth stage. The results concerning the impact of seed stage government-sponsored equity are similar. Importantly, these results are not driven by repeat investors. Moreover, across the sources, a two-way substitution relationship exists between angels and government-sponsored equity. Precisely, if a firm raised angel funding at the seed stage, it is less likely to have government-sponsored funding during the early-growth stage, and vice versa. In general, our findings point towards negative signalling effects of seed stage equity funding. We had predicted a positive relationship between the sources of equity, whereby initial funding in the seed stage would represent a positive signal for sources obtained in the early-growth stage, so Hypothesis 7 is not supported. Overall, these results support the evidence presented by Hellmann *et al*. (2015).

Table 6.10. Multivariate Probit – Determinants at Early-growth Stage (N=141)

	Angel		VC		GovSpon	
	I β (Std. Error)	II Marginal Effect	III β (Std. Error)	IV Marginal Effect	V β (Std. Error)	VI Marginal Effect
Financing:						
PersInvestSeed	0.2089 (0.4421)	0.0608	0.1519 (0.4714)	0.0575	0.63708* (0.3179)	0.2341
FConnSeed	0.2502 (0.2853)	0.0909	0.0886 (0.2942)	0.0410	0.3253 (0.3042)	0.1143
DebtSeed	0.2330 (0.4607)	0.0769	0.4425 (0.4161)	0.1664	0.9272** (0.4651)	0.3456
VCSeed	-0.2822 (0.3907)	-0.0910	0.3076 (0.4143)	0.1079	0.0643 (0.4008)	0.0302
AngelSeeed	-0.3972* (0.2957)	-0.1361	-0.3682* (0.3003)	-0.1460	-0.9120*** (0.3224)	-0.3329
GovSponSeed	-0.7353** (0.3629)	-0.2442	-0.3953 (0.4071)	-0.1503	-1.8203*** (0.4701)	-0.6765
Entrepreneurial Perspective:						
FinancingPref	-0.4046 (0.2882)	-0.1310	-0.0648 (0.2760)	-0.0162	0.2944 (03179)	0.1001
LossOfControl	0.0794 (0.1444)	0.0231	-0.2157* (0.1505)	-0.0812	0.2734* (0.1665)	0.1024
Monitoring	0.0257 (0.1325)	0.0214	-0.1056 (0.1334)	-0.0331	-0.3096** (0.1379)	-0.1194
RiskSharing	-0.0381 (0.1212)	-0.0069	0.1437 (0.1201)	0.0554	0.0160 (0.1255)	0.0069
Firm-specific:						
SizeStage	-0.0083** (0.0037)	-0.0012	0.0292* (0.0121)	0.0113	-0.0110 (0.0040)	-0.0044
ServiceFirm	0.1126 (0.3733)	0.0472	0.3716 (0.3509)	0.1429	0.3314 (0.3721)	0.1216
Affiliation:						
IncCentre	-0.8444** (0.3327)	-0.2155	0.1356 (0.3159)	0.0291	0.6941** (0.3260)	0.2397
Market and Product:						
Rivalry	-0.0119 (0.0273)	-0.0081	-0.0269 (0.0297)	-0.0112	-0.0107 (0.0306)	-0.0018
IntSales	0.0044 (0.0041)	0.0015	0.0032 (0.0042)	0.0011	0.0014 (0.0048)	0.0005
ProductDiff	0.2057 (0.1891)	0.0923	0.0775 (0.1945)	0.0269	0.2777* (0.2037)	0.0836
Innovation:						
TotalInnov	0.0629 (0.1663)	0.0261	0.1527 (0.1624)	0.0618	0.1078 (0.1987)	0.0438
FreqRandD	0.3922* (0.2112)	0.1622	0.1934 (0.2029)	0.0923	0.1854 (0.2098)	0.0555
Patent	0.9944*** (0.2823)	0.4059	0.5457** (0.2715)	0.2599	0.2349 (0.2821)	0.0498

Human Capital:						
FoundEdu	0.3487*	0.1221	-0.1315	-0.0589	-0.4425**	-0.1610
	(0.2039)		(0.2094)		(0.2329)	
FoundIndExp	0.0011	0.0105	-0.0269*	-0.0101	-0.0205	-0.0075
	(0.0166)		(0.0172)		(0.0175)	
FoundIntExp	0.0308	0.0002	0.0612	0.0308	0.3907	0.1465
	(0.2801)		(0.2957)		(0.3389)	
WorkforceQual	0.0312***	0.0124	0.0029	0.0027	0.0017	0.0015
	(0.0126)		(0.0097)		(0.0131)	
MillsRatio	-0.3765	-0.1004	-1.0081	-0.3691	-1.9265**	-0.7322
	(0.5684)		(0.6085)		(0.8499)	
Constant	3.5583		0.6447		0.7272	
	(2.3252)		(2.2367)		(2.3624)	
Log Likelihood	-235.6012					
No. Observations	151					
Wald Chi-square	215.06					
Prob>Chi2	0.0521					

Notes: [(1)] Robust standard errors in parentheses; [(2)] Significance levels: * p<0.1; ** p<0.05; *** p-<0.01; [(3)] *MillsRatio* controls for sample self-selection.

Moving next to the expansion stage, as with the first phase of analysis, it was necessary to reduce the model somewhat for estimation purposes. Specifically, the following variable are excluded: *FoundEdu*; *WorkforceQual*; *LossControl; IncreasedMonitoring*; *RiskSharing*; and *ServiceFirm*. We now examine the findings of this MVP, which are presented in Table 6.11. Once again, we are primarily interested in results concerning the relationships between the investor types. We can reject the hypothesis that the correlation between the error terms of the equations are all zero (Chi^2=826.26, p<0.01) and thus can have confidence in our findings.

We begin with the results for the angel estimation (Column I). The coefficient on angel financing during the early-growth stage is positive and significant, suggesting those firms that have received investment from an angel in the previous stage are more likely to obtain angel funding at expansion. This provides support for Hypothesis 8. Importantly, as with the early-growth estimation above, this result is not driven by repeat angel investors, as our dependent variable captures investment by a new angel (rather than re-investment from an existing angel). We also see that *GovSponSeed* is negative and significant, suggesting that those obtaining angel finance at expansion did not receive government-sponsored funding during the seed year. In terms of magnitude, this is the largest marginal effect observed (Column II). Thus, those obtaining angel finance during expansion years are unlikely to have received finance from a government-managed fund during their seed year. This insinuate a substitute relationship between the sources, contrary to our expectations in Hypothesis 8. As to the control variables, while we find no changes in the signs of the coefficients, we see that R&D-intensity becomes positive and significant, once we take prior sources of financing into consideration. Moreover, it has the second largest effect on angel financing at the expansion stage (Column II).

Moving on to venture capital (Column III), personal investment at the seed stage is negative and significant, suggesting that those firms obtaining venture capital at the expansion stage are unlikely to have used the personal funds of their founder(s) at seed. This finding demonstrates that those that receive venture capital have a lower dependence on entrepreneurs' personal funds and, once again, is contrary to our predictions in Hypothesis 1. Debt financing from the early-growth stage has a positive significant effect, pointing to a complementary relationship between the two sources. Thus, it appears that debt financing exerts a positive signalling role for future venture capital, supporting Hypothesis 3, although this impact is transitory and only applicable to debt raised during the early-growth stage. Nevertheless, the marginal effect for debt is the second largest observed in the equation for venture capital at expansion (Column IV). Next, we see that *VCSeed* is negative and significant, suggesting a substitute relationship within this source. This is contrary to our expectations in Hypothesis 8. In terms of magnitude, this is the third largest marginal effect observed (Column IV). To the impact of prior angel investment, we see that both *AngelSeed* and *AngelEarly* are positively and significant for venture capital in the expansion stage. Thus, the presence of angel investors from prior stages is associated with subsequent venture capital financing during at the expansion stage, consistent with Hypothesis 8, although contrary to the evidence presented by

Hellmann *et al*. (2015). Lastly, as to the other explanatory variables, the sign and significance of all coefficients are as observed previously in Subsection 6.4.1.

Finally, for government-sponsored funding (Column V), personal investment at seed is positive and significant, again offering support for Hypothesis 1 and highlighting the complementary relationship between the entrepreneur's personal investment and government-sponsored funding. As to sources of equity, *VCSeed* is negative and significant, suggesting that those obtaining government-sponsored funding at the expansion stage did not obtain venture capital funding at the seed stage. This suggests that the relationship between the sources if one of substitutes, contrary to Hypothesis 8. In terms of magnitude, this is the largest marginal effect observed (Column VI). Government-sponsored funding at both the seed or early-growth stages are negative and significant, also contrary to Hypothesis 8. This is, however, a plausible result, given that there is one primary government-managed equity fund in Ireland (provided through Enterprise Ireland) and, as such, firms typically obtain support from one fund rather than multiple publicly-sponsored funds. As to the other explanatory variables, *ProdDiff* becomes significant for government-sponsored funding at the expansion stage. As such, having a unique product represents a positive signal to government-sponsored fund providers and increases the likelihood of the firm obtaining this source of equity at the expansion stage.

Overall, these findings show a number of interesting patterns in the relationships between prior and subsequent equity financing. Within the sources of equity, venture capital at seed substitutes for venture capital at the expansion stage. Angel at the early-growth stage complements angel funding at the expansion stage. Moreover, it appears that technology-based firms obtain government-sponsored equity funding from one scheme, with both government-sponsored funding at seed and early-growth having a negative impact on the probability of having government-sponsored funding at expansion. As to the relationships between the sources, angel funding at the seed and early-growth stages complement subsequent venture capital funding at expansion. Those obtaining government-sponsored funding at expansion are unlikely to have obtained venture capital funding at seed, suggesting the sources substitute each other, while those obtaining angel funding at expansion are unlikely to have received government-sponsored funding at seed.

Table 6.11. Determinants at Expansion Stage (N=86)

	Angel		VC		GovSpon	
	I β (Std. Error)	II Marginal Effect	III β (Std. Error)	IV Marginal Effect	V β (Std. Error)	VI Marginal Effect
Financing:						
PersInvestSeed	0.6245 (0.7201)	0.0915	-1.1841* (0.6443)	-0.0062	0.9901* (0.7618)	0.0254
PersInvestEarly	0.0873 (0.3238)	0.0046	-0.1839 (0.3646)	-0.1604	0.1265 (0.3739)	0.0469
FConnSeed	0.1369 (0.5367)	0.4394	-0.3560 (0.4419)	-0.1839	0.4642 (0.5346)	0.4870
FConnEarly	0.4393 (0.4521)	0.0863	-0.0817 (0.4042)	-0.2252	0.4969 (0.4622)	0.0492
DebtSeed	-0.2017 (0.6911)	-0.0023	-0.9495 (0.7592)	-0.0607	0.2502 (0.8679)	0.4352
DebtEarly	0.3318 (0.4592)	0.2029	0.6327* (0.3987)	0.1960	0.0947 (0.4681)	0.3444
VCSeed	-0.4212 (0.4689)	-0.7423	-1.1562* (0.6669)	-0.1466	-0.9040* (0.5874)	-0.9911
VCEarly	0.0257 (0.3761)	0.0330	0.0612 (0.3879)	0.0828	0.0144 (0.6279)	0.0091
AngelSeed	-0.0101 (0.4499)	-0.0961	0.8045* (0.4652)	0.0911	0.1339 (0.4379)	0.0992
AngelEarly	0.2377* (0.5334)	0.0637	0.6104* (0.3465)	0.0332	0.3037 (0.3860)	0.0239
GovSponSeed	-0.6962* (0.6601)	-0.3902	-0.0328 (0.6222)	-0.0382	-1.5883* (0.9036)	-0.5501
GovSponEarly	0.2395 (0.3705)	1.0507	0.0861 (0.3224)	0.5499	-1.2677*** (0.7618)	-0.8004
Entrepreneurial Perspective:						
FinancingPref	-0.4409 (0.3965)	-0.6786	-0.3393 (0.4033)	-0.2954	0.6782 (0.4887)	0.0011
Firm-specific:						
SizeStage	-0.0022 (0.0028)	-0.0002	0.0043* (0.0029)	0.0023	-0.0009 (0.0027)	-0.0213
Affiliation:						
IncCentre	-0.6049 (0.6200)	-0.5268	0.2923 (0.4930)	0.1036	1.3622*** (0.5538)	0.8926

Market and Product:						
Rivalry	-0.0107	-0.0024	-0.0249*	-0.0005	-0.0175	-0.0090
	(0.0351)		(0.0185)		(0.0302)	
Exports	-0.0035	-0.0006	0.0127*	0.0009	0.0079	0.0012
	(0.0071)		(0.0077)		(0.0070)	
ProductDiff	-0.1985	-0.5621	0.4387**	0.2953	0.5452*	0.3836
	(0.2337)		(0.2374)		(0.2989)	
Innovation:						
TotalInnov	-0.2774	-0.0143	0.0082	0.0791	0.4091	0.1266
	(0.2337)		(0.2257)		(0.2764)	
FreqRandD	0.3942*	0.6731	0.3432	0.3546	0.6081*	0.4110
	(0.2494)		(0.3009)		(0.3471)	
Patent	0.3313	0.0557	0.7430*	0.0998	0.0119	0.3786
	(0.4952)		(0.4229)		(0.6427)	
Human Capital:						
FoundIndExp	0.0050	0.0241	-0.0010	-0.0193	-0.0315	-0.0212
	(0.0295)		(0.0249)		(0.0313)	
FoundIntExp	0.6302*	0.1008	0.3893	0.0768	0.8953	0.0272
	(0.4902)		(0.4863)		(0.7415)	
MillsRatio	-0.6213	-0.2784	-1.2132	-0.0316	-1.5828	-0.0421
	(0.9071)		(0.8816)		(0.9899)	
Constant	2.1133		1.3587		5.5675	
	(2.7800)		(2.5768)		(3.4639)	
Log Likelihood	-97.4399					
No. Observations	86					
Wald Chi-square (69)	826.26					
Prob>Chi2	0.0005					

Notes: (1) Robust standard errors in parentheses; (2) Significance levels: * p<0.1; ** p<0.05; *** p-<0.01; (3) *MillsRatio* controls for sample self-selection.

6.5 General Conclusions

Entrepreneurial equity investment by venture capitalists, business angels, and government-sponsored funds represent key sources of equity capital for technology-based firms. Scholars interested in financial resource acquisition have identified various factors that attract external equity investors, including human capital (see Gulati and Higgins, 2003; Gimmon and Levie, 2010), intellectual property (see Engel and Keilbach, 2010; Audretsch *et al*., 2012) and endorsement by third parties (see Janney and Folta, 2006; Plummer *et al*., 2016). This research, however, is largely segmented by type of equity investor and stage of investment. Specifically, the existing demand-side research investigating the determinants of equity financing has predominantly focused on venture capital as the sole source of external equity obtained and, moreover, has adopted a static approach by examining financial resource acquisition at one point in time (see Elitzur and Gavious, 2003; Colombo and Grilli, 2010; Patzelt, 2010). Responding to this gap in the literature, this Chapter examined the factors that determine angel, venture capital and government-sponsored equity financing over distinct stages in the firm's development and in light of the relationship between the firm's sources of financing.

In short, MVP models (with Heckman correction for sample selection) were employed to explore whether the determinants of equity financing, introduced in Chapter 5, differ when examined according to source of equity, stage of the lifecycle, and given the relationship between the different sources of financing utilised by the firm. Although analysis tested the signalling impact of attributes of the firm (i.e. size, market, product, innovation) and entrepreneur (i.e. education and experience), the main focus was on the role of financial information. Specifically, the first phase of analysis tested the signalling impact of present non-equity (i.e. personal investment, f-connection funding, debt) sources of financing for sources of equity obtained at the seed, early-growth and expansion stages while the second focused on the signals that prior equity and non-equity sources of financing offer for the sources of equity obtained during the early-growth and expansion stages. Overall, the findings make important contributions to the literature since this analysis is, to the best of our knowledge, the first to provide evidence of the changing nature of determinants of equity financing over time in the context of angel, venture capital and government-sponsored equity funding and in light of the relationship (i.e. substitutes/complements) between these equity investors within a lifecycle framework.

Of the many determinants identified in this analysis, the following are worthy of a reprise: First, the entrepreneur's personal investment during the seed stage significantly impacts each source of equity financing. Specifically, we saw that those firms obtaining venture capital funding during the seed or early-growth years have less recourse to the personal funds of their founder(s) while the opposite is the case for those with angel or government-sponsored funding. Interestingly, this effect was stronger for venture capital than for the other sources. The significance of the signal from personal investment was also found in the early-growth stage for venture capital and government-sponsored equity. Thus, it appears that venture capital substitutes the use of personal financing in the initial stages of the lifecycle of technology-based firms. Second, our results showed that f-connection funding is a key complement to angel financing over each stage in the lifecycle. This finding is in line with the evidence provided by Conti *et al*. (2013), who report that investment from founders, family and friends represent an important signal of commitment for start-up companies seeking angel investors. F-connection funding also represents a positive signal for government-sponsored equity at both the seed and early-growth stages, before debt takes over at the expansion stage. Third, results highlight the link between innovation activities and equity financing, particularly formal sources. Specifically, we consistently saw that patents positively impacted venture capital at all three stages of the lifecycle. Frequency of innovation was also a significant (positive) signal, but only for venture capital financing at the seed stage. Furthermore, we saw that R&D-intensity represented a significant (positive) determinant of government-sponsored funding at all three stages. Patenting and R&D-intensity were found to be significant for angel financing, but only at the early-growth stage. Overall, these findings emphasis the key signalling role of technology-based firms' innovation activity for external equity financing. Third, while confirming the role of human capital for angel financing, we see that the signalling effects from different human capital attributes vary across the stages. Specifically, while founder-CEO industry-specific experience positively impacts on the likelihood of receiving angel financing at the seed stage, moving to the early-growth stage it is educational attainment that becomes the significant signal. Moreover, education represents a significant signal at the expansion stage, along with international experience. Overall, this serves to show how signals effective in obtaining angel financing vary over the firm's lifecycle. Finally, as regards the relationship between the sources, at the early-growth stage results indicate a substitution effect with seed stage funding. This is consistent with the findings of Hellmann *et al.*, (2015). However, moving into expansion, the presence of angel investors from the seed stage positively impacts on the probability that the firm will obtain angel and venture capital financing during expansion. Thus, seed stage angel financing complements expansion stage private equity.

The contributions of Chapter 6 lie in three directions: Firstly, empirical analysis untangles the determinants of equity tested in Chapter 5 by examining the significance of the factors according to the sources of equity. Secondly, empirical analysis is unique in that MVP models are estimated by stage in the lifecycle, illustrating that the determinants may differ not only by source but also over time. Finally, empirical analysis provides original evidence of the extent to which the sources of equity, and indeed non-equity, financing complement or substitute each other over the lifecycle and, additionally, the impact these relationships have on the determinants of the sources of equity.

Although this analysis provided unique and novel evidence of the changing nature of signals in the context of new sources of equity obtained at distinct stages in the lifecycle, and the relationship between the sources of equity, the work nonetheless has limitations. First, the focus here is on the determinants of new equity investment obtained within the specified stage. This analysis could be extended to explore how the signals behave when investment is obtained by a repeat investor. In other words, empirical models could investigate the extent to which the impact of the signals change after the initial investment. Furthermore, given the age profile of the sample of equity financed firms (see Chapter 4, Section 4.3), collecting data from a larger sample would allow for a more proportionate representation across all lifecycle stages and offer greater insight into the signalling effects of different firm characteristics across not only the seed and early-growth stages, but also from expansion and into later stages. In other words, the lack of evidence in this area could also be addressed by extending this study to a larger sample of equity financed firms. Lastly, a natural step for the analysis of the substitutes/complement aspect would be to collect data on the amount of equity investment obtained from each source at each financing round. Employing such data would facilitate a more in-depth analysis of the interconnectedness of different equity investor types.

Lastly, this analysis has a number of implications. For **entrepreneurs** seeking external equity investment, the significance of different signals by investor type and stage of the lifecycle provide valuable knowledge and understanding of the factors that investors are looking for in an investee. Knowing how to present their investment opportunity effectively to potential equity investors is an important aspect of being ‘investor ready’ (Mason and Kwok, 2010). Recognising that different audiences look at the investment proposal from different perspectives, the findings herein can guide entrepreneurs in selecting appropriate signals, so that they can differentiate their application for funding to suit the source of equity targeted within their stage of development. Entrepreneurs have a limited amount of time and, in most cases, only one opportunity to pitch to an investor (Hsu *et al*., 2014). Understanding how signals matter differently across investor types increases the likelihood that entrepreneurs will be successful at each stage of their fund-raising campaign. For **policymakers**, the availability of resources dedicated to helping entrepreneurs overcome the intricacies of procuring external equity investment, while always a beneficial facility, could be tailored to specific investor types and stages of development, to further enhance access to equity for technology-based entrepreneurs. Findings also go some way to confirming the complementary relationship between initial angel financing and subsequent venture capital investment. Knowing this is important for policy-makers in attempting to foster equity financing. Specifically, adopting programs to support seed and early stage angel investment should enhance access to venture capital as the firm moves into expansion years. Moreover, by highlighting the complementary relationship between founder and f-connection funding and angel and government-sponsored financing, results also reveal a role for policymakers in promoting personal financial networks in facilitating access to financing. Finally, for **equity investors**, findings provide an in-depth understanding of the factors that determine investment by source and stage, based on data gathered from firms that have successfully obtained equity. This affords a much more accurate and reliable guide to the investment criteria of the different funders than conventional studies that generate a ‘laundry list’ of criteria (Mason and Stark, 2004). The central message is that different equity investors will look for different factors, or types of information, at different stages. This insight can prove useful not only in helping equity financiers to benchmark their own decision-making criteria but also allow them to compare their criteria to other investors and sources of equity funding. Furthermore, for novice equity investors and those entering the profession, the results can provide valuable guidance in understanding decision factors for investment in nascent through to expansion stage firms, and allow for deeper comprehension of the decision-making process of the different sources of equity.

CHAPTER 7 : IMPACT OF EQUITY FINANCING – AN EMPIRICAL INVESTIGATION OF PERFORMANCE AND EXIT

7.1 Introduction

Understanding equity investors' impact on their portfolio companies, beyond the provision of financial capital, has drawn considerable attention from scholars through the years (see Gorman and Sahlman, 1989; MacMillan *et al*., 1989; Fried *et al*., 1998; Kortum and Lerner, 2000; Davila *et al*., 2003; Balboa *et al*., 2011; Cumming *et al*., 2017). The underlying supposition is that equity investors offer a complex bundle of value-adding activities which, ultimately, impact the development and exit of funded firms (see Dennis, 2004; Cumming and Johan, 2008a; Croce *et al*., 2013). This Chapter explores this facet of equity financing, concentrating on the impact of equity on the performance of funded firms and in influencing entrepreneurial exit intentions.

Generally, the literature suggests that equity financing is positively correlated with funded firms' performance, such as innovative output (see Kortum and Lerner, 2000; Engel and Keilbach, 2007), growth (see Balboa *et al*., 2011; Puri and Zarutskie, 2012), and survival (see Manigart *et al*., 2002; Chemmanur and Chen., 2014). The vast majority of this evidence is based on the analysis of the effects of venture capital. By adopting a narrow definition of equity these studies fail to acknowledge the fact that firms may obtain equity funding from multiple sources (Cosh *et al*., 2009). Indeed, the available evidence regarding the impact of angel and government-managed equity funding on the performance of funded firms remains extremely scant (see Grilli and Murtinu, 2014a, b; Dutta and Folta, 2016). Addressing this gap, analysis undertaken herein adopts a broad definition of an equity-financed firm, encompassing angel, venture capital and government-sponsored funding to test the impact of equity investment on three performance indicators – innovation, growth and survival. No study, to the best of the author's knowledge, adopts such a broad definition in investigating the impact of equity on this combination of performance indicators. Going further, empirical analysis investigates how the impact of equity financing differs depending on the source of equity obtained, differentiating between the sources of equity.[119] Equity investors are different in several aspects, including ownership structures, objectives, skills and competencies (see Bottazzi *et al*., 2008; Bertoni *et al*., 2013). Further, resource endowments are not homogeneous across the differ types of equity investor (Leleux and Surlemont, 2003). As such, investments by different investors are unlikely to produce the same effects (Manigart and Wright, 2013) and, therefore, it is possible that impact on funded firm performance may differ depending on the source of equity obtained. Thus, a gap in the existing literature becomes particularly apparent once heterogeneity among the sources of equity is considered. A handful of studies compare the contributions of private with publicly-sponsored venture capital (see Luukkonen *et al*., 2013; Grilli and Murtinu, 2014a, b; Alperovych *et al*., 2015; Bertoni and Tykvová, 2015; Cumming *et al*., 2017). The only study, that we are aware of, to contrast venture capital and angels is that by Dutta and Folta (2016), who focus only on contribution to patenting and time to exit. Overall, the effects of the different types of equity financing are largely under-researched and consequently unknown. To the best of our knowledge, this analysis is the first to distinguish between these three sources (angel, venture capital, government-sponsored equity) in exploring impact on innovative output, growth and survival. Overall, this in-depth analysis contributes to our understanding of the role of equity, and the different sources of equity, in impacting funded firm performance,

In recent years, there has been increased interest in entrepreneurial exit (see DeTienne, 2010; Wennberg and DeTienne, 2014; Leroy *et al*., 2015), defined as "*the process by which the founders of privately held companies leave the firms that they helped to create*" (DeTienne and Cardon, 2012, page 353). Although these studies provide interesting insight into the factors that drive entrepreneurial exit, a noticeable limitation is the conceptualisation of the exit

[119] It is well accepted that equity financing is far from being a homogeneous category (see Wright and Robbie, 1998; Bottazzi *et al*., 2008; Block *et al*., 2018). The reader is referred to Chapter 2 (Section 2.4).

decision as revolving around the entrepreneur (Mason and Botelho, 2016). Equity financiers, however, may play an important role in influencing entrepreneurial exit. Contracts between entrepreneurs and their equity investors are commonly established in a way that control rights over exit decisions are allocated to equity investors (see Black and Gilson, 1998; Schwienbacher, 2008). Consequently, for equity financed firms, it is not '*if*' but rather '*when*' an exit will occur (Mason and Botelho, 2016). It follows then that the investor effect should be included in the emerging entrepreneurial exits research agenda (see DeTienne and Wennberg, 2013; Mason and Botelho, 2016). As such, an entrepreneur-centric view of exit is inappropriate and it is important to consider the role of these financiers in influencing exit. No study, to our knowledge, considers the impact of equity on entrepreneurial exit from the entrepreneurial perspective. As such, another key contribution of this Chapter is the novel empirical examination of the factors that affect entrepreneurial exit intentions, distinguishing among different exit routes and taking into account the presence of equity investors. Once again, heterogeneity within the equity market is also considered in analysis. Evidence of this kind does not currently exist.

Going forward, this Chapter is structured as follows: Section 7.2 considers the related literature and derives hypotheses, while Section 7.3 elaborates on the data, methods and key variables used to test these hypotheses. Thereafter, Section 7.4 presents our results on the impact of equity financing on performance (i.e. innovative output, growth and survival) and entrepreneurial exit intentions. Finally, Section 7.5 discusses the conclusions and policy implications from analysis.

7.2 Related Literature

Researchers and practitioners generally contend that equity finance is an important resource which, aside from the capital infusion, brings non-financial benefits that increase the performance of funded firms (Rosenbusch *et al*., 2013) and, subsequently, improve chances of achieving a successful exit (Cumming *et al*., 2017). We explore this aspect of equity financing, surveying the theoretical (Subsection 7.2.1) and empirical (Subsection 7.2.2) literature pertaining to the potential impact of equity investors on funded firm performance and entrepreneurial exit intentions.

7.2.1 Theoretical Perspective

Two theoretical approaches underpin the empirical analysis – agency theory (Jensen and Meckling, 1976) and the resource-based view of the firm (see Penrose, 1959; Peteraf, 1993; Barney, 2001). Both are briefly considered herein (the reader is referred to Chapter 2, Subsections 2.2.2 and 2.4.2 for an in-depth discussion).

Agency theory is frequently used as a theoretical basis for exploring equity investors' impact on and involvement in portfolio firms. In short, equity investors are assumed to be particularly adept at dealing with agency issues that arise pre- and post-investment which, in turn, leads to enhanced performance and positively impacts on exit outcome (see Amit *et al*., 1990; Baum and Silverman, 2004; Cumming and Johan, 2008a). Pre-investment, investors carefully evaluate and screen potential investees (Wright *et al*., 2006) and are typically highly selective in the types of firms in which they will invest (Mason and Pierrakis, 2013). As such, they are particularly adept at identifying exceptionally promising ventures (Baum and Silverman, 2004) Post-investment, investors have a monitoring incentive to decrease the probability of moral hazard (Jensen and Meckling, 1976).[120] On the one hand, they are active partners (Gorman and Sahlman, 1989), who have the expertise to monitor and control actions (Gompers, 1995).[121] On the other, they make use of specific financial instruments and contractual clauses (for example, stage financing) that protect their investments from opportunistic behaviours on the part of the entrepreneur (Kaplan and Strömberg, 2001). This approach creates high-powered incentives for entrepreneurs to pursue growth (see Casamatta, 2003; Grilli and Murtinu, 2014b) and ensures that the firm is well-managed (see Jain and Kini, 1995; Hellmann and Puri, 2002). It is thus proposed that equity investors impact funded firm performance both by acting as a '*scout*', able to identify a venture's future potential, and as a '*coach*', able to help the venture to realise it (Baum and Silverman, 2004).

Within the agency framework it is also proposed that equity investors can play an important certification role (see Megginson and Weiss, 1991; Lerner, 1994). The certification hypothesis is derived from the reputation capital of investors, as well as the rigorous process by which they select and monitor portfolio firms (see Barry *et al*., 1990; Sahlman, 1990). Essentially, through their investment, equity investors certify the quality of the venture (see Gompers and Lerner, 1999; Hochberg *et al*., 2007), such that agency costs and information asymmetries are somewhat mitigated. This, in turn, is particularly key for the achievement of a successful exit outcome (see Cumming and Johan, 2008a; Cumming *et al*., 2017).

Agency theory, however, neglects to consider that equity investor involvement also allows the portfolio firm to increase its bundle of resources (see Hellmann and Puri, 2002; Sørensen, 2007). Within the resource-based view (Penrose, 1959), which highlights the importance of a firm's resources and the circumstances under which they can create sustained

[120] To mitigate the agency problem post-investment a principal can carefully monitor the agent's behaviour and reward behaviour on the basis of an observable measure, such as the performance of the company (Eisenhardt, 1989). The reader is referred to Chapter 2, Subsection 2.2.2 for in-depth discussion.
[121] Unlike other institutional shareholders or banks, equity investors often have close relationships with their portfolio firms and this provides them with the opportunity to monitor via different governance mechanisms such as representation on the boards of funded firms (Lerner, 1995).

competitive advantage (Barney, 1991), success depends on the characteristics of the firm's resource bundle.[122] The task of the entrepreneur is to develop, assemble and acquire the resources and capabilities necessary to achieve competitive advantage (Barney, 1991). In other words, the nature of the firm's endowments and the ability of the entrepreneur to mobilise and secure additional endowments are the key to competitive advantage, success and survival (Coleman *et al*., 2013). Given the considerable resource needs of firms, especially technology-based firms, it seems reasonable to consider equity investment as an attractive resource, not only providing capital but also offering non-financial benefits, such as expertise, competencies and know-how (see Bertoni *et al*., 2011; Rodríguez-Gulías *et al*., 2018). Effectively, both knowledge and funding gaps can be filled through changes in the firm's ownership structure (Colombo *et al*., 2014). The skills and processes of equity investors represent distinctive capabilities (see Prahalad and Hamel, 1990; King and Zeithalm, 2001), intentionally focused on coaching investee firms and influencing their growth and survival (Meglio *et al*., 2017). Thus, the resource-based view adds to the agency perspective by recognising that access to resources and capabilities is an important driver of firm success (Ireland *et al*., 2003).

A combination of both agency theory and the resource-based view provide the theoretical basis for our investigation, following research in this area (see Meuleman *et al*., 2009; Croce *et al*., 2013). We propose that equity investors play a key role in screening (see Amit *et al*., 1998; Baum and Silverman, 2004) and monitoring investees (see Lerner, 1995; Bernstein *et al*., 2016), as well as providing access to resources and competences (Colombo *et al*., 2014) and certifying the quality of the funded firm (Cumming and Johan, 2008b), such that equity financing is positively correlated with firm performance and exit expectations.

[122] This includes human resources, such as the founding team and the management (Shane and Stuart, 2002), technical resources, encompassing product and technology (Roberts, 1991), organisational resources (Wernerfelt, 1984) and financial resources (Hellmann and Puri, 2000).

Thus far we have contended that equity financing will enhance the performance and exit options of funded firms, without distinguishing between the sources of equity. However, equity investors are not a homogeneous group and treating them as such ignores the differences between investor types (Bruton *et al*., 2010) which, ultimately, can impact on their involvement in and impact on the type of resources endowed to the funded firms (Knockaert *et al*., 2006). Firstly, equity investors vary in the extent to which they possess human capital (Pierrakis and Saridakis, 2017). The general presumption is that venture capitalists possess better skills and resources in terms of managerial and industry-specific competencies and networks for supporting funded firms (see Vanacker *et al*., 2013; Grilli and Murtinu, 2014a, b). Government-sponsored fund managers, usually civil servants (Alperovych *et al*., 2015), are not likely to have either the experience or skills necessary to support and monitor entrepreneurial high-tech firms (Lerner, 2002) or offer the advice and networks that specialised private investors offer (Leleux and Surlemont, 2003). Although angels often tend to invest in industries in which they have gained entrepreneurial experience, the limited empirical research suggests they are less experienced than venture capitalists in managing investees (Van Osnabrugge, 2000). Secondly, sources differ in the governing techniques (for example, contractual covenants, board membership) employed to facilitate the establishment of formal structure and monitoring of activities (see Sahlman, 1990; Dutta and Folta, 2016). Angels generally take a relatively flexible approach, preferring to adopt an informal hands-on attitude (see Van Osnabrugge, 2000; Ibrahim, 2008), with weaker control rights and less contractual provisions (Goldfarb *et al*., 2007). By contrast as indicated above, venture capitalists write extensive contracts, putting together specific shareholder agreements and stipulating differentiated shareholder rights (Cumming, 2008) and making use of specific financial instruments and contractual clauses (for example, stage financing) that protect their investments from opportunistic behaviours on the part of the entrepreneur (see Kaplan and

Strömberg, 2001; Bienz and Hirsch, 2011) and create high-powered incentives for entrepreneurs to pursue growth (see Casamatta, 2003; Grilli and Murtinu, 2014b). Government-sponsored funds typically use less sophisticated governance mechanisms and have fewer voting rights than private investors (Hirsch and Walz, 2013). As such, they are usually less able to tightly monitor their portfolio firms (Secrieru and Vigneault, 2004). Third, investment motives differ (Hellmann, 1998), and this will have implications for the amount of time and effort investors devote to their portfolio firms (Luukkonen *et al*., 2013). Venture capitalists push the growth of funded firms to increase the likelihood of an IPO or to make them more attractive for trade sale (Chemmanur *et al.*, 2011), given that financial return maximisation and cost efficiency is an absolute priority (Cumming *et al*., 2007). Additionally, due to the structure of their performance-sensitive contracts and remuneration schemes (Jääskeläinen et al., 2007), they have stronger incentives to actively support portfolio firms. Government-sponsored fund managers face pressure to pursue non-financial related goals, such as employment maximisation (Cumming and MacIntosh, 2006). Compensation terms that are comparatively invariant across managers and funds, and invariant over time, exacerbate agency problems in fund managers' efforts to screen and monitor portfolio firms (Cumming *et al*., 2017). Consequently, governmental-sponsored investors may lack the incentive to put funded firms sufficiently under pressure to pursue growth (Bertoni and Tykvová, 2015). Angels conduct investments both for their return potential and for personal motives (Mason and Harrison, 2002a) and, as such, are likely to be more generally incentivised and take an active role regardless (Vanacker *et al*., 2013).

Overall, we posit that, although equity finance has a beneficial impact on funded firm performance and eventual exit, because venture capitalists, business angels and government-sponsored fund managers differ in terms of skills, governance structure and motivation, their impact on investees may also differ. We now consider existing empirical evidence with a view to informing and developing our hypotheses.

7.2.2 Empirical Evidence and Hypotheses Development

The available evidence suggests that, aside from providing capital, equity finance can enhance funded firm performance (see Baum and Silverman, 2004; Croce *et al*., 2013) and play an active role in directing exit decisions (see Collewaert, 2012; Mason and Botelho, 2016). Although organisational performance is a multi-dimensional construct (see Combs, 2005; Davidsson *et al*., 2009; Rosenbusch *et al*., 2013), the related literature offers a variety of measures, three of which were selected for this study, namely: innovative output, measured by patent count (see Hellmann and Puri, 2000; Chemmanur *et al.*, 2014; Dutta and Folta, 2016); growth, measured by employment and asset growth rates (see Belke *et al*., 2006; Balboa *et al*., 2011; Bertoni *et al*., 2013; Grilli and Murtinu, 2014b); and firm survival (see Manigart *et al.*, 2002; Audretsch and Lehman, 2004; Puri and Zarutskie, 2012). These will each be discussed in turn. The Subsection ends with consideration of the potential role equity investors play as an influential factor in the entrepreneurial exit process.

Equity Financing and Innovation

It is generally agreed that equity financing plays a central role in the emergence of new industries by funding and supporting innovative firms (Pierrakis and Saridakis, 2017). Indeed, Lerner and Watson (2008) argue that the venture capital model is more effective in commercialising scientific discoveries than the corporate sector, despite the latter's large expenditure on R&D activities. In short, equity financing can speed the development of firms by enabling them to transform ideas quickly into marketable products and become industry leaders through firm mover advantages (Zhang, 2007).

Several studies, although predominantly focused on venture capital, show a positive relationship between equity investment and innovative output, typically proxied by patenting activity (see Baum and Silverman, 2004; Zhang, 2009). Kortum and Lerner (2000) present a stylised model of R&D expenditure, venture capital and innovation. Testing various specifications of a patent production function with U.S. manufacturing industry-level data, the authors find that venture capital is associated with a substantial increase in patenting activity. They report that the average number of patents for a firm with venture capital is 12.74 but for a firm without is 2.40 (thus the average venture capital funded firm possesses 5.3 times the number of patents compared to the average non-venture capital financed firm). Ueda and Hirukawa (2011) support this finding for the U.S. while Popov and Roosenboom, (2012) find similar results for Europe. Bertoni *et al*. (2010), for Italian technology-based firms, find that being venture capital financed increases the likelihood of patenting by almost threefold and the expected number of patents almost fivefold. Engel and Keilbach (2007), for Germany, report that venture capital financed firms apply for ten times as many patents as matched non-venture capital financed firms. Caselli *et al*. (2009) use a similar matching procedure to assess patenting activity in Italian firms, with results showing a higher average number of patents in those with venture capital financing. We hypothesise firstly that:

Hypothesis 1: *The innovation output of equity-financed firms is higher than that of non-equity-financed firms.*

While we contend that the impact of equity on innovative output is positive, the sources of equity may contribute differently to that impact. Thus, our second hypothesis focuses on how equity investors potentially differ in their support of innovation activities. It is generally agreed that venture capitalists have better skills and resources compared to their governmental counterparts and angels in supporting firms' resource base building, enabling them to more easily move the firm towards those innovation outcomes that provide the highest potential financial payoff (see Leleux and Surlemont, 2003; Luukkonen *et al*., 2013; Dutta and Folta, 2016). While the empirical evidence is limited, it does point towards differences in impact on innovation. In the only study to compare the impact of angels and venture capitalists on innovation within funded firms, Dutta and Folta (2016) find no difference in innovation rates (patent count) but report that venture capital has a greater effect on the impact of innovation (patent citations). Bertoni and Tykvová (2015) compare the innovative output (patents) of biotech and pharmaceutical companies backed by governmental and private venture capital. Their results show that firms backed by private venture capitalists markedly outperform those backed by governmental funds. They further report that governmental venture capital has no impact on innovation as a stand-alone investor but, when syndicated with private investment, the impact becomes positive. Accordingly, our second hypothesis follows:

Hypothesis 2: *The impact of venture capital on innovation output is higher than that of government-sponsored equity or angel financing.*

Equity Financing and Growth

Evidence suggests that equity investment positively impacts on funded firm growth (see Peneder, 2010; Bertoni *et al*., 2011; Pagila and Harjoto, 2014). Manigart and Van Hyfte (1999), based on a sample of Belgian firms, report that although those funded by venture capital do not achieve significantly higher employment growth than non-venture capital funded firms, they do achieve higher growth in total assets. Conversely, Davila *et al*. (2003), for the US, report a significant positive impact of venture capital on employment growth. Alemany and Marti (2005) find that both employment and total assets grow faster in Spanish venture capital financed firms relative to non-venture capital financed. Puri and Zarutskie (2012) likewise confirm a positive impact of venture capital financing on growth in employment. While venture capital and non-venture capital financed firms are matched at an average of 26 employees, after three years venture capital financed firms had an average of 55 employees while those without had 38 employees. Bertoni *et al*. (2013), for Italian technology-based firms, show that both independent and corporate venture capitalists have a positive and sizeable long-term treatment effect on the employment growth of portfolio firms. As such, we posit that:

> ***Hypothesis 3****: Employment growth of equity-financed firms is higher than that of non-equity-financed firms.*
>
> ***Hypothesis 4****: Asset growth of equity-financed firms is higher than that of non-equity-financed firms.*

We also expect impact on firm growth to vary according to source. The central goal of venture capitalists is to increase the market valuation of their funded firm (Barry, 1994). Consequently, a strategic trade-off exists between aiming for growth or profitability (Davidsson *et al*., 2009). Extant evidence suggests that venture capitalists are likely to emphasise the former, aiming to establish portfolio firms as market leaders in fast growth markets in order to command a premium when exiting (Roberts and Barley, 2004). Given the orientation towards growth and increasing market valuation, venture capitalists have an incentive to provide resources that enable strong growth (Rosenbusch *et al*., 2013) and should be more focused than angels or government-sponsored investors on accelerating growth (Luukkonen *et al*., 2013). Empirical evidence, although extremely limited, tends to concur. Grilli and Murtinu (2014a) find that those backed by private venture capitalists outperform those backed by governmental venture capital in terms of growth in sales, employees and total assets. Balboa *et al*. (2007) find a negligible effect of governmental venture capital on employment growth. Croce *et al*. (2018b) analyse the effect on employment growth of investments by Spanish government versus private venture capitalists before and during a period of economic crisis. They find that the investments of government investors have a higher impact on employment growth than those funded by private investors in a period of normal economic activity while the opposite is the case for firms funded before the onset of the crisis. The authors attribute these results to the higher value added and monitoring provided by private venture capitalists during the crisis and the fact that they are better able to properly screen, monitor and add value, even in adverse situations. To the best of the author's knowledge, no empirical evidence exists on the impact of angel funding on portfolio firm asset or employment growth. It follows from our theoretical rationale (Subsection 7.2.1) that angels, unconstrained by the time-oriented performance-based motives of formal investors and (typically) obtaining weaker control rights, lack the ability, and indeed impetus, to drive the growth of funded firms. Accordingly, we hypothesise that:

Hypothesis 5*: The impact of venture capital on employment growth is higher than that of government-sponsored equity or angel financing.*

Hypothesis 6*: The impact of venture capital on asset growth is higher than that of government-sponsored equity or angel financing.*

Equity Financing and Funded Firm Survival

A key function of equity financiers is to provide funding and expertise to innovative firms with high-growth potential who likely face capital market imperfections that restrict their access to traditional forms of finance (see Carpenter and Petersen, 2002a; Pommet, 2017). However, these innovative and high-growth potential firms are characterised by high failure rates (Storey and Tether, 1998) and, as such, an important role for equity investors is to contribute to reduce the failure rates of funded firms (Manigart *et al*., 2002). Since equity investors specialise in providing financing and helping entrepreneurs to develop required competencies, their presence should help to improve funded firm survival (Jain and Kini, 2000). Furthermore, equity investors make decisions based on specific investment criteria and, as such, are better placed to selected the most promising companies with the highest possibilities of success (see Baum and Silverman, 2004; Gompers and Lerner, 2004). Additionally, equity investors use various control mechanisms to manage business risk and reduce agency conflicts inherent in the financing of firms (see Sahlman, 1990; Gompers and Lerner, 2004). More generally, financial capital constraints are known to have a negative impact on survival (Bosma *et al*., 2004). Thus, if we assume that equity investors perform their roles well, select the most promising firms and enhance development not only by providing access to financial capital but also through their purported monitoring and value-adding activities (see Lerner, 1994; Brander *et al*., 2002; Baum and Silverman, 2004) then we could reasonably expect that:

Hypothesis 7: *Equity financed firms will have a higher probability of survival compared to non-equity-financed firms.*

When we take the different sources of equity into account, the available evidence points towards differences in impact on funded firm survival. Manigart *et al*. (2002), differentiating between bankrupt and surviving venture, find that the cumulative survival rate of venture capital financed firms is 56.15% whereas non-venture capital financed have a cumulative rate of 58.27%. However, the authors also report that portfolio firms backed by experienced government venture capitalists have higher survival rates compared to those backed by independent venture capital firms, explained by the fact that the former have mainly a regional economic development goal and hence prefer to keep the 'living deads' alive (Manigart *et al*., 2002). Puri and Zarutskie (2012) likewise report that venture capital financed firms, although initially more likely to survive (first five years), have higher shut-down rates relative to non-venture capital funded firms. These results suggest that venture capital support may not translate into a higher probability of survival. Pommet (2017), based on a sample of French companies that went public on the Nouveau Market, finds that among exiting venture capital back firms there is a higher probability of liquidation. Overall, this evidence suggests that venture capital backed firms, despite their better short-run growth opportunities, are on average riskier and, hence, their probabilities of survival will be lower and their failure rates higher than non-venture capital backed companies (Dimov and De Clercq, 2006). Evidence on angel investors is extremely limited. Kerr *et al*. (2014), based on data collected from two US-based angel groups (Tech Coast Angels and CommonAngels) during the 2000-2006 period find that angel financing is associated with improved likelihood of survival for four or more years. Lerner *et al*. (2018) report similar findings. Specifically, angel-financed firms are 14–23% more likely to survive for 1.5–3 years relative to non-angel-financed firms. In general, angels are more patient investors (Wilson, 1995). Formal venture capitalists tend to have shorter investment horizons because they need to raise capital for other projects or have to return capital to limited partners for liquidity or diversification reasons (Bayar and Chemmanur, 2011). Based on this we posit that:

Hypothesis 8: *Firms have a higher probability of survival with angel financing or government-sponsored funding in comparison to firms with venture capital.*

Equity Financing and Entrepreneurial Exit

"*Finally, remember one inviolate truth: Eventually, every owner leaves his business. The question is, will you leave feet first on a stretcher or will you sip champagne in celebration of your victory?*" (Minor, 2003, page xvii). Ultimately, one way or another, all entrepreneurs will exit the business they created (Engel, 1999) making entrepreneurial exit an important aspect of entrepreneurship (DeTienne *et al*., 2015). Entrepreneurial exit is defined as the process by which the founders of privately held firms leave the enterprise they helped create, thereby removing themselves, in varying degrees, from the primary ownership and decision-making structure of the firm (DeTienne, 2010). Entrepreneurs can exit in many ways, including family succession, trade or independent sale, management or employee buyout, selling their ownership stake via an IPO, bankruptcy or closure (Wennberg and DeTienne, 2014). Few scholarly articles to-date have investigated the factors that impact on the entrepreneur's choice of exit strategy from the entrepreneur's perspective (see Wennberg *et al*., 2010; DeTienne and Cardon, 2012; Leroy *et al*., 2015). This is problematic as entrepreneurs often have a choice of which exit strategy to pursue, and our understanding of that choice, or even the choice of whether to develop an exit plan, is very limited (DeTienne and Cardon, 2012).

The emphasis in this emerging stream of research, and in the analysis herein, is on the entrepreneur's intended exit path – their own plans to exit their business (DeTienne, 2010). Such enquiry draws on the theory of planned behaviour, which argues that, because most human behaviour is under the control of the actor, behaviour can be accurately predicted by understanding an individual's intentions to perform said behaviour (see Ajzen and Fishbein, 1980; Ajzen, 1991). This has been very influential as a theoretical justification for the examination of the factors that impact the intentions of the entrepreneur for his/her exit path (see Krueger *et al*., 2000; DeTienne and Cardon, 2012; Leroy *et al.*, 2015).

A noticeable gap in the literature is the impact of equity on entrepreneurial exit. Specifically, the conceptualisation of the exit decision and exit process as revolving around the entrepreneur is inappropriate for those businesses that have raised financing from equity investors, who require a harvest event to realise their financial return (Mason and Botelho, 2016). Indeed, the equity investor may force an exit event (Giot and Schwienbacher, 2007), with several studies documenting the widespread use of contractual arrangements that guarantee the equity investor explicit intervention rights regarding exit decisions (see Gompers, 1997; Cumming, 2008). Accordingly, as noted by DeTienne and Wennberg (2013), investor-led exits are a key issue for emerging entrepreneurial exit research. As such, the presence of equity investors adds another dimension to investigation of the entrepreneur's exit decision.

A number of entrepreneurs – perhaps the majority – initiate a business without much thought to an eventual outcome (King, 2002). In their survey of 364 CEOs of fast growing, privately held companies, PriceWaterhouseCoopers report that 65% of CEOs indicate they plan to leave their company within ten years, yet 43% have done little or no planning (Dahl, 2005). Unfortunately, we lack knowledge of the factors that distinguish those entrepreneurs that develop an exit plan from those that do not. According to DeTienne (2010), founders with a growth or profit motivation are more likely to develop an exit strategy than those who create a business as part of their lifestyle or as income-replacement. This argument is supported by empirical evidence which demonstrates that growth entrepreneurs use a more structured approach to organising their business, begin planning earlier for the growth of the firm (Gundry and Welsch, 2001), and spend more time in guided preparation (Chrisman and McMullan, 2004). However, when the founder's equity ownership is diluted, we might expect the influence of or pressure from other constituents to also impact on the development of an exit plan. Essentially, without the pressure from equity investors, entrepreneurs may have more of a tactical rather than strategic focus (DeTienne, 2010). Equity financiers require a harvest event to realise financial returns – venture capital funds need to return capital to their limited partners, while angels need liquidity to make further investments (Mason and Botelho, 2016). Consequently, for equity financed businesses it is not whether an exit event will take place but when it will occur and how long the equity investor will be involved in the firm before cashing out (Giot and Schwienbacher, 2007). As such, equity investors have an active role in the exit process (see Mason, 2006; Gill and Walz, 2016; Cumming *et al*., 2017). It follows that, as the entrepreneur's ownership in the firm becomes diluted, they may be in a position where the presence of equity financiers forces them to formalise a plan for their eventual exit. As such, we hypothesis that:

> ***Hypothesis 9****: Entrepreneurs within equity financed firms are more likely to devise a plan for their own exit.*

Equity investors, however, may differ in the extent to which they emphasise the development of an exit plan. Unfortunately, there is a lack of evidence on this issue. In general, the prospective exit is a key criterion in venture capitalists' investment appraisal (see MacMillan *et al*., 1985; Petty *et al*., 1999). Indeed, the available evidence suggests that an exit strategy is often already shaped prior to venture capitalists even closing the first round of financing (Cumming and Johan, 2008b).[123] With angels, on the other hand, the specific exit is oftentimes unplanned, with agreements typically less formal and standardised than with formal investors (DeClercq *et al*., 2006). In general, angels are rather patient investors (Mason et al., 2019), without a clear preference as to when they want to exit or even not wanting to exit at all (see Landström, 1993; Collewaert, 2012). Government-sponsored funds, which use or leverage public money for their operations, often have an unlimited lifetime and thus fund managers are unlikely to develop a clear exit strategy for portfolio firms (Alperovych *et al*., 2015). Based on these considerations, we propose that:

> ***Hypothesis 10****: Entrepreneurs with venture capital are more likely to devise a plan for their own exit than those with angel or government-sponsored equity.*

As to the entrepreneur's choice of mode of exit, a key issue is that, for equity financed firms, both the entrepreneur and equity investor will be involved in the eventual exit decision. Indeed, the investor may take the lead in developing an exit strategy, managing the exit process and determining its timing (Mason and Botelho, 2016). It is generally agreed that the two fundamental exit routes for successful equity financed firms are public offerings (IPO) and acquisitions (see Sahlman, 1990; Gompers and Lerner, 1999; Cumming *et al*., 2017). Generally, because exit via secondary sale, buyback and write-off (or liquidation) generates much lower returns upon exit, these options are typically considered unsuccessful exits

[123] Not only do venture capitalists attempt to time their exit using staged financing (Gompers, 1995) which provides exit options at all financing rounds, but several studies document the use of contractual arrangements that guarantee the venture capitalist explicit intervention rights regarding exit issues (see Gompers, 1997; Cumming, 2008).

(Cumming and MacIntosh, 2003a). As such, we hypothesis that equity financiers will push the firm (and entrepreneur) towards exit by IPO or acquisition. Thus:

> ***Hypothesis 11****: Entrepreneurs within equity financed firms are more likely to pursue IPO or acquisition as their entrepreneurial exit strategy.*

We further conjecture that the entrepreneur's choice of exit strategy may be related to the source of equity obtained. While their exists, to our knowledge, no empirical evidence in this area, supply-side studies provide insight into the role equity investors may play in directing entrepreneurs towards an exit route. Typically, venture capitalists preplan their exit outcomes only as IPOs or, when not achievable, acquisition (Cumming and Johan, 2008a). Consistent with this, Poulsen and Stegemoller (2008) report that venture capital financed firms are more likely to go public than be acquired. In their model of exit choices, Bayar and Chemmanur (2011) show that venture capital financed firms are more likely to choose to go public rather than to be acquired relative to those that are non-venture capital financed. The limited evidence available suggests that trade sales, along with sale to existing shareholders, are the most common exit routes for angels (see Mason and Harrison, 2002a). For government-managed funds, Cumming and Johan (2008a) find that, compared to independent venture capitalists, these investors are 2.1% less likely to achieve an IPO, 22.9% less likely to achieve an acquisition, 7.1% more likely to exit via secondary sale, and 14.6% more likely to exit through buyback. As such, we hypothesise that:

> ***Hypothesis 12****: Entrepreneurs with venture capital are more likely to pursue exit via IPO, whereas those with angel or government-sponsored investors are more likely to pursue an acquisition as their exit strategy.*

7.2.3 Conclusions

Among the sources of entrepreneurial finance, equity can provide not only capital but also enhance the performance of the firm (see Lerner, 1995; Lahr and Mina, 2016) and impact on any exit decisions made by the entrepreneur (see Bayar and Chemmanur, 2011; Mason and Botelho, 2016). With this in mind, the over-reaching objective of this section was to build a theoretical and empirical foundation for our investigation into the impact of equity financing.

We began with a discussion of the theory from which our hypotheses are drawn. Agency theory (Jensen and Meckling, 1976) and the resource-based view (Penrose, 1959) provide the basis for analysis. Following this, attention turned to the existing empirical evidence. In short, we proposed that equity financiers, through their careful screening and subsequent active involvement with investees, generally exert a positive effect on innovation, growth and survival within funded firms (see Baum and Silverman, 2004; Engel and Kielbach, 2007) while also impacting on eventual exit options (see Cumming and Johan, 2008a, b; Mason and Botelho, 2016). However, taking heterogeneity among the sources of equity into consideration, it is possible that equity investors differ in the extent to which they nurture their portfolio firms (Dutta and Folta, 2016). In short, the knowledge embedded in the human capital of the investor, incentive compensation arrangements that give incentives to maximise the value of the fund's investments and contractual covenants that minimise agency costs lead to differences in impact and involvement across the sources of equity. We now turn to our empirical investigation.

7.3 Data and Methods

This Section sets out and explains the: (1) data employed in econometric analysis (Subsection 7.3.1); (2) methods used in examining the impact of equity finance on firm performance (innovative output, growth and survival) and entrepreneurial exit (Subsection 7.3.2); and (3) variables included in these econometric estimations (Subsection 7.3.3).

7.3.1 Data

In exploring the impact of equity financing, and the sources of equity (angel, venture capital, and government-sponsored equity), on funded firm performance and entrepreneurial exit intentions, two datasets are employed. The first dataset is used to assess the contribution of equity and is based on data gathered from 294 technology-based firms. This is the dataset employed in the empirical analysis in Chapter 5. The second dataset is used to examine whether this contribution differs across the sources of equity and is based on data gathered from 153 equity financed technology-based firms. This is the dataset employed in the empirical analysis in Chapter 6. These two datasets are described briefly below, with the reader referred to Chapter 4 for a more detailed description.

The main dataset contains information for 294 technology-based firms and is used in models evaluating the impact of being equity financed (as opposed to being non-equity financed) on firm performance and entrepreneurial exit intentions. This dataset is comprised of a total of 153 (52%) equity-financed firms, with the remaining 141 (48%) being non-equity financed. Firms were, on average, 8 (mean of 7.7 and standard deviation of 5.6) years in operation with approximately 25 (mean of 25.3 and standard deviation of 55.7) employees. Of these firms, 247 (84%) are classified as knowledge-intensive service firms. For empirical estimations testing impact on innovative output, data regarding patents granted collected through the survey instruments (see Chapter 3, Subsection 3.2.2) was verified, where possible[124], through searches of databases provided by the Irish, European and U.S. patent offices. For the most part, the figures in the survey were accurate. In some cases, respondents (all non-equity financed) did not distinguish between patents granted within and outside of Europe, instead giving one overall figure. This was rectified through searches of the patent office databases. For the survival analysis in Subsection 7.4.1 this dataset is reduced somewhat, with 61 anonymous respondents excluded as they were not traceable. These respondents were all non-equity financed firms. There was complete data for 233 firms, comprising of 153 (65.7%) equity and 80 (34.3%) non-equity financed firms.[125] In line with the literature (see Bridges and Guariglia, 2008; Delmar *et al*., 2013), a firm is defined as dead if its status, as of December 2018, is liquidated, in receivership or dissolved.[126] As the analysis focuses on the survival of firms, those that were acquired or merged were treated as survivors, following Manigart *et al*. (2002), Wagner and Cockburn (2010), and Delmar *et al*. (2013). The survival status of firms was assessed using the FAME database and confirmed through the Company Registration Office (CRO) and searches of public sources. Firms are traced from December 2011 to December 2018. Summary data is provided in Table 7.1.

Table 7.1. Summary Statistics – Firm Survival

	Equity Financed	Non-Equity Financed	Total
Status:			
Liquidated	32 (20.9%)	19 (23.8%)	51 (21.9%)
Acquired	33 (21.6%)	3 (3.7%)	36 (15.4%)
Survivor	88 (57.5%)	58 (72.5%)	146 (62.7%)
Total	153 (100%)	80 (100%)	233 (100%)

Source: Author's Own

[124] Given that 61 non-equity financed respondents chose to remain anonymous, it was not possible to verify patent numbers and thus figures were taken directly from the survey. Of these 61 respondents, 4 (6.5%) held a patent.
[125] A feature of data collection for this study was that non-equity financed respondents could remain anonymous. In total, 61 respondents chose not to disclose their identity and therefore could not be identified to confirm their status as of December 2018. These cases were dropped from the database for survival analysis.
[126] As outlined in Commission Regulation No 2700/98, enterprise deaths are classified as the dissolution of a combination of factors of production and the removal of the enterprise from the business register, with the restriction that no other enterprises are involved in the event (European Commission, 17th December 1998).

The second dataset contains information solely on equity financed firms and is used in examining the impact of each source of equity of firm performance and entrepreneurial exit intentions. The firms in this dataset are, on average, 7 (mean of 6.8 and standard deviation of 4.7) years old and have approximately 30 (mean of 29.6 and standard deviation of 67.6) employees. In total, 130 (85%) are knowledge-intensive service firms. A total of 117 (76.5%) firms had angel financing, 104 (68%) firms had venture capital and 121 (79.1%) firms had government-sponsored equity funding. Of these, 59 (38.6%) had obtained funding from all three sources. A total of 17 (11.1%) had both angel and venture capital financing. With government-sponsored funding, 24 (15.7%) also received venture capital while 30 (19.6%) also had angel finance. Because the data was collected through face-to-face interviews, every respondent was identifiable in this dataset. As such, survival analysis is also conducted based on the 153 equity financed firms.

Finally, as in Chapter 6, empirical analysis based solely on equity financed firms takes account, in the spirit of Heckman (1979), of the non-randomness of being equity financed. As such, a two-step Heckman selection model (Heckman, 1979) is used to address bias that may arise due to unobservable factors that affect both the probability of a firm self-selecting its treatment (i.e. choice to seek equity finance) and the treatment outcome (i.e. being equity financed). In the first step, a correction term (Inverse Mills' Ratio (IMR)) is estimated through a choice model (Chapter 5). In the second step, the IMR is added as a regressor in estimations based solely on equity financed firms.

7.3.2 Methods

In order to test the hypotheses developed in Section 7.2, we employ four statistical methods. Ordinary Least Squares estimation is used in testing the impact of being equity financed on innovation output and growth (assets and employment). The survival analysis employs a complementary log-log estimation. A probit estimation is used to examine the factors that determine whether the entrepreneur has an exit plan in place. Finally, a multinomial probit model is used to examine the factors that determine the entrepreneur's choice of expected exit path. The purpose of this Subsection is to outline these methods.

Innovation and Growth

To test the impact of equity financing on firm performance, we consider the following equation:

$$\begin{aligned} \mathit{Performance}_{\mathrm{i}} = \beta_0 + \beta_1\text{EquityFinanced} + \beta_{2\mathrm{i}}\text{FirmSpecific}_{\mathrm{i}} + \beta_{3\mathrm{i}}\text{MarketProduct}_{\mathrm{i}} \\ + \beta_{4\mathrm{i}}\text{Innovation}_{\mathrm{i}} + \beta_{5\mathrm{i}}\text{HumanCapital}_{\mathrm{i}} + \varepsilon_{\mathrm{i}} \end{aligned} \tag{7.1}$$

where the dependent variable $\mathit{Performance}_{\mathrm{i}}$ represents alternative measures of firm performance (i.e. count of patents[127], employment growth and asset growth); β_0 is the intercept coefficient; *EquityFinanced* is a binary variable indicating whether the firm is equity financed; $\mathit{FirmSpecific}_i$ captures firm attributes (size, age, sector); $\mathit{MarketProduct}_i$ captures attributes of the market/product (rivalry, exports, product differentiation); $\mathit{Innovation}_i$ represents innovation-specific aspects (frequency of innovation, R&D, patents); $\mathit{HumanCapital}_i$ controls for human capital attributes (education and experience); the $\beta_{j\mathrm{i}}$ are the associated coefficients; and ε_{i} is the error term.

Second, we test the impact of sources of equity on firm performance. For this purpose, we expand Equation (7.1) replacing $\mathit{EquityFinanced}_i$ with three dummy variables as follows:

$$\begin{aligned} \mathit{Performance}_{\mathrm{i}} = \alpha_0 + \alpha_1\text{Angel} + \alpha_2\text{VC} + \alpha_3\text{GovSpon} + \alpha_{4\mathrm{i}}\text{FirmSpecific}_{\mathrm{i}} + \\ \alpha_{5\mathrm{i}}\text{MarketProduct}_{\mathrm{i}} + \alpha_{6\mathrm{i}}\text{Innovation}_{\mathrm{i}} + \alpha_{7\mathrm{i}}\text{HumanCapital}_{\mathrm{i}} + \varepsilon_{\mathrm{i}} \end{aligned} \tag{7.2}$$

[127] For innovation activity, three OLS models are estimated. In the first, the dependent variable is a count of total patents (i.e. granted within Ireland, Europe and the U.S.). In the second and third, the dependent variable is a count of patents granted in Europe and the U.S. respectively. The definition of these variables is outlined next in Subsection 7.3.3.

where *Angel*, *VC*, and *GovSpon* are binary indicators of the sources of equity obtained (angel, venture capital or government-sponsored equity); $FirmSpecifc_i$ captures firm attributes (size, age, sector); $MarketProduct_i$ captures attributes of the market/product (rivalry, exports, product differentiation); $Innovation_i$ represents innovation-specific aspects (frequency of innovation, R&D, patents); $HumanCapital_i$ controls for human capital attributes (education and experience); the α_{ji} are the associated coefficients; and ε_i is the error term.

Firm Survival

To evaluate the impact of equity and the sources of equity on firm survival a complementary log-log (cloglog) model, a discrete time version of the Cox proportional hazard model, is utilised. This method is appropriate in the presence of right censoring, where we only know that the firm has survived up to a given point (Esteve-Perez *et al.*, 2008). Here, the firm's spell length is observed from the birth year to the end of the *j*th year, at which time the firm's spell is either complete (firm exits) or right censored (does not). This yields right-censored durations since a proportion of the firms are still in operation at the end of the observation period (31st December 2018) and, as such, a failure event has not yet occurred (Jenkins, 2005).

If T_i is the discrete survival time variable of the *i*th firm with explanatory variables X_i, the discrete-time hazard rate λ_{it} is defined as:

$$\lambda_{it} = \Pr(T_{i=t} \mid T_i \geq t, X_i) \qquad t = 1, 2\ldots \tag{7.3}$$

where the associated probability of exit in the *j*th interval can be expressed as:

$$\lambda_{ij} = 1 - \exp\left[-\exp(\beta' X + \alpha_j)\right] \tag{7.4}$$

where α_j is the baseline hazard rate for the *j*th interval; X is a vector of explanatory factors that are thought to affect survival (once again capturing firm-specific, market and product;

innovation activity; and human capital factors); and β denotes the vector of parameters to be estimated. The complementary log-log transformation, or cloglog, of this function is:

$$\log(-\log(1 - \lambda_{ij})) = \beta' X_i + \alpha_j \tag{7.5}$$

where the coefficient vector β' is identical to that of the continuous-time proportional hazard model, and α_j is a constant related to the conditional survival probability in the interval defined by T_i = j at X_i = 0. The parameter α_j depends on j but not on X and informs about the duration dependence in the interval hazard, assumed to be common to all firms (Basile *et al.*, 2017). As with the OLS models discussed above, the cloglog estimated for all firms includes the independent variable *EquityFinanced* to capture whether the firm is equity financed. For equity financed firms, it includes the three independent variables that capture the source(s) of equity financing obtained (i.e. the variables *Angel, VC, GovSpon*).

Entrepreneurial Exit Intentions

Turning to exit, we estimate two models. We begin with a brief consideration of the factors impacting on the existence of an exit plan using a probit model, as follows:

$$Y_i = X_i\beta + u_i \tag{7.6}$$

where the dependent variable Y_i takes a value of '*1*' if entrepreneur *i* has an exit plan in place and '*0*' otherwise; the matrix X_i contains observations on those factors thought to affect the formulation of an exit plan (i.e. equity financing/sources of equity, firm-specific, market and product, innovation activity, and human capital); the vector β includes the estimated parameter coefficients; and u ~ N (0, 1). Each regression is estimated using maximum likelihood with robust standard errors. Marginal effects[128] and elasticities[129] at the means are also calculated.

[128] Marginal effects represent a change in the probability of having an exit plan if a metric variable increases by 100 per cent or the value of an indicator variable changes from zero to one (Engel, 2004). For the normal distribution marginal effects are calculated as $\frac{\partial E[y|x]}{\partial x} = \phi(x'\beta)\beta$ (Greene, 2008).

[129] Calculate elasticities at the point of means for Y_i with respect to X_i in the form $\frac{\partial y}{\partial x} = \frac{\partial \log y}{\partial \log x}$

In exploring entrepreneurial exit intentions, our primary focus is on the determinants of the choice of expected exit route. Because respondents were not forced to choose one possible exit route, the dependent variables can take on more than two outcomes which do not have a natural ordering. Thus, a multinomial probit (Louviere *et al*., 2000) is used to examine how the presence of equity investors, along with a range of firm- and entrepreneur-specific factors, impact on the entrepreneur's expected exit path. Modelling exit as a failure in dichotomous models is conceptually tenuous, given the multitude of exit routes available to entrepreneurs (Wennberg *et al*., 2010) and thus the analysis considers alternative entrepreneurial exit routes available. Using a multinomial probit estimation intended exit route choice is represented as a decision among unordered alternatives and it is assumed that an exit choice is selected when it yields the highest utility for the entrepreneur (Ryan and Power, 2012). Each entrepreneur's indirect utility from choosing a specific exit is a function of the attributes of the firm and individual, along with a stochastic error term. The indirect utility of each exit route is not observable, but the entrepreneur's intended choice is. A typical representation of the structural form of the model is:

$$U_{ij} = \beta' X_{ij} + \varepsilon_{ij} \tag{7.7}$$

where U_{ij} represents the utility of entrepreneur *i* from choosing exit route *j*; *i* ranges from 1 to 294 depending on the entrepreneur under consideration; *j* takes the value of '*1*' for exit through an IPO, '*2*' sale and '*3*' cessation[130]; X_{ij} is the vector of variables capturing whether the firm is equity financed or the sources of equity along with the firm-specific, market and product, innovation activity, and human capital; and ε_{ij} is the stochastic error term.

If the entrepreneur wishes to maximise his/her utility, the probability that he/she chooses IPO (I) over the other potential exit routes, namely sale (S) or firm closure (C) is:

$$P_{iI} = U_{iI} > U_{iS} \text{ and } U_{iI} > U_{iC} \tag{7.8}$$

[130] No respondent selected 'Family transfer' as their expected exit route and hence this is excluded from analysis.

In other words, the probability that entrepreneur *i* chooses to exit through IPO assumes that the expected utility from selling his/her ownership stake through a public offering is greater than both the expected utility from selling or closing the firm. This expression can be rewritten to represent the case when firm sale is the preferred option:

$$P_{iS} = U_{iS} > U_{iI} \text{ and } U_{iS} > U_{iC} \tag{7.9}$$

Or, alternatively, firm closure:

$$P_{iC} = U_{iC} > U_{iI} \text{ and } U_{iC} > U_{Is} \tag{7.10}$$

Due to identification restrictions, the multinomial probit model does not yield the probability of a specific alternative. It does, however, give the probability of choosing one specific alternative (for example, IPO) relative to another (for example, sale). Similar estimation methods were adopted by Stam *et al*. (2010), Wennberg *et al*. (2010) and Ryan and Power (2012). The key premise that intentions are the best single predictor of planned behaviour (Bagozzi *et al*., 1989) enables a discussion of the influences on exit intentions.

7.3.3 Variables

This Subsection presents the variables used in econometric estimations, including summary statistics (Table 7.2) and a brief account of how these variables are defined. We begin with the dependent variables (i.e. measures of firm performance and entrepreneurial exit) and then move to the explanatory variables, grouped under identical headings as in previous empirical chapters (see Subsections 5.3.3 and 6.3.3) for continuity.

Innovation

Innovative output is captured through patent counts, a measure commonly used in the literature (see Kortum and Lerner, 2000; Engel and Keilbach, 2007). In total, 89 (30.3%) firms hold patents. As mentioned previously in Subsection 7.3.2, three OLS regressions are estimated, investigating impact on total patents granted to the firm, total patents granted within Europe and total patents granted in the U.S. As such, *TotalPatents* is a count of all patents granted to the firm since foundation, both within Europe (through the Irish Patent Office and European Patent Office) and United States (through the US Patent and Trademark Office). Following Lahr and Mina (2016), we consider firms' global patent portfolios and count all patents granted by different authorities for similar or over-lapping know-how as multiple patenting events. Additionally, the dependent variables *EuropeanPatents* and *USPatents* capture patents granted through the European and U.S. patent offices. In the survey instrumentation, those respondents that held patents were asked to specify how many were granted under the following headings: (1) Ireland; (2) Europe; and (3) internationally.[131] The reader is referred to Chapter 3 (Subsection 3.2.2) for details of the question design and Chapter 4 (Subsection 4.6.7) for descriptive statistics. These answers were used to compute the dependent variable (*TotalPatents*). Just over a quarter (29.2%) have one patent and the maximum, held by one equity financed firm, is 98 (48 within Europe and 40 in the U.S.).

In total, three OLS models are estimated with dependent variables alternating between total patent count, European patents and U.S. patents. These OLS models are estimated for the full sample of 294 firms and also for the 153 equity-financed firms in exploring the impact of equity financing and the sources of equity on patenting. In the latter Heckman's two step procedure is employed to correct for sample selection bias as explained above.

Growth

We focus on two measures of firm growth. First, *EmpGrowth* is an indicator of employment growth in the period in which the firm is observed (start-up to 2012). For a similar

[131] Respondents were also asked to specify the country in which these patents were granted. All were obtained through the U.S. Patent and Trademark Office and, therefore, are referred to as U.S. Patents herein.

approach see, for instance, Colombo and Grilli (2005b) and Balboa *et al*. (2011). Second, *AssetGrowth* captures growth in total assets in the same period. Respondents were not required to provide growth rates in the survey. Instead, growth rates were computed using figures provided for total assets and number of employees at two points in time – the end of the first year of operation and the end of the last financial year. These were then used to compute total asset and employment growth rates in constant 2012 prices. To circumvent the problems of bias towards small companies raised by the use of relative ratios to measure firm growth as a change in the number of employees or total assets, we compute these growth rates as a mean of annual rates measured using a logarithmic difference[132] to prevent a bias in favour of smaller companies as in Coad (2009) and Levratto *et al*. (2017).[133] The mean employment growth rate is 4.07% with a standard deviation of 8.03%.

Survival

The fourth and final performance measure is firm survival. In the estimated c-log-log models, the dependent variable indicates whether the firm has closed or entered liquidation by 31st December 2018. The dependent variable is binary, with firm deaths coded as '*1*' and '*0*' otherwise. Of the 233 firms in the reduced sample for survival analysis, 51 (22%) had exited. The reader is referred to Table 7.1 for further detail.

Entrepreneurial Exit

Turning to the analysis of exit strategies, the first dependent variable is a binary indicator of whether the entrepreneur has an exit plan in place, set equal to '*1*' if they do and

[132] We calculate growth rates as: $EmpGrowth_i = \frac{\sum_1^P[\ln(Emp_{i,t})-\ln(EmpS_{i,t-1})]}{P}$; $AssetGrowth_i = \frac{\sum_1^P[\ln(Assets_{i,t})-\ln(AssetsS_{i,t-1})]}{P}$ where *Emp* represents the number of employees at survey and *EmpS* represents the number of employees at seed; *Assets* represents the value of total assets at survey and *AssetsS* represents the value of total assets at seed; the index *t-1* denotes a lagged variable and *P* is the number of years covered (i.e. firm age).

[133] Small initial size means that large relative growth is easier to achieve with quite small absolute growth, whereas large initial size demands large absolute growth to achieve high relative growth (Levratto *et al*., 2017).

‘*0*’ otherwise. Of the 294 entrepreneurs, 142 (48.3%) stated that they have a plan for their exit. In terms of exit routes, categories were collapsed into three to reduce the number of degrees of freedom used in analysis and because numbers in management buyout, discontinuance and liquidation categories are quite small.[134] The dependent variable is thus a categorical indicator of the entrepreneur’s intended exit, where the routes are defined as follows: 1 = IPO; 2 = Sale (trade sale and management buyout); and 3 = voluntary cessation (liquidation and discontinuance). Almost two-thirds (65%) expect to eventually exit through a trade sale.

Independent Variables

We now move to a brief description of the independent variables required for our econometric estimations. As these have been used and described previously (see Subsections 5.3.3 and 6.3.3), we provide only a brief overview here. Our main independent variable relates to equity financing, capturing either the presence of external equity or sources obtained. We first distinguish equity from non-equity financed firms. Specifically, *EquityFinanced* captures equity investment[135] and takes a value of ‘*1*’ if the firm is equity financed (‘*0*’ otherwise). The database is comprised of 153 (52%) equity and 141 (48%) non-equity financed firms – this reduces to 80 non-equity financed firms for survival analysis. In testing the impact according to source, we replace *EquityFinanced* with three dummy variables (*Angel, VC*, *GovSpon*) which take a value of ‘*1*’ if the firm obtained that source, and ‘*0*’ otherwise. Of the 153 equity-financed firms in the dataset, 117 (76.5%) obtained angel financing, 104 (68%) obtained venture capital and 121 (79.1%) got government-sponsored equity funding.

[134] A mere 10 (3.4%) respondents indicated that they expect to exit through management buyout. These firms are all non-equity financed and are collapsed into the ‘*Sale*’ category. Moreover, although 36 (12.2%) feel that they will exit once their firm ceases operations, 13 (4.4%) selected liquidation (all non-equity financed). Thus, discontinuance and liquidation are combined into one grouping, with a total of 49 (16.7%) firms, and categorised as ‘*Cessation*’, following DeTienne *et al*. (2015). No respondent selected ‘*Family Transfer*’ as a potential exit.

[135] For the purposes of analysis here, we again pool all equity financed firms regardless of source of equity finance obtained, as in Chapter 5.

In addition, we capture firm and entrepreneur attributes, categorised within four groups (firm-specific, market and product, human capital and innovation). Beginning with firm-specific, we control for: *Size* measured by the number of full-time equivalent employees; *Age* years trading to data collection; and sector using a dummy variable *ServiceFirm* which takes a value of '*1*' if the firm operates in a knowledge-intensive service sector and '*0*' otherwise.

The next group captures attributes of the firm's market and product. Competitive pressure is approximated by a count of rivals. Next, *Exports* measures the percentage of total revenue generated in foreign markets (i.e. export sales). The extent of product differentiation (*ProductDiff*) is a self-appraised measure, with respondents asked to indicate whether their product is very similar, similar, different or very different to that of their main rivals.

Regarding innovation activity, in the OLS estimations for patenting, we include measures of frequency of innovation and R&D. The former is computed as follows: in the survey instrument, respondents were asked to self-appraise their firm's frequency of product and process innovation within the following categories: continuously (coded 4), regularly (coded 3), rarely (coded 2) or never (coded 1). Frequency was then calibrated as the sum of product and process innovation. Thus, for *TotalInno*, an '*8*' indicates that the firm undertakes both product and process innovation on a continuous basis (i.e. 4 + 4), while '*2*' indicates that the respondent specified 'never' (i.e. 1 + 1) for both. Higher values of the variable represent a higher level of innovation (product and process). Next, R&D is proxied by the percentage of the firm's total revenues dedicated to expenditure on R&D (see Rosenbusch *et al*., 2011; Børing, 2015; Micucci and Rossi, 2017). In the OLS for growth (asset and employment), survival and entrepreneurial exit intentions, the dummy variable *Patent* is included to capture innovation activity. This takes a value of '*1*' if the firm possesses a patent and '*0*' otherwise. The variables for frequency of innovation and R&D are excluded as it is not possible to estimate the models successfully with these included, due to high correlation with the Mills ratio.

The next group captures human capital characteristics. Three control variables measure human capital at the individual (founder/CEO) and organisational (workforce) level. The first, *FoundEdu*, is a rank of founder-CEOs education level, where: 1 = up to Degree (Level 8); 2 = Masters (Level 9); and 3 = Ph.D. (Level 10). Second, *FoundIndExp* measures the number of years of industry-specific experience of the founder-CEO. A person is deemed to have industry-specific experience if they have previously worked in the industrial sector of the firm, irrespective of their function (Carpentier and Suret, 2015). The final human capital variable, *WorkforceQual*, captures human capital contained within the workforce, measured as the percentage of employees who possess a third-level degree or equivalent.

Finally, to close this discussion, let us briefly consider the correlation matrix for explanatory variables, presented in Tables 7.5 to 7.7. In general, correlations among the variables are mostly low to moderate (i.e. below 0.5), suggesting limited potential for distortions. Obviously, all patent measures (total, European, U.S.) are highly correlated but, as these are dependent variables and not included together in the same regression, this is not an issue for analysis. For the full sample (Table 7.3), the highest correlation is seen between the patent dummy and total patent count (0.3885 with p-value<0.01) but, as these are not included in the same regression, this correlation is not an issue for analysis here. We see the second highest correlation between exporting and equity finance (0.3740 with p-value<o.o1). Again, this is not considered an issue for analysis. For the dataset used in survival analysis (Table 7.4), the highest correlations are seen between R&D expenditure and equity financing (0.5083 with p-value 0.01), followed by the correlation between exporting and equity financing (0.4155 with p-value 0.05). In the equity financed dataset (Table 7.5), the highest correlation is between market rivalry and product differentiation (0.5100). Attention was taken to ensure that this did not distort the regression or impact on later results.

Table 7.2. Description of Variables

	Definition	All Firms (N = 294)	Equity Financed (N = 153)	Non-Equity Financed (N = 141)
		Number (%) [a] / Mean (Std. Dev.) [b]		
Patents	Count of patents granted to the firm	2.45 (9.60)	4.18 (12.99)	0.57 (1.61)
EUPatents	Count of patents granted to the firm within Europe	1.53 (6.14)	2.56 (8.33)	0.42 (1.04)
USPatents	Count of patents granted to the firm in the U.S.	0.92 (4.42)	1.63 (6.02)	0.16 (0.69)
EmpGrowth	Absolute employment growth rate from foundation to 2012	4.07 (2.32)	4.11 (8.77)	4.03 (7.17)
AssetGrowth	Absolute asset growth rate from foundation to 2012	76.97 (4.07)	116.56 (1213.76)	34.01 (104.55)
Exited	= '1' exited by 31st December 2018; = '0' otherwise	51 (21.9%)	32 (20.9%)	19 (23.8%)
ExitPlan	= '1' if exit plan in place; = '0' otherwise	155 (52.7%)	69 (45.1%)	86 (61.1%)
ExitRoute	= '1' (IPO); = '2' (Sale); ='3' (Cessation)	1.98 (5.93)	1.76 (0.53)	2.23 (0.56)
EquityFinanced	= '1' if equity financed; = '0' otherwise	153 (52%)	-	-
Angel	= '1' if angel financed; = '0' otherwise	-	117 (76.5%)	-
VC	= '1' if venture capital financed; = '0' otherwise	-	104 (68%)	-
GovSpon	= '1' if government-sponsored equity financed; = '0' otherwise	-	121 (79.1%)	-
Size	Number of full-time equivalent employees to end 2011	25.3 (55.7)	29.7 (65.8)	21.5 (41.9)
Age	Elapsed years from foundation to end 2011	7.7 (5.6)	6.6 (3.7)	8.8 (6.9)
ServiceFirm	= '1' knowledge-intensive service firm (NACE 58-63, 66, 69-75, 78, 79, 82); = '0' otherwise	247 (84%)	130 (85%)	117 (83%)
Rivalry	Number of major rivals the firm faces in its main market	22.15 (116.19)	4.60 (5.17)	41.2 (165.9)
Exports	Export sales as a percentage of total sales for the last fiscal year	53.96 (39.68)	68.18 (35.52)	38.52 (38.27)
ProdDiff	= '1' (very similar); = '2' (similar); = '3' (different); = '4' (very different)	2.08 (0.79)	2.22 (0.75)	1.94 (0.81)
TotalInno	Sum of product and process innovation, where 2 is the lowest and 8 the highest	6.97 (1.34)	7.37 (0.97)	6.45 (1.55)
R&DExpend	Percentage of R&D expenditures in total revenues	36.62 (29.17)	48.38 (26.46)	23.85 (26.55)
Patent	= '1' if holds patent(s); = '0' otherwise	89 (30.3%)	62 (40.5%)	27 (19.1%)
FoundEdu	= '1' (up to Degree); = '2' (Masters); = '3' (Ph.D.)	1.53 (0.63)	1.68 (0.65)	1.36 (0.58)
FoundIndExp	Number of years' experience working in the firm's industrial sector	18.54 (7.60)	18.69 (7.02)	18.38 (8.21)
WorkQual	Percentage of employees who possess a third level or equivalent qualification	85.51 (20.76)	90.75 (13.47)	79.82 (25.34)

Note: [a] Number (percentage) reported for dummy variables; [b] Mean (standard deviation) reported for ordinal and scale variables

Table 7.3. Correlation Matrix – All Firms

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1)	Patents	1.0000										
(2)	EUPatents	0.9357*	1.0000									
(3)	USPatents	0.8720*	0.6433*	1.0000								
(4)	EmpGrowth	0.1125	0.1072	0.0955	1.0000							
(5)	AssetGrowth	0.0130	0.0339	-0.0188	0.1776*	1.0000						
(6)	ExitPlan	0.0838*	0.0727**	0.0810*	-0.0904	-0.0280	1.0000					
(7)	ExitRoute	-0.2566	-0.2377	-0.2272	-0.1905	-0.0820	0.0749*	1.0000				
(8)	EquityFinanced	0.1882*	0.1743*	0.1666*	0.1589	0.1690	0.0406*	-0.3958*	1.0000			
(9)	Size	0.2932*	0.2414	0.3014	0.1459*	-0.0367	0.0369	-0.1940	0.0633	1.0000		
(10)	Age	0.0226	0.0166	0.0260	-0.2725*	-0.2631	0.3003*	0.2297	-0.1977*	0.2453***	1.0000	
(11)	ServiceFirm	-0.1760*	-0.1819*	-0.1297*	0.0784	-0.0766*	0.0122	-0.0753	0.0271	-0.0466	-0.1187**	1.0000
(12)	Rivalry	-0.0357	-0.0346	-0.0294	-0.0386	0.0261*	-0.0031	0.2163	-0.1576*	-0.0512	0.0214	-0.0383
(13)	Exports	0.1666*	0.1628*	0.1356**	0.1422**	0.0853	-0.0615	-0.2911	0.3740***	0.1635***	-0.1129**	0.0066
(14)	ProdDiff	0.0553	0.0661	0.0281	0.0496	0.0373	0.0165	-0.1424*	0.1765*	-0.0268	-0.1164**	0.0685
(15)	TotalInno	0.1353**	0.1287**	0.1151**	0.1563	0.1420	-0.0379*	-0.3565	0.3132*	-0.0185	-0.3138*	0.1700**
(16)	R&DExpend	0.1676*	0.1830	0.1099	0.1095	0.0977	-0.1474	-0.2719	0.4208	-0.1073	-0.3851*	0.0695
(17)	Patent	0.3885*	0.3792*	0.3170*	0.1335	0.1580	0.0029	-0.3189*	0.2324*	0.1868*	-0.0227	-0.1166**
(18)	FoundEdu	-0.0051*	0.0015*	-0.0133	0.0882	0.1092***	0.0212	-0.1216**	0.2516*	-0.0111	0.0009	-0.0032
(19)	FoundIndExp	0.0629	0.0456	0.0732	0.0322**	-0.0805	0.1053	0.0907	0.0204	0.1894***	0.3055*	-0.0290
(20)	WorkQual	0.0501	0.0501	0.0391	0.0336	0.1075***	-0.0855***	-0.1422	0.2635*	-0.1228**	-0.2718*	0.1003***

		(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)		
(12)	Rivalry	1.0000										
(13)	Exports	-0.0468	1.0000									
(14)	ProdDiff	-0.2134*	0.0754	1.0000								
(15)	TotalInno	-0.0256	0.1947*	0.1498*	1.0000							
(16)	R&DExpend	-0.1432	0.3283*	0.1684*	0.4077*	1.0000						
(17)	Patent	-0.0888*	0.2999*	0.0349	0.1917*	0.2815	1.0000					
(18)	FoundEdu	0.0172**	0.1679*	0.1249**	0.0713	0.1787*	0.1767*	1.0000				
(19)	FoundIndExp	0.0109	0.0623	-0.0101	0.0133	-0.0995***	0.0616	-0.0989**	1.0000			
(20)	WorkQual	0.0187	0.2054*	0.0929	0.1744*	0.2689*	0.1606*	0.2186*	-0.1193**	1.0000		

Diagnostics: *significant at p<0.1, ** significant at p<0.05, *** significant at p<0.01

Table 7.4. Correlation Matrix – All Firms Survival Analysis

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1)	Exited2018	1.0000										
(2)	EquityFinanced	-0.0326	1.0000									
(3)	Size	-0.1366	0.0383**	1.0000								
(4)	Age	-0.1388	-0.2758*	0.2667**	1.0000							
(5)	ServiceFirm	-0.0963	0.0632	-0.0299*	-0.2381*	1.0000						
(6)	Rivalry	0.1902*	-0.2173*	-0.0547	0.0241	-0.0421*	1.0000					
(7)	Exports	-0.0652**	0.4155*	0.1855	-0.0814	-0.0118	-0.0560	1.0000				
(8)	ProdDiff	-0.0678	0.1604*	-0.0169	-0.1361	0.1008**	-0.2510**	0.0880	1.0000			
(9)	TotalInno	-0.0124	0.2975*	-0.0068	-0.2657	0.1882	-0.0383	0.2448	0.1655	1.0000		
(10)	R&DExpend	-0.0408	0.5183*	-0.1363	-0.3341	0.0642	-0.1629	0.3276	0.1878	0.3514*	1.0000	
(11)	Patent	-0.0687	0.2170	0.2519	0.0609	-0.0986	-0.1198	0.3738	0.0786	0.1606***	0.2609	1.0000
(12)	FoundEdu	-0.0288	0.1517	-0.0193	-0.0132	0.0679	0.0266	0.1774	0.1316	0.0568	0.2206	0.1906
(13)	FoundIndExp	0.0015	-0.1014	0.1927	0.3847	-0.0091	-0.0322	0.0074	-0.0592	-0.0627	-0.1378	0.0637
(14)	WorkQual	0.0665	0.2720	-0.1286	-0.3295	0.1129*	0.0025	0.2049	0.1087**	0.1744	0.3329	0.2029

		(12)	(13)	(14)
(12)	FoundEdu	1.0000		
(13)	FoundIndExp	-0.1328	1.0000	
(14)	WorkQual	0.2549	-0.1762	1.0000

Diagnostics: *significant at p<0.1, ** significant at p<0.05, *** significant at p<0.01

Table 7.5. Correlation Matrix – Equity-Financed Firms

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1)	Patents	1.0000											
(2)	EUPatents	0.9236*	1.0000										
(3)	USPatents	0.8688*	0.6320	1.0000									
(4)	EmpGrowth	0.1216	0.1193	0.0937	1.0000								
(5)	AssetGrowth	-0.0335	-0.0046	-0.0664	0.1163	1.0000							
(6)	ExitPlan	0.1183*	0.1032**	0.1152*	-0.0663	0.0036	1.0000						
(7)	ExitRoute	-0.1935*	-0.1434*	-0.2149	-0.1433*	0.0857	-0.0563	1.0000					
(8)	Exited2018	-0.1016**	-0.0959***	-0.0892**	0.0035	0.0450	-0.1133	0.3133	1.0000				
(9)	Angel	-0.0184	-0.0121	-0.0242	0.0317***	0.0997	0.0563	-0.0706	0.0869	1.0000			
(10)	VC	0.1979*	0.1819*	0.1746*	0.0649	-0.0497*	-0.0106	-0.2468*	-0.1333	-0.1166	1.0000		
(11)	GovSpon	-0.0772*	-0.0789*	-0.0587	-0.0182	0.0193	-0.0408	-0.0050	0.0183	-0.1337***	0.0259	1.0000	
(12)	Size	0.3229*	0.2629*	0.3340*	0.1769**	-0.0823	0.1120	-0.3004*	-0.1139**	-0.1647*	0.1928*	-0.0818	1.0000
(13)	Age	0.1118	0.0920	0.1151	-0.1570**	-0.2692*	0.3251*	-0.1811*	-0.1336	-0.1810*	0.1997*	-0.1141**	0.3702*
(14)	ServiceFirm	-0.2541*	-0.2596*	-0.1908*	0.0009***	-0.0640	-0.0723	0.0308	-0.0448	-0.0178	-0.0927	0.0535	0.0360
(15)	Rivalry	-0.0058	-0.0120	0.0057	-0.0796	-0.1415***	-0.0040	0.0190	0.1671**	-0.1209**	0.1060	-0.0092	0.1133
(16)	Exports	0.1391***	0.1439	0.0974	0.1176	0.0199	-0.0819***	0.1601***	-0.0788	-0.0877**	0.1456**	0.2473*	0.1473
(17)	ProdDiff	0.0931	0.0972	0.0660	0.0571	0.1064***	-0.0253	-0.0293	-0.1150	0.0038	-0.0489	-0.0188	-0.0772
(18)	TotalInno	0.1134***	0.1076	0.0958	0.1420**	0.1019	-0.1323***	0.0394	0.0622	-0.0411	0.0181	0.0982	-0.0275
(19)	R&DExpend	0.0980	0.1430	0.0124	0.0243	0.1870**	-0.0795	-0.0387	-0.0722	0.0127	0.0166***	0.0524	-0.1945
(20)	Patent	0.3675*	0.3503*	0.3072*	0.1813	0.0740	0.0922	-0.2988*	-0.1940*	-0.0146	0.2584	0.1559	0.2458*
(21)	FoundEdu	-0.0731	-0.0619	-0.0718	0.0523***	0.1341	-0.0586	-0.1022	-0.0563	-0.1775**	0.0970**	0.0288	-0.0629
(22)	FoundIndExp	0.1134	0.0851	0.1260	0.2161*	-0.1295	0.0544	-0.0858***	0.0423	0.0258	-0.0088	-0.1034	0.1770**
(23)	WorkQual	-0.0049	0.0111	-0.0250	-0.0949	0.0809	-0.1668	-0.0018	-0.1423**	-0.1164**	0.0534***	0.3576*	-0.1484**

		(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	
(13)	Age	1.0000											
(14)	ServiceFirm	-0.2501*	1.0000										
(15)	Rivalry	0.1351	-0.2204**	1.0000									
(16)	Exports	0.1331	-0.1208	-0.0046	1.0000								
(17)	ProdDiff	-0.1307***	0.1492**	-0.5100*	0.0218	1.0000							
(18)	TotalInno	-0.3001	0.1617	-0.1068	0.0932	0.3046*	1.0000						
(19)	R&DExpend	-0.2890	0.0172	0.0196	0.1858	0.1189	0.3071	1.0000					
(20)	Patent	0.1542***	-0.1875**	-0.0619	0.3161*	0.1134	0.1281**	0.2343*	1.0000				
(21)	FoundEdu	0.0981**	0.0053	-0.0444	0.1083	0.0471**	0.0792	0.2180*	0.1352***	1.0000			
(22)	FoundIndExp	0.2488	-0.0162	-0.0299	0.0324	0.0016	-0.0521	-0.1344	0.1654	0.0144	1.0000		
(23)	WorkQual	-0.2220	0.1281	-0.0962	0.0781	0.1688***	0.2326*	0.2690*	0.2451*	0.2004*	-0.0749	1.0000	

Diagnostics: *significant at p<0.1, ** significant at p<0.05, *** significant at p<0.01

7.4 Results

This Section presents the findings from our empirical analysis. We begin with the results of estimations assessing firm performance (Subsection 7.4.1) before moving on to those regarding entrepreneurial exit intentions (Subsection 7.4.2). As outlined previously (Section 7.3), in empirical analysis we are interested, first, in the impact of equity financing and, second, in disentangling this impact according to the source(s) of equity obtained. Thus, results for all estimations are presented first for all technology-based firms (N=294), without sample selection, to assess the impact of being equity financed compared to non-equity financed and, second, for equity financed firms (N=153), with Heckman sample selection, to assess impact according to source of equity.

7.4.1 Equity Financing and Impact on Firm Performance

In this Subsection, we explore the performance of funded firms through an assessment of innovation, growth and survival. Our primary aim is to assess the relationship between equity financing and funded firm performance.

Innovation

We begin by examining innovation output, measured by patenting (see Engel and Keilbach, 2007; Lahr and Mina, 2016). For this purpose, we present the results of two sets of econometric models. The first compares equity and non-equity financed firms on the basis of their patent stock while the second examines the individual sources of equity to assess the impact according to investor type. Each set consists of three robust OLS regressions, with the following dependent variables: total patent stock (Column I); European patent stock (Column II); and U.S. patent stock (Column III). The results for the total sample (i.e. equity and non-equity financed firms) are presented in Table 7.6 and we will begin our discussion with these.

We see that all *F*-tests are significant, and we can reject the null hypothesis that $R^2=0$. Thus, we can have confidence in the estimations.

Overall, we find that equity financing positively impacts on patenting. In terms of total patent stock (Column I), equity-financed firms hold approximately 2 more patents than their non-equity-financed counterparts, assuming all other variables in the model are held constant. Breaking this down further, equity-financed firms hold approximately one additional European (Column II) and U.S. (Column III) patent, *ceteris paribus*. These coefficients are all significant at the 5% level and, overall, lend support to Hypothesis 1. In terms of magnitude, the coefficient on equity finance has the second largest impact on patents (Columns I, II and III). Thus, it appears that equity financing has a positive impact on patenting within Irish technology-based firms. This supports the findings of Kortum and Lerner (2000) and Mann and Sager (2007) for the U.S., Engel and Keilbach (2007) for Germany, Bertoni *et al*. (2010) and Caselli *et al.* (2009) for Italy, and Arqué-Castells (2012) for Spain.

Next, let us briefly consider the impact of the control variables. Firm size has a positive and significant impact on patenting. For every unit increase in size, we would expect approximately a 0.05 unit increase in total patents (0.02 unit increase in European and U.S. patents), *ceteris paribus*. This positive size effect is in line with the existing evidence (see Arundel, 2001; Bertoni *et al*., 2010; Lahr and Mina, 2016). As pointed out by Cohen *et al*. (2000), the bigger the firm the higher the probability of using patents, given not only the costs of application but also of enforcement which are sizeable for smaller firm. Sector also impacts on patenting activity. Although weakly significant (at the 10% level), knowledge-intensive service firms hold approximately 5 less patents than technology-based manufacturing firms. This result is hardly surprising, considering the peculiarities of innovation within such firms.

First, innovations are mainly intangible or knowledge-products (Durst *et al*., 2015).[136] Second, service-based innovation can be difficult to copy because of reliance, for example, on the input of highly-skilled and experienced professionals (Samuelson, 2010). Consequently, in many cases, knowledge-intensive service firms' innovation is simply not suitable for patenting (see Cohen *et al*., 2000; Arora *et al*., 2016; Miozzo *et al*., 2016). There is also some evidence that appropriability mechanisms are less important for capturing value from service firms than for manufacturing firms (see Miles *et al*., 2000; Hipp, 2008). Age does not have a statistically significant impact, consistent with evidence provided by Hall *et al*. (2013).

Controls within both the '*Market and Product*' and '*Human Capital*' groups show no significant impact on patenting. Strong evidence of the productivity effects of innovation activity is consistent with prior studies (see Baum and Silverman, 2004; Choen, 2010; Lahr and Mina, 2016). Specifically, we see that both the frequency of innovation and expenditure on R&D significantly impact patenting. Each unit increase in the frequency of product and/or process innovation leads to approximately 0.6 more patents (0.4 and 0.3 for European and U.S. respectively), all else held constant. The coefficients are all significant at the 5% level. Similarly, a one percent increase in R&D expenditure results in approximately 0.05 more patents (0.03 and 0.01 for European and U.S. patents respectively), *ceteris paribus*. This is consistent with the evidence suggesting that propensity to patent rises with R&D intensity (see Arundel, 2001; Hall *et al*., 2014). These coefficients are again significant at the 5% level. When interpreted in conjunction with one another these results, unsurprisingly, suggest that product/process innovations and R&D are key drivers of patenting.

[136] These can vary from complex engineering or IT solutions (Miozzo and Grimshaw, 2011) to professional services such as R&D, design or management consultancy (Miozzo *et al*., 2012).

Table 7.6. Impact of Equity Financing on Patent Stock for All Firms (N=294)

	I Total Patents	II European Patents	III U.S. Patents
EquityFinanced	1.7054**	0.8579**	0.8475**
	(0.7458)	(0.3883)	(0.4208)
Firm-specific:			
Size	0.0492**	0.0258**	0.0234***
	(0.0217)	(0.0111)	(0.0128)
Age	0.0925	0.0710	0.0215
	(0.0833)	(0.0489)	(0.0420)
ServiceFirm	-4.9997***	-3.3127***	-1.6870***
	(2.8877)	(2.0359)	(1.1612)
Market & Product:			
Rivalry	0.0014	0.0009	0.0005
	(0.0023)	(0.0015)	(0.0009)
Exports	0.0074	0.0059	0.0015
	(0.0135)	(0.0069)	(0.0082)
ProdDiff	0.4273	0.3635	0.0638
	(0.5998)	(0.4682)	(0.1885)
Human Capital:			
FoundEdu	-1.1850	-0.7049	-0.4801
	(0.9345)	(0.7105)	(0.3293)
FoundIndExp	-0.0070	-0.0118	-0.0048
	(0.0581)	(0.0300)	(0.0298)
WorkQual	0.0218	0.0119	0.0099
	(0.0168)	(0.0096)	(0.0081)
Innovation:			
FreqInno	0.6402**	0.3727**	0.2675***
	(0.3401)	(0.1819)	(0.1723)
R&DExpend	0.0479**	0.0351***	0.0128***
	(0.0238)	(0.0191)	(0.0075)
Constant	-3.6558	-2.0370	-1.6188
	(3.2442)	(1.7534)	(1.6250)
Number Obs.	294	294	294
F (12, 281)	1.72	1.64	1.85
Prob>F	0.0332	0.0598	0.0409
R^2	0.1807	0.1566	0.1474
Root MSE	8.8711	5.7544	4.1685

Notes: (1) Robust standard errors in parentheses; (2) Significance levels: * p<0.1; ** p<0.05; *** p-<0.01

Next, we focus on Hypothesis 2 and investigate whether the impact on patenting activity varies by source of equity (i.e. angel, independent venture capital, and government-sponsored funding). We again estimate three robust OLS regressions, with dependent variables total (Column I), European (Column II) and U.S. (Column III) patent numbers, this time based only on the sample of equity financed firms (N=153). Results are presented in Table 7.7. All robust OLS regressions include in the set of covariates the inverse Mill's ratio, calculated from the estimate of the selection equation in Chapter 5 (Section 5.4), to take into account sample selection bias.[137] We see that the *F*-test is significant for all estimations, rejecting the null hypothesis that $R^2=0$ and implying that we can have confidence in the results.

Interestingly, the estimates reveal that venture capital has a positive and highly significant (at the 1% level) impact on the firm's total patent stock (Column I). Results suggest that those funded by venture capitalists possess approximately 3 more patents *ceteris paribus*. Furthermore, these firms possess approximately two additional patents within Europe (Column II) and one in the U.S. (Column III), *ceteris paribus*. In terms of magnitude, venture capital has the second largest impact on patenting in each estimation, exceeded only by the industry effect. Both angel and government-sponsored equity have no significant impact. In fact, the sign on the coefficient for government-sponsored equity is negative. This supports the evidence of Bertoni and Tykvová (2015) and Pierrakis and Saridakis (2017), both of whom find government-managed venture capital is negatively associated with patenting. Regarding the impact of angel funding, in the only other study to compare angel and venture capital, Dutta and Folta (2016) report that, while they find no significant difference in patent count between venture capital and angel financed firms, the former has a superior impact on patent citations.

[137] To recap, we use a typical Heckman two-step procedure – in Chapter 5, a probit model was estimated for the firm's probability of being equity financed. Based on this estimate we computed the inverse Mill's ratio which was subsequently inserted as a control for sample self-selection in all equations based solely on the sample of equity financed firms (N=153). This additional variable controls for the unobserved heterogeneity that affects the probability of being equity financed.

The authors conclude that venture capital, therefore, has a greater innovation impact. The general picture that emerges from our analysis is that venture capital is the source of equity that significantly and positively impacts on patenting activity, rather than angel or government-managed funding. Thus, our findings lend support for Hypothesis 2.

Regarding control variables, the estimated coefficients for firm size are positive and significant (at the 10% level). Specifically, a one unit increase in size, all else held constant, leads to approximately 0.07 more patents (Column I) (0.03 European and U.S. patents (Columns II and III respectively)). This is consistent with the suggestion that propensity to patent rises with firm size (see Arundel, 2001; Hall *et al*., 2014). Industry effects again point towards greater patenting activity among equity-financed technology-based manufacturing firms. As mentioned above, in terms of magnitude, these are the largest coefficients observed in each estimation. Knowledge-intensive service firms have approximately 11 less patents (Column I) than technology-based manufacturing firms (approximately 7 and 4 less European (Column II) and U.S. patents (Column II) respectively), *ceteris paribus*. While the majority of the evidence is based on manufacturing firms and their technological innovations (see Cohen *et al*., 2000; James *et al*., 2013; Hall *et al*., 2014), studies focused on knowledge-intensive service firms suggest they typically do not use formal IP and, of those that do, copyrights and trademarks are usually more appropriate protection mechanisms for their innovations (see Mariesse and Mohnen, 2004; Hipp and Herstatt, 2006).

Finally, R&D positively and significantly impacts on patenting. A one percent increase in R&D expenditure results in approximately 0.07 more patents (Column I) (0.06 and 0.01 for European and U.S. patents (Column II and III) respectively), *ceteris paribus*. These coefficients are weakly significant at the 10% level but again confirm the association between R&D and patents.

Table 7.7. Impact of Sources of Equity Financing on Patent Stock for Equity-Financed Firms (N=153) with Heckman Correction for Sample Selection

	I Total Patents	II European Patents	III U.S. Patents
Angel	0.3786	0.1925	0.1752
	(1.7209)	(0.9263)	(0.9261)
VC	3.5065*	2.0848**	1.4009**
	(1.3866)	(0.9365)	(0.6049)
GovSpon	-2.0140	-1.5125	-0.5096
	(3.4117)	(2.6676)	(1.2693)
Firm-specific:			
Size	0.0667*	0.0365*	0.0303**
	(0.0272)	(0.0151)	(0.054)
Age	-0.1012	-0.0095	-0.0514
	(0.2713)	(0.1841)	(0.1236)
ServiceFirm	-11.0684***	-7.1719***	-3.9356***
	(6.3657)	(4.3115)	(2.8277)
Market & Product:			
Rivalry	-0.1682	-0.1202	-0.0473
	(0.2585)	(0.1841)	(0.1008)
Exports	0.0086	0.0095	0.0013
	(0.0312)	(0.0184)	(0.0173)
ProdDiff	1.4865	0.9227	0.5627
	(1.2294)	(0.7064)	(0.5929)
Human Capital:			
FoundEdu	-2.3078	-1.4473	-0.8424
	(1.8551)	(1.3536)	(0.7525)
FoundIndExp	0.1414	0.0700	0.0702
	(0.1338)	(0.0670)	(0.0716)
WorkQual	0.0395	0.0324	0.0085
	(0.0668)	(0.0349)	(0.0368)
Innovation:			
FreqInno	1.2070	0.6633	0.5554
	(1.2524)	(0.6692)	(0.6413)
R&DExpend	0.0690***	0.0571***	0.0117***
	(0.0404)	(0.0345)	(0.0112)
MillsRatio	-0.0097	-0.3848	-0.3265
	(4.7601)	(2.3369)	(2.6806)
Constant	-6.4282	-4.2381	-2.3772
	(16.0887)	(9.0208)	(10.9088)
Number Obs.	153	153	153
F (14, 138)	1.86	1.56	2.31
Prob>F	0.0328	0.0628	0.0058
R^2	0.2672	0.2408	0.2065
Root MSE	11.733	7.649	5.6449

Notes: (1) Robust standard errors in parentheses; (2) Significance levels: * p<0.1; ** p<0.05; *** p-<0.01; (3) *MillsRatio* controls for sample self-selection.

Growth

We now turn to our second performance measure, firm growth, captured through asset and employment growth rates. We again estimate two sets of econometric models. First, we compare the growth rates of equity and non-equity financed firms (N=294). To this end, we estimate two robust OLS regressions, with dependent variables as follows: (1) asset growth rate; and (2) employment growth rate. These results are presented in Table 7.8. Second, we estimate two robust OLS regressions, again with dependent variables asset growth rate and employment growth rate, but only do so for the sample of equity financed firms (N=153). The aim is to isolate the impact of each source of equity financing on firm growth. Both of these equations include in the set of covariates the inverse Mill's ratio, calculated from the estimate of the selection equation in Chapter 5. These results are presented in Table 7.9. For both sets of results (Table 7.8 and 7.9), we see that the *F*-tests are significant for all, thus we can reject the null hypothesis that R^2=0 and have confidence in the results.

We start our discussion with the results comparing the asset (Column I) and employment (Column II) growth rates of equity and non-equity financed firms (Table 7.8). Firstly, we see that the asset growth rate among equity financed firms is approximately 3.4% higher than that of their non-equity financed counterparts, *ceteris paribus* (Column I). The coefficient on equity financed, significant at the 5% level, is the second largest observed in the estimation and lends support to Hypothesis 3. Moreover, the coefficient on *EquityFinanced* is also positive and significant in the employment growth estimation (Column II), suggesting that equity financing is also associated with higher levels of job creation. Thus, Hypothesis 4 is also confirmed. Regarding magnitude, the presence of external equity has the largest impact on employment growth rates among technology-based firms. Generally, these results provide support for the proposition that financial constraints affect asset (see Carpenter and Petersen, 2002b; Musso and Schiavo, 2008) and employment (Haynes and Brown, 2009) growth. More specifically, they confirm the positive causal impact of equity financing on funded firm growth. Manigart and Van Hyfte (1999), examining venture capital financed Belgian firms, find a significant impact relative to the control group in terms of growth of assets (although did not find a significant relationship with employment growth). Engel and Keilbach (2007) find similar results for German venture capital financed firms. In a recent study, Levratto *et al*. (2018) show evidence of the positive impact of angel funding on asset growth.

Let us briefly consider the impact of control variables. Knowledge-intensive service firms enjoy higher levels of employment growth (Column II), as the coefficient on this variable is positive and significant at the 5% level. Service firms have come to dominate the employment landscape and new job creation in European economics (see European Commission, 2011; Stare and Damijan, 2015). Neither market/product-related nor human capital factors appear to impact on asset (Column I) or employment (Column II) growth. Innovation activity, on the other hand, is significant. Specifically, findings indicate a significant positive relationship between R&D and asset growth (Column I). Although the impact, in terms of magnitude, is one of the smallest observed, the result is nonetheless justified when we consider that, in undertaking R&D activities, firms not only put in place transaction-specific, complementary assets but also subsequently benefit from the assets created by R&D (see Teece, 1998; Wang, 2011). It is widely assumed that higher R&D investment translates into competitive advantage and triggers firm growth (see Geroski and Machin, 1992; Coad and Rao, 2008; García-Manjón *et al*., 2012). Possessing a patent also positively and significantly impacts on both asset (Column I) and employment (Column II) growth rates. Although weakly significant in each (p-value<0.1), the coefficient on this variable is the largest observed in the asset growth estimation and second largest in the employment growth. Helmers and Rogers (2011), based on their analysis of high- and medium-tech firms in the UK, report that the asset growth rate per annum is approximately 7% higher in those that possess a patent. Niefert

(2005), examining German start-ups, finds that patenting has a positive effect on employment growth, particularly in the second year after application. Overall, findings support the existing evidence that R&D and patenting are positively associated with firms' productivity and growth (see Chen and Chang, 2010; Colombelli *et al*., 2013; Harrison *et al*., 2014).

Table 7.8. Impact of Equity Financing on Firm Growth for All Firms (N=294)

	I Asset Growth p.a.	II Employment Growth p.a.
EquityFinanced	3.4331*	1.6695*
	(1.9600)	(0.9503)
Firm-specific:		
Size	-0.0085	-
	(0.0083)	
ServiceFirm	-3.9596	1.4235**
	(3.3191	(0.8997)
Market & Product:		
Rivalry	0.0103	-0.0001
	(0.0138)	(0.0028)
Exports	0.0119	0.0124
	(0.0297)	(0.0122)
ProdDiff	0.1539	0.1081
	(1.1942)	(0.4973)
Human Capital:		
FoundEdu	0.9299	0.4810
	(1.3509)	(0.8013)
FoundIndExp	0.1536	0.0235
	(0.1143)	(0.0610)
WorkQual	0.0182	-0.0153
	(0.0519)	(0.0281)
Innovation:		
R&DExpend	0.0899***	0.0071
	(0.0363)	(0.0202)
Patent	3.8671*	1.4495***
	(2.6674)	(1.1147)
Constant	10.6946**	3.6942
	(4.9492)	(2.4926)
Number Obs.	294	294
F (12, 281)	2.71	1.66
Prob>F	0.0024	0.0598
R^2	0.0804	0.0511
Root MSE	17.626	7.1029

Notes: (1) Robust standard errors in parentheses; (2) Significance levels: * p<0.1; ** p<0.05; *** p-<0.01; (3) The variables *TotalInno* and *R&DExpend* are excluded from these equations due to correlation issues. The validity of these variables is confirmed in OLS estimations for patenting and thus are dropped from these models; **(4)** The variable *Age* is also excluded due to high correlation with the dependent variables.

Now let us consider the impact of the sources of equity on firm growth. Results of robust OLS models for asset (Column I) and employment (Column II) growth rates are presented in Table 7.9. Before proceeding, we note that the *MillsRatio*, to take into account sample self-selection, is negative and statistically significant for employment growth (Column II) but insignificant for asset (Column I). This suggests that unobserved factors that are associated with growth seem to be either negatively (employment growth) or not correlated (asset growth) with the selection of firms into the equity market.

Interestingly, when examined by type of equity, we find that individual sources (i.e. angel, venture capital, government-sponsored equity) have no significant impact on asset (Column I) or employment (Column II) growth. If we consider our findings together, it appears that, while equity financing positively impacts firm growth, the difference is between equity and non-equity financed firms, rather than between the sources of equity. In other words, superior growth comes from being financed by external equity, regardless of the source of those funds. Thus, Hypotheses 5 and 6 are not supported.

Let us briefly consider the other variables. Those operating in niche markets enjoy higher asset growth rates (Column I). Opportunities for growth can be hampered by competition (Hoogstra and van Dijk, 2004) and, by operating in a market niche, firms may find it easier to grow rapidly (Barkham *et al*., 2012). High-growth firms tend to occupy deliberately chosen niches where they can exploit innovations and any technological sophistication they might have (Stokes and Wilson, 2006). We also see a positive impact of human capital on growth. Founder-CEO industry-specific experience is positively and significantly related to asset and employment growth while organisational human capital has a positive significant impact on the latter. Overall, this is an unsurprising finding, given the prevalent view that human capital positively affects firm growth, and indeed performance in general (see Colombo and Grilli, 2010; Unger *et al*., 2011; Ganotakis, 2012).

Table 7.9. Impact of Sources of Equity Financing on Firm Growth for Equity-Financed Firms (N=153) with Heckman Correction for Sample Selection

	I Asset Growth	II Employment Growth
Angel	3.8389	0.0019
	(3.3127)	(0.0115)
VC	2.2464	0.0042
	(3.9059)	(0.0121)
GovSpon	0.2045	-0.0020
	(3.3605)	(0.0172)
Firm-specific:		
Size	-0.0017	-
	(0.0158)	
ServiceFirm	-3.8158	0.0181
	(4.7034)	(0.0161)
Market & Product:		
Rivalry	-0.3761*	-0.0002
	(0.2337)	(0.0009)
Exports	0.0574	0.0002
	(0.0461)	(0.0002)
ProdDiff	0.0828	0.0002
	(1.9877)	(0.0077)
Human Capital:		
FoundEdu	2.0323	0.0038
	(1.7541)	(0.0074)
FoundIndExp	0.3409*	0.0017*
	(0.2171)	(0.0009)
WorkQual	0.0661	0.0014***
	(0.1070)	(0.0005)
Innovation:		
R&DExpend	0.0552	0.0002
	(0.0608)	(0.0003)
Patent	0.1690	0.0133
	(3.6982)	(0.0148)
MillsRatio	-10.7983	-0.0719***
	(6.5156)	(0.0259)
Constant	35.9500**	0.2372*
	(16.2112)	(0.0682)
Number Obs.	153	153
F (13, 139)	1.73	2.31
Prob>F	0.0561	0.0069
R^2	0.1175	0.2106
Root MSE	17.84	0.0665

Notes: (1) Robust standard errors in parentheses; (2) Significance levels: * p<0.1; ** p<0.05; *** p-<0.01; (3) *MillsRatio* controls for sample self-selection; (4) The variables *TotalInno* and *R&DExpend* are excluded from these equations due to correlation issues; (5) The variable *Age* is also excluded due to high correlation with the dependent variables.

Firm Survival

Finally, we turn to our analysis of the impact of equity on funded firm survival. Table 7.10 presents the results of two complementary log-log estimations for the likelihood of exit for all technology-based firms (Column I) and equity financed technology-based firms (Column II).[138] The dependent variable in each is binary where firm deaths are coded '*1*' and '*0*' otherwise. A positive (negative) coefficient (β') indicates that the particular covariate (X_i) increases (decreases) the likelihood of the firm exiting. A test of the null hypothesis that the coefficients in estimations equal zero was rejected, thus we can have confidence in these results. Again, the estimation for equity financed firms (Column II) includes the Heckman correction for sample self-selection (*MillsRatio*).

The coefficient capturing the presence of equity financing (Column I) has no impact on firm survival. Looking at this effect across the different sources of equity (Column II), the three coefficients are, once again, not statistically significant. Thus, we fail to find support for Hypotheses 7 or 8.

We now briefly discuss our control variables. Overall (Columns I and II), we find that older firms have a higher probability of survival, providing evidence of a liability of newness. Stinchcombe (1965) introduced the construct of the *liability of newness* to explain the struggles of new firms to survive post entry. In comparison to mature firms, newer firms establishing their routines are resource constrained, have less experience, weaker social ties and less ties with customers (see Stinchcombe, 1965; Aldrich and Auster, 1986; Hannan and Freeman, 1989). While aging, firms accumulate and update their knowledge on innovation, marketing and products which will improve their chances of survival (see Giovannetti *et al.*, 2011; Yang *et al.*, 2017). We also see that firms operating in a knowledge-intensive service sectors have a higher probability of survival (Columns I and II). In terms of magnitude, this coefficient is the

[138] The reader is reminded that, due to anonymous responses, the full sample of equity and non-equity financed technology-based firms reduces to 233 (from 294).

largest observed in both estimations. The coefficient on *Rivalry* has a significant positive sign in the estimation based on all firms (Column I). This suggests that firms facing more competition in their main market face a lower probability of survival. In other words, operating in a niche market improves survival prospects. Related evidence does suggest that high rates of competition and market power are negatively correlated with entry growth and the survival of firms (Caves, 1998). Using market concentration as a proxy for market power exercised by existing firms, Audretsch (1991) observe that survival prospects fall with concentration. Finally, the coefficient on founder-CEO industry-specific experience is negative and significant in both estimations, suggesting that such experience is associated with a higher probability of survival (Columns I and II). Human capital has been widely evidenced to affect venture survival and post-entry performance (see Bates, 1990; Brüderl *et al*., 1992; Dimov and Shepherd, 2005; Gimmon and Levie, 2010). For the U.S., Van Praag (2003) and Coleman *et al*. (2013) report that entrepreneurs' prior industry-specific experience lowers hazard rates. Bosma *et al*. (2004) find that same-sector experience has a significant effect on the survival of Dutch firms.

Our central findings are consistent with existing evidence. In a nutshell, we find that older, knowledge-intensive service firms, operating in niche markets and having founder-CEOs with greater industry-specific experience have a higher probability of survival. Equity financing does not seem to play a significant role in funded firm survival. Unfortunately, we find no empirical evidence supporting either Hypotheses 7 or 8.

Table 7.10. Complementary Log-Log Estimations of Firm Survival for All Firms (N=233) and Equity Financed Firms (N=153) with Heckman Correction for Sample Selection

	I **All Firms** **(N=233)**	**II** **Equity Financed** **(N=153)**
EquityFinanced	-0.0157	-
	(0.3232)	
Angel	-	0.8071
		(0.5819)
VC	-	-0.3977
		(0.3711)
GovSpon	-	-0.1879
		(0.5197)
Firm-specific:		
Size	-0.0115	-0.0155
	(0.0083)	(0.0138)
Age	-0.0769***	-0.1848**
	(0.0517)	(0.0833)
ServiceFirm	-0.5929***	-0.9478**
	(0.3816)	(0.4889)
Market & Product:		
Rivalry	0.0016**	0.0261
	(0.0008)	(0.0370)
Exports	-0.0026	-0.0075
	(0.0036)	(0.0077)
Human Capital:		
FoundEdu	0.0362	0.2036
	(0.2527)	(0.4144)
FoundIndExp	0.0262***	0.0512**
	(0.0173)	(0.0247)
Innovation:		
Patent	-0.0346	-0.3479
	(0.3729)	(0.4574)
MillsRatio	-	0.1246
		(0.4574)
Constant	-0.6263	-1.4819
	(0.3729)	(0.9024)
Number Obs.	233	153
Wald Chi^2	17.60	18.77
Prob> Chi^2	0.0401	0.0642
Log Likelihood	-111.7172	-66.5750

Notes: (1) Robust standard errors in parentheses; (2) Significance levels: * p<0.1; ** p<0.05; *** p-<0.01; (3) *MillsRatio* controls for sample self-selection in Column II; (4) The variables *ProdDiff*, *WorkQual*, *TotalInno* and *R&DExpend* are excluded from these equations due to correlation issues.

7.4.2 Equity Financing and Entrepreneurial Exit

We turn now to our investigation of entrepreneurial exit and, specifically, the role played by equity investors in impacting the entrepreneur's exit intentions. In exploring entrepreneurial exit, analysis explores two aspects, namely the development of an exit plan and the factors that affect the choice of intended exit route. We begin this discussion by assessing the factors that distinguish between those entrepreneurs who develop an exit plan and those who do not. In doing so, two parsimonious probit models are estimated, the first comparing equity and non-equity financed firms (N=294) and the second focused only on equity financed firms to assess the impact of the different sources (N=153). Results are presented in Tables 7.11 (all firms) and 7.12 (equity financed firms), with robust standard errors in brackets. Marginal effects (Column II) and elasticities at the means (Column III) are also reported in each. Wald-chi squares of 21.22 (p-value<0.01) and 27.36 (p-value<0.01) respectively indicate that we can have confidence in the estimates. In considering these results, positive (negative) coefficients (β) increase (decrease) the probability of the entrepreneur developing an exit plan.

Beginning with the results comparing equity and non-equity financed firms (Table 7.11), we see that entrepreneurs in non-equity financed firms are more likely to formulate a plan for their own exit (Column I). Specifically, looking at estimated marginal effects (Column II), entrepreneurs within equity financed firms are approximately 11% less likely to have a plan in place for their own exit. This is contrary to our expectations in Hypothesis 9. A possible explanation for this finding may reside in the context in which equity investors and entrepreneurs are embedded. Specifically, contracts for equity financing are often constructed in such a way that control rights regarding exit decisions are allocated to the equity investor (see Sahlman, 1990; Black and Gilson, 1998; Schwienbacher, 2008) who often have a pre-planned exit strategy prior to investment. As such, investors may not only take the lead in developing the exit strategy (Mason and Bothelo, 2016) but could have the rights to force an exit (Schwienbacher, 2008). Several authors document the widespread use of contractual arrangements that guarantee the investor explicit intervention rights on exit issues (see Kaplan and Strömberg, 2001; Smith, 2005; Bienz and Walz, 2006; Cumming and Johan, 2013). Thus, where the firm is equity financed, the entrepreneur's exit may already be decided by equity investors expectations, lessening the need for a personal plan.

Looking at the control variables, the positive and significant coefficient on age suggests that those entrepreneurs within older firms are more likely to have a plan in place for their exit. From Table 7.11 (Column III) we see that a 1% increase in firm age leads to a 0.6% increase in the probability that the entrepreneur will formulate an exit plan and vice versa. This elasticity is the highest observed. Two factors known to influence the likelihood that a business will exit are business size and age (Mitchell, 1994) and studies have found that the probability of exit increases with time trading (see Baum, 1989; Hannan, 1998; Esteve-Pérez and Máῃez-Castillejo, 2008). It follows then that, as their firm gets older, the entrepreneur will begin planning for their exit and, as such, be more likely to develop a plan for that exit.

Looking next to the results for equity-financed firms (Table 7.12), we find no statistically significant impact by source of equity obtained (Column I). Thus, the presence of equity investors does not appear to play a significant role in incentivising the entrepreneur to formalise a plan for their own exit. As such, we cannot confirm Hypothesis 10. Once again, those within older firms are significantly more likely to have an exit plan in place. Specifically, a 1% increase in firm age, *ceteris paribus*, is associated with a 0.7% increase in the likelihood of the entrepreneur formulating an exit plan (Column III). Moreover, this is the largest elasticity observed in the estimation. Lastly, the positive significant coefficient on *Patent* suggests that those entrepreneurs whose firms hold at least one patent are more likely to devise an exit plan. Interestingly, in terms of magnitude, this is the largest coefficient observed in the estimation (Column I). According to DeTienne *et al*. (2015) entrepreneurs require a reward for risky innovative activities and, consequently, are more likely to develop a financial harvest strategy. Following this line of thought, our findings suggest that, having invested the resources to develop patentable technology, entrepreneurs formulate an exit plan, possibly in the hope of eventually receiving a reward for their innovativeness.

Overall, our analysis provides evidence that entrepreneurs within older firms are more likely to develop an exit plan. Moreover, it appears that those entrepreneurs within non-equity financed firms are those with an exit plan in place, contrary to our expectations (Hypothesis 9). For those with equity financiers, having a patent is positively associated with the development of an exit plan. We cannot confirm Hypothesis 10, as the sources of equity do not significantly impact on the probability that the entrepreneur will have an exit plan in place.

Table 7.11. Factors determining development of a plan for entrepreneurial exit – All Firms (N=294)

	I β (Std. Error)	II Marginal Effects (Std. Error)	III Elasticities at Mean (Std. Error)
EquityFinanced	-0.2849*	-0.1125*	-0.1079*
	(0.1717)	(0.0672)	(0.0648)
Firm-specific:			
SizeCurrent	-0.0018	-0.0007	-0.0332
	(0.0017)	(0.0007)	(0.0311)
Age	0.1145***	0.0454***	0.6411***
	(0.0271)	(0.0106)	(0.1415)
ServiceFirm	0.1163	0.0463	0.0711
	(0.2217)	(0.0883)	(0.1353)
Market & Product:			
Rivalry	-0.0002	-0.0009	-0.0036
	(0.0006)	(0.0002)	(0.0103)
ProdDiff	0.1062	0.0421	0.1609
	(0.1079)	(0.0427)	(0.1626)
Human Capital:			
FoundEdu	-0.0709	-0.0281	-0.0788
	(0.1240)	(0.0491)	(0.1376)
FoundIndExp	-0.0021	-0.0008	-0.0283
	(0.0112)	(0.0044)	(0.1506)
Innovation:			
Patent	0.1567	0.0618	0.0345
	(0.1824)	(0.0715)	(0.0401)
Constant	-0.7886*		
	(0.4397)		
Log Likelihood	-177.1504		
No. Observations	294		
Wald Chi-square (9)	21.22		
Pseudo R^2	0.1288		
Prob > Chi^2	0.0114		

Notes: (1) Robust standard errors in parentheses; (2) Significance levels: * p<0.1; ** p<0.05; *** p-<0.01

Table 7.12. Factors determining development of a plan for entrepreneurial exit – Equity Financed Firms (N=153) with Heckman Correction for Sample Selection

	I β (Std. Error)	II Marginal Effects (Std. Error)	III Elasticities at Mean (Std. Error)
Angel	0.3221	0.1279	0.1798
	(0.2794)	(0.1102)	(0.1572)
VC	-0.2338	-0.0920	-0.1160
	(0.2526)	(0.0983)	(0.1256)
GovSpon	0.0673	0.0267	0.0388
	(0.2829)	(0.1125)	(0.1632)
Firm-specific:			
SizeCurrent	-0.0001	-0.0001	-0.0031
	(0.0019)	(0.0008)	(0.0428)
Age	0.1441***	0.0571***	0.7197***
	(0.0389)	(0.0154)	(0.1977)
ServiceFirm	-0.0225	-0.0089	-0.0139
	(0.3235)	(0.1281)	(0.2007)
Market & Product:			
Rivalry	-0.0131	-0.0052	-0.0438
	(0.0236)	(0.0093)	(0.0791)
ProdDiff	0.0644	0.0255	0.1061
	(0.1836)	(0.0728)	(0.3023)
Human Capital:			
FoundEdu	-0.0757	-0.0300	-0.0918
	(0.1909)	(0.00757)	(0.2311)
FoundIndExp	-0.0127	-0.0050	-0.1729
	(0.0156)	(0.0062)	(0.2119)
Innovation:			
Patent	0.4094*	0.1607*	0.1289*
	(0.2701)	(0.1042)	(0.0858)
MillsRatio	0.6560*	0.2601*	0.2578*
	(0.3900)	(0.1547)	(0.1532)
Constant	-1.2429		
	(0.9497)		
Log Likelihood	-90.7659		
No. Observations	153		
Wald Chi-square (12)	27.36		
Pseudo R^2	0.1428		
Prob > Chi^2	0.0069		

Notes: **(1)** Robust standard errors in parentheses; **(2)** Significance levels: * p<0.1; ** p<0.05; *** p-<0.01; **(3)** *MillsRatio* controls for sample self-selection.

Next to our findings regarding intentions for entrepreneurial exit. We test the factors that impact on the entrepreneur's intentions for their own (entrepreneurial) exit (IPO, sale or cessation) using multinomial probit estimations. Again, models are estimated, first, for equity and non-equity financed firms (N=294) and, second, for equity-financed firms (N=153). These results are presented in Tables 7.13 and 7.14 respectively. As before, estimations for equity financed firms contain the Heckman correction term (*MillsRatio*) to take into account sample self-selection. Wald Chi-squares, used to assess the explanatory power of estimates, indicate that we can have confidence in the results.

Focusing initially on the results for all firms (Table 7.13) and the probability with which the entrepreneur intends to exit via sale of the firm in comparison with the probability that they will exit via IPO (i.e. sell their shares on the stock exchange), we find a significant negative coefficient on equity financing (Column I). This indicates that entrepreneurs who intend to exit via sale of the firm are more likely to be non-equity financed, compared to entrepreneurs who expect to exit via IPO, *ceteris paribus*. This offers support for Hypothesis 11 and is in line with the findings of Cumming and MacIntosh (2003a), who posit a pecking order of exit outcomes for equity financed firms as follows: IPO; trade sale; secondary sale; buyback; and, lastly, write-off. From the equity investors' perspective, sale is generally deemed to be the second-best form of exit, with the IPO being the most preferred in terms of upside potential (Cumming and Johan, 2008b). It follows that an IPO would be a more likely exit expectation for those entrepreneurs who have equity investors. Additionally, we find that entrepreneurs who intend to exit via sale are operating smaller firms than those who plan to take their firm public, *ceteris paribus*. This is consistent with the existing evidence, which reports that IPO firms tend to be larger on average (see Brau *et al*., 2003; Cao, 2011). Moreover, entrepreneurs with intentions to exit via sale are significantly less likely to possess a patent than those who intend to exit via IPO. This provides some support for the findings of Cockburn and MacGarvie

(2009), who find that patents are positively correlated with exit through IPO. Relatedly, Useche (2014) reports that patents, as signals to financial markets, are positively correlated with IPO performance.

Given that our results for the probability that the entrepreneur intends to exit via sale in comparison to cessation (Column II) and those for entrepreneurs with intentions to exit via IPO relative to cessation (Column III) are comparable we will consider these results together. First, and foremost, we find a significant and positive coefficient on equity financing for both. Thus, entrepreneurs who intend to exit through sale of the firm or sale of their shares on the public market are more likely to have obtained equity finance than those who intend to exit via cessation, *ceteris paribus*. This implies that entrepreneurs who have obtained equity financing are more likely to select IPO or trade sale as their intended exit routes as opposed to cessation, again confirming Hypothesis 11. These findings also support existing evidence suggesting that entrepreneurs and equity investors in growth-oriented ventures tend to harvest by either conducting an IPO or by being acquired by another company (see Brau *et al*., 2003; Bayar and Chemmanur, 2011).

Those entrepreneurs intending to pursue a financial harvest exit strategy (IPO or acquisition) are more likely to have formulated an exit plan than entrepreneurs who intend exit by cessation, *ceteris paribus*. According to DeTienne (2010), founders with growth goals may be more likely to develop an exit strategy, effectively planning for the exit that will provide the highest pay-out. It follows then that founders with intentions to pursue a financial harvest exit would be more likely to formulate a plan for that exit. Where the entrepreneur is aiming for an acquisition or IPO, they will need to focus upon developing a strong competitive advantage, demonstrate earnings growth and stability, develop a robust growth strategy, and form a strong management team (DeTienne and Cardon, 2012). As such, financial harvest exit strategies are often positively related to planning-based approaches (Fauchart and Gruber, 2011) to firm formation, developing their strategies early and formally articulating their eventual exit strategy (DeTienne, 2010). Voluntary cessation strategies are unlikely to be formalised even though the individual expects that they will eventually shut down (DeTienne *et al.*, 2015).

The positive and significant coefficient on firm size suggests that those entrepreneurs who intend to sell or take their firm public are operating larger businesses than those intending to cease operations, *ceteris paribus*. This provides support for the findings of DeTienne *et al*. (2015), who report that number of employees is negatively related to voluntary cessation strategies. Entrepreneurs employing larger numbers of personnel are likely to face stronger pressure to avoid liquidating the firm (Leroy *et al*., 2015) and, as such, attempt to avoid cessation. Firms that pursue voluntary cessation strategies are often sole proprietorships or smaller firms that do not provide substantial employment (see Feeser and Willard, 1990; DeTienne *et al*., 2015). Moreover, as a firm increases in size and develops legitimacy the entrepreneur's exit options increase, with growing firms becoming attractive to private equity firms, strategic buyers, and as public offerings (DeTienne, 2010). Relatedly, Battisti and Okamuro (2010) argue that small firms are less attractive to outside buyers and consequently are more likely to close if they fail to transfer to an employee. We find that entrepreneurs with intentions to exit via sale or IPO are significantly more likely to be operating younger firms than those intending to exit via cessation, *ceteris paribus*. This supports DeTienne (2010), who finds that founders with a growth motivation (i.e. to follow a financial harvest exit strategy) are less likely to be intricately involved in the organisation as it reaches maturity. It is also consistent with the findings of Zajec *et al*. (2006), Wagner (2004), Ryan and Power (2012), and Foreman-Peck and Nicholls (2013) who report that younger firms are more likely to be sold or transferred. The positive and significant coefficient on *ServiceFirm* indicates that these entrepreneurs are more likely operating knowledge-intensive service firms.

Looking at human capital, we see that entrepreneurs who intend to exit via sale or IPO have significantly more industry-specific experience than those who intend to exit through cessation, *ceteris paribus*. According to DeTienne and Cardon (2012), entrepreneurs with more human capital will feel stimulated to aspire for higher goals and pay-outs and, as such, aim for financial harvest exit strategies. The authors subsequently find that experience is positively related to IPO and acquisition intentions but negatively to liquidation. No effects were found for entrepreneurial education level. These results, or the lack thereof, are in line with those of Wennberg *et al*. (2010) and Leroy *et al*. (2015), who both report that experience, but not education, increases the probability of a firm being sold rather than liquidated. Coupled with this, studies of habitual entrepreneurship have highlighted the importance of previous experience for the successful sale of a venture (Ucbasaran *et al*., 2003). In their study of entrepreneurs from knowledge-intensive service sectors, Wennberg *et al*. (2010) find that past work experience positively influences the probability of harvest sale versus liquidation exit.

Lastly, entrepreneurs who intend to exit via IPO or sale are significantly more likely than those who intend to follow a cessation exit strategy to possess a patent, *ceteris paribus*. This is consistent with Cockburn and MacGavie (2009) who report a positive correlation between patents and exit via IPO and acquisition. As discussed previously, patents play a signalling and certification role that makes them particularly useful in reducing problems of asymmetric information in markets for entrepreneurial financing (see Long, 2002; Mann, 2004; Useche, 2014).[139] For investors in an IPO or buyers in an acquisition the certification component may be particularly important because the examination process at a patent office is designed to provide a certification function through the rejection of inventions that fail to meet the standards required for patentability (Hsu and Ziedonis, 2008). As such, the patent office

[139] Briefly, following Spence's (1973), researchers posit that patents act as quality signals in that they are readily observable attributes correlated with firm performance, they are costly to obtain and they provide a selection mechanism which allows observers to distinguish among different qualities (see Long, 2002; Hsu and Ziedonis, 2008).

effectively serves as an intermediary that verifies the information contained in the patent for these external parties (Long, 2002). DeTienne *et al*. (2015) propose that innovation activities are related to the development of a financial harvest strategy because of the entrepreneur's risk/reward expectations. In short, because innovative opportunities carry additional risk, the expected returns from bearing those risks of innovative activities are also higher. According to the authors, it thus follows that entrepreneurs who pursue innovation will develop a financial harvest exit strategy which will allow them to attain the greatest reward for bearing that risk. Lastly, the literature recognises that acquisitions are an important channel through which incumbents gain access to novel and innovative technologies (see Granstrand and Sjolander, 1990; Desyllas and Hughes, 2008, 2009). Evidence shows that patenting is positively correlated with the probability of being acquired (see Ali-Yrkkö *et al*., 2005; Marco and Rausser, 2008). Thus, patenting can play an important role for those entrepreneurs aiming for a financial harvest exit.

Our principal conclusion is that equity financing appears to be significant in shaping entrepreneurial exit intentions, supporting the proposition of Mason and Botelho (2016). Specifically, those who intend to exit via IPO are significantly more likely to be equity financed than those who intend to exit via trade sale. Similarly, those who intend to exit via either IPO or sale are significantly more likely to be equity financed than those who intend to exit via cessation. Interestingly, these entrepreneurs are more likely to have an exit plan in place. Those intending to exit via cessation are more likely to be non-equity financed and are unlikely to have an exit plan in place. Logically, because equity financed firms are typically more focused on financial performance, it follows that those with equity financiers will be more inclined towards financial harvest strategies which provide the greatest return for stakeholders (Cumming and MacIntosh, 2003a, b).

Table 7.13. Determinants of Entrepreneurial Exit Intentions Multinomial Probit – All Firms (N=294)

	I Sale relative to IPO	II Sale relative to Cessation	III IPO relative to Cessation
EquityFinanced	-0.9125***	0.9114***	1.8239***
	(0.3056)	(0.3247)	(0.3868)
ExitPlan	0.3008	0.4609*	0.7618**
	(0.2672)	(0.3247)	(0.3662)
Firm-specific:			
Size	-0.0057**	0.0098**	0.0156***
	(0.0026)	(0.0052)	(0.0054)
Age	0.0075	-0.0542*	-0.0616*
	(0.0343)	(0.0307)	(0.0403)
ServiceFirm	-0.0512	0.6673**	0.7185*
	(0.3762)	(0.3360)	(0.4351)
Market & Product:			
Rivalry	-0.0056	-0.0072	-0.0016
	(0.0071)	(0.0071)	(0.0009)
ProdDiff	-0.0454	0.1441	0.1895
	(0.1649)	(0.2007)	(0.2198)
Human Capital:			
FoundEdu	-0.0930	-0.1650	-0.0720
	(0.2221)	(0.2495)	(0.2934)
FoundIndExp	0.0076	0.0370**	0.0446**
	(0.0182)	(0.0173)	(0.0214)
Innovation:			
Patent	-0.6858***	1.0138**	1.6996***
	(0.2787)	(0.4529)	(0.4883)
Constant	2.1134***	1.3993	-0.7141
	(0.7009)	(0.7550)	(0.8374)
No. Observations		294	
Log Pseudolikelihood		-203.2542	
Wald chi2 (20)		86.15	
Prob > chi2		0.0000	

Notes: (1) Robust standard errors in parentheses; (2) Significance levels: * p<0.1; ** p<0.05; *** p-<0.01

Largely, our findings are comparable for the determinants of entrepreneurial exit intentions for the 153 entrepreneurs within equity financed firms (Table 7.14). Beginning with results for the probability that the entrepreneur intends to exit via sale in comparison with the probability that they intend to exit via IPO, we find a significant negative coefficient on venture capital financing (Column I). This suggests that entrepreneurs with intentions to sell are significantly less likely to have a venture capitalist involved in their business than those who intend to exit via IPO, *ceteris paribus*. In other words, entrepreneurs who intend to take their firm public relative are significantly more likely to have a venture capitalist involved in their business, compared to those who intend to exit through a trade sale. This provides support for Hypothesis 12. IPOs are typically considered the preferred exit mechanism for venture capitalists, generating superior returns and also providing reputational effects for these investors (see Gompers and Lerner, 1999; Brau *et al.*, 2003; Söderblom and Wiklund, 2006; Poulsen and Stegemoller, 2008). Logically, it follows that those entrepreneurs that have obtained venture capital funding would be more likely to pursue, or indeed expect, to exit via IPO. Once again, the size variable is significant and negative, indicating that those entrepreneurs who intend to exit via sale are more likely to be operating a smaller firm, *ceteris paribus*, than those who intend to exit via IPO. This supports existing evidence (see Brau *et al.*, 2003; Cao, 2011).

Turning to results for the probability that an entrepreneur intends to exit via sale (Column II) or IPO (Column III) relative to cessation, we will once again consider these findings together. Interestingly, both angel and venture capital financing are positive and significant, again in line with Hypothesis 12. Thus, entrepreneurs who intend to sell or go public are significantly more likely to have angel financing than those who intend to exit via cessation, *ceteris paribus*. This is also the case for those with venture capital financing. Those with angels or venture capitalists involved in their business are more likely to aim for a successful exit, with a view to providing returns to their investors (see Hellmann and Puri, 2000; Dutta and Folta, 2016). The presence of government-managed equity investors does not significantly impact on exit intentions. It appears that private equity investors are the sources of equity that significantly impact entrepreneurial exit. This is somewhat consistent with the existing evidence, although sparse. In a European study, Cumming *et al*. (2017) find a positive impact of private venture capital on the likelihood of achieving an exit through IPO or acquisition, whereas government-managed venture capital funds have a negligible impact. For Canada, Cumming and Johan (2008a) find that those backed by government-managed venture capital are less likely to exit via IPO or acquisition, whereas they are more likely to exit via secondary sales or buybacks.

Mostly, findings relating to control variables are comparable to those outlined previously. Briefly, those entrepreneurs in this subsample who intend to exit via initial public offering or trade sale are significantly more likely to have an exit plan than those who plan to pursue a cessation exit strategy, *ceteris paribus*. This provides support for DeTienne (2010). We find entrepreneurs with intentions to pursue a financial harvest exit are operating larger, younger firms than those who intend to exit via cessation, *ceteris paribus*. Interestingly, the coefficient on *ProdDiff* is positive and significant. The realisation that their product is unique or novel may entice the entrepreneur towards a financial harvest exit strategy, with a view to reaping rewards for their efforts in product differentiation (see DeTienne, 2010; DeTienne *et al.*, 2015). Moreover, in their theoretical analysis of the firm's choice of exit mechanism between an IPO or acquisition, Bayar and Chemmanur (2012) predict that those firms with business models viable against product market competition are more likely to go public. Once again, those entrepreneurs who intend to exit via sale have significantly greater industry-specific experience than those who expect a cessation exit, *ceteris paribus*. The coefficient is insignificant for the probability that an entrepreneur expects to exit via IPO relative to cessation. Finally, the positive and significant impact of patenting is once again observed. Thus, those entrepreneurs who intend to follow a financial harvest exit strategy are significantly more likely than those who intend to pursue a cessation strategy to be in possession of at least one patent. This confirms the role of innovation in predicting financial harvest exit, consistent with DeTienne *et al*. (2015).

Overall, these results highlight the role of the individual sources of equity financing in entrepreneurial exit intentions. Interestingly, it appears that both angel and venture capital financing are positively related to IPO and trade sale exit intentions. There is also further evidence of the role of venture capital in steering entrepreneurs towards an IPO, with entrepreneurs intending to exit via IPO being significantly more likely to have venture capital than those intending to exit via sale. We find no significant role for government-sponsored equity in influencing entrepreneurial exit intentions.

Table 7.14. Determinants of Entrepreneurial Exit Intentions Multinomial Probit – Equity Financed Firms (N=153) with Heckman Correction for Sample Selection

	I Sale relative to IPO	II Sale relative to Cessation	III IPO relative to Cessation
Angel	-0.0857	1.0995**	1.1852**
	(0.4072)	(0.5264)	(0.5528)
VC	-0.5509*	0.0826*	0.6335*
	(0.3688)	(0.4648)	(0.4914)
GovSpon	0.2223	0.2603	-0.0380
	(0.4472)	(0.5631)	(0.6144)
ExitPlan	-0.2187	-0.6251*	-0.4064*
	(0.3464)	(0.4626)	(0.4825)
Firm-specific:			
Size	-0.0092***	0.0389*	0.0481*
	(0.0032)	(0.0273)	(0.0273)
Age	0.0385	0.1939***	0.1553**
	(0.0405)	(0.0768)	(0.0767)
ServiceFirm	0.1505	0.6057	0.4552
	(0.4870)	(0.6744)	(0.7311)
Market & Product:			
Rivalry	0.0412	0.0999	0.0587
	(0.0396)	(0.0608)	(0.0639)
ProdDiff	0.3489	0.8649***	0.5159*
	(0.2788)	(0.3647)	(0.3705)
Human Capital:			
FoundEdu	-0.1524	0.1953	0.3477
	(0.2813)	(0.4453)	(0.4698)
FoundIndExp	-0.0272	0.0634**	0.0362*
	(0.0260)	(0.0308)	(0.0338)
Innovation:			
Patent	-0.1588	1.2853***	1.4442***
	(0.4038)	(0.5096)	(0.5578)
MillsRatio	0.2939	-0.0224	-0.3164
	(0.6075)	(0.8430)	(0.9032)
Constant	1.1913	-2.8379	-4.0294*
	(1.4230)	(2.2041)	(2.2271)
No. Observations		153	
Log Pseudolikelihood		-109.2721	
Wald chi2 (26)		50.48	
Prob > chi2		0.0028	

Notes: (1) Robust standard errors in parentheses; (2) Significance levels: * p<0.1; ** p<0.05; *** p-<0.01; (3) *MillsRatio* controls for sample self-selection

7.5 General Conclusions

The over-reaching aim of the empirical analysis undertaken in this Chapter was to investigate the implications of equity financing for funded firm performance and entrepreneurial exit intentions. This was done not only through a comparison of equity and non-equity financed firms but also through an assessment according to source of equity. We began by examining the impact of equity on firm performance. Specifically, three indicators of firm performance are considered, namely: patent counts; firm growth (assets and employment); and firm survival.

Overall, the results suggest that equity financing has a positive effect on the patenting and growth of funded firms. It was found that equity financing positively impacts on patenting activity. This is novel evidence in the Irish context and supports the findings of Engel and Keilbach (2007) for Germany, Bertoni *et al*. (2010) and Caselli *et al*. (2009) for Italy, and Arqué-Castells (2012) for Spain. Interestingly, it appears that it is venture capital that impacts on patenting within funded firms. This finding suggests that, while equity financed firms do patent more than non-equity financed, it is venture capital that makes the significant contribution in this respect. Equity financing also has a positive effect on the growth of funded firm's assets and employment, although there is no significant difference by source. Thus, it appears that higher growth rates are due to the firm being equity financed. Overall, the findings confirm the positive causal impact of equity financing on funded firm growth as reported by Manigart and Van Hyfte (1999) for Belgium, Engel and Keilbach (2007) for Germany, and Levratto *et al*. (2018) for France, providing new evidence in the Irish context. Results suggest that equity financing, and the sources of equity, do not exert a significant impact on the probability of firm survival. The first contribution of this Chapter was to provide unique evidence on the impact of equity on the performance of funded firms.

The focus then turned to the role of equity investors in impacting entrepreneurial exit intentions. Here, attention is on entrepreneurial exit strategy – the mode through which the entrepreneur intends to exit the firm (DeTienne *et al.*, 2015). Results show that equity financing is a significant factor. Entrepreneurs within equity financed firms were significantly less likely to formalise a plan for their own exit. This suggests that, when the entrepreneur's ownership is not diluted by equity investors, there is motivation to consider an exit strategy. Moreover, entrepreneurs within equity financed firms are more likely to pursue financial harvest (IPO or sale) exits over cessation compared to non-equity financed. Additionally, those who plan to exit via IPO rather than sale are more likely to be equity financed. Second, results showed that those entrepreneurs that had obtained venture capital were more likely to expect to exit through IPO rather than sale. Additionally, having obtained angel or venture capital investment was significantly (and positive) related to the intention to pursue a financial harvest exit (IPO or sale) rather than cessation. Government-sponsored equity had no significant impact. By way of explanation, all funds provided through Enterprise Ireland's Seed and Venture Capital scheme are independently managed by private sector fund managers (Enterprise Ireland, 2018). Thus, it is plausible that government-sponsored funders do not impact on entrepreneurial decisions and, instead, the impact is picked up by the presence of private investors (i.e. angels and venture capitalists). Overall, the results suggest that equity financing is positively related to financial harvest exit strategies. The second key contribution of this Chapter is the new evidence presented regarding the impact of equity investors on entrepreneurial exit intentions.

A number of implications arise from these results. As regards **policy-makers**, the findings reinforce the key policy goal of encouraging and facilitating equity investment in innovative and promising ventures. Essentially, the development of the demand and supply of equity financing should figure prominently in policy agenda, with a focus on developing a well-functioning equity market. Design of policy schemes that attract high-quality equity investors and at the same time induce technology-based firms with future growth prospects to look for external equity capital is a crucial priority for policy makers. Additionally, an obvious focus for policy-makers should be on providing more attention and resources to helping promising technology-based companies prepare to float or sell. For example, incorporating discussions of entrepreneurial exit planning in entrepreneurship seminars and courses, with the goal of increasing the percentage of entrepreneurs who develop purposeful exit strategies and plans early in the lifecycle of their firms, would hopefully enable to achieve their chosen exit. For **entrepreneurs,** these findings demonstrate that equity investors can not only provide financial capital but also be beneficial for their firm's performance. This may, in turn, act to encourage entrepreneurs towards external equity as a source of funding. Overall, it is important to know the benefits equity financing, and the different sources of equity available, can offer to investees. Empirical evidence also raises awareness of the factors that impact on technology-based entrepreneurs expected choice of exit mode and the role of equity investors in impacting that choice. Findings indicate that entrepreneurs that have obtained equity investment are more likely to pursue a financial harvest exit strategy. As a practical implication, it is important that entrepreneurs understand the influence of equity financing on their exit and how this impact may differ according to the source of equity obtained. For instance, if an entrepreneur has a high goal for their venture, such as exiting via IPO, then venture capital and angel investors can help them to achieve that goal. Lastly, for **equity investors**, it is naturally beneficial for financiers to understand how they can add value to their portfolio firms. The findings presented herein imply that equity investors have an important role to play in innovation, growth and also in influencing entrepreneurs towards financial harvest exit aspirations. An obvious implication is that these results can aid investors in considering their capacity to provide advice and assistance to portfolio firms in these areas, and also guide investors in focusing attention on those areas where they can add value. This can, ultimately, improve the performance of portfolio firms and, consequently, of the investment fund. This analysis also improves understanding of impact across the sources of equity. For investors considering syndication, it is important to understand what benefits other equity investors can bring to the syndicate. Overall, the findings provide valuable insight and understanding into the creation and development of successful firms.

Although this analysis provided unique and novel evidence of the impact of equity financing on funded firms, the work nonetheless has limitations. While findings suggest that equity financing positively impacts on funded firm innovation and growth, a fruitful avenue for future research would be to extend analysis to examine whether these differences are attributable to a direct effect of equity due to monitoring and governance or from an indirect effect due to selection. Research could investigate whether equity investors emphasise picking winners or building them (Baum and Silverman, 2004). As an extension, it would be interesting to investigate how impact differs among equity investors of varying abilities. In other words, are some investors particularly effective scouts and others particularly effective coaches, or is the beneficial impact of equity a combination of the two? Future research that distinguishes equity investors based on capabilities, such as experience or prior investment track record, may uncover additional nuances in the relationship between equity financing and funded firm performance. It would also be interesting to investigate whether the impact on funded firm performance depends on the ownership concentration of equity investors. Furthermore, while offering a unique insight into the role of equity, and the sources of equity, in influencing entrepreneurial exit intentions, a key area for future research would be to examine the impact of the investor-entrepreneur relationship in this context in greater detail. Specifically, an investigation of the nature and social aspects of the relationship would provide a useful lens through which to explore entrepreneurial exit.

CHAPTER 8 : SUMMARY AND CONCLUSIONS

8.1 Aims and General Findings

This thesis aimed to provide a deeper understanding of the financing of technology-based firms, particularly equity financing. The achievement of this objective consisted of a number of components. In the descriptive aspect of this study, novel primary-source data was used to compile a detailed profile of technology-based firms (i.e. age, size, market extent, human capital, innovation, etc.) and financing patterns over the lifecycle (i.e. through seed, early-growth, expansion and later stages). Additionally, for those with equity finance, a description of features of equity investment (e.g. board representation, location of investors, stock ownership, etc.) and attitudes towards equity financing was provided. Following this, empirical investigation explored three main themes. First, analysis examined the factors determining whether the firm is equity financed (e.g. market and product, innovation activity, human capital, financing preferences, etc.). Second, this analysis was extended to examine the extent to which the determinants of equity financing differ when examined according to source of equity (angel, venture capital, government-sponsored), stage of the lifecycle (seed, early-growth, expansion) and given the relationship between the different sources of equity financing. Third, analysis examined the role of equity finance in impacting funded firm performance and entrepreneurial exit intentions.

The study was fieldwork based. It involved gathering new data in face-to-face interviews with the founder-CEOs of 153 equity-financed firms. A condensed self-administered survey also gathered data from 141 non-equity financed firms. The survey instrument incorporated a novel template for the collection of detailed data on a comprehensive range of sources of internal and external financing obtained at distinct stages in the firm's lifecycle. The resultant data was used to create a novel profile of the financing patterns of technology-based firms within a lifecycle framework, along with a detailed description of equity investment. It also enabled a number of hypotheses to be tested on the determinants of equity and sources of equity, the relationship between the sources (i.e. whether they complement or substitute each other in the financing of technology-based firms) and the role of equity investors in influencing funded firm performance and the entrepreneurs' expected exit mode (i.e. IPO, sale, cessation). The main outcomes were as follows:

- On average, the technology-based firms which took part in this study were 8 years old. The vast majority (84%) operate in knowledge-intensive service sectors. The predominant firm types were micro (52% had less than 10 FTEs) and small (37% had between 10 and 49 FTEs) firms.

- Observed financing patterns are in accordance with the predictions of the financial lifecycle (see Roberts, 1991; Berger and Udell, 1998). At seed, the most prevalent source of finance is personal investment of the founder(s), along with Government grants. Moving into early-growth, although personal funding remains widespread, we see increasing use of retained profits. This continues into expansion and later stages, particularly for non-equity financed firms.

- Those with equity financing have obtained funding from, on average, two sources of equity. For the 153 equity financed firms, a total of 121 (79.1%) have obtained government-sponsored equity, 117 (76.5%) angel investment and 104 (68%) venture capital. While co-investment is a common control mechanism in equity investment (Lockett and Wright, 2001), a facet of the main government-sponsored equity fund in Ireland, Enterprise Ireland's Seed and Venture Capital Scheme, is that investments are made on a matching basis, whereby the firm must obtain funding that will at least match the commitment from this fund.

- In testing the determinants of equity, there is evidence that export-oriented firms operating in niche markets have a greater probability of being equity financed. Innovation activity along with human capital, of both the founder-CEO and workforce, also represent positive signals. Entrepreneurial preferences affect financing choices, with entrepreneurs in equity financed firms preferring external as opposed to internal finance. While f-connection funding positively and significantly impacts on equity financing, the opposite is the case for debt financing.

- Extending analysis of determinants across source (angel, venture capital, government-sponsored equity) and stage (seed, early-growth, expansion) we find, in general, that determinants differ not only by investor type but also by stage. To illustrate briefly, personal investment is significant for all three sources at the seed stage (Table 6.6) but while it has a positive effect on both angel and government-sponsored funding, the effect is negative for venture capital. Personal investment remains significant and negative for venture capital but positive for government-sponsored funding in the early-growth stage (Table 6.7). The effect is not significant at expansion, for any source (Table 6.8). This suggests that the signal emanating from personal investment is not only temporary in nature but also dependent on the source of equity sought. In general, results show that the factors associated with the technology-based firm and entrepreneur play differing signalling roles depending on the source of equity targeted and the firm's stage in the lifecycle. Interestingly, f-connection investment has a positive significant impact on the likelihood of obtaining angel funding at each stage. For venture capital, patents represent a positive significant signal across the stages while for government-sponsored funding it is R&D that is a consistent (positive) signal.

- Next, attention turned to the relationship between the sources of equity, specifically the extent to which the sources substitute or complement each other in the financing of technology-based firms. At the early-growth stage, results indicate a substitution effect with seed stage funding. Within investor types, those with angel funding at seed are less likely to obtain (new) angel investment during the early-growth stage. Furthermore, a substitutes relationship is found within government-sponsored funding. Across investor types, results also show substitution effects. Angel funding at seed has a negative significant effect on venture capital during early-growth. For the expansion stage, the results are somewhat mixed. Within investor types, venture capital at seed has a significant negative impact (substitution effect) on (new) venture capital at expansion. The presence of angel investors from seed, on the other hand, positively impacts (complements effect) the probability of being angel funded at expansion. Across investor types, venture capital at seed significantly and negatively impacts on government-sponsored funding at expansion. Those with angel funding at the early-growth stage are more likely to go on to obtain venture capital at expansion. Those that obtain government-sponsored funding in previous stages are less likely to obtain angel and government-sponsored funding in the expansion stage. By way of explanation, there is one main publicly-sponsored equity fund in Ireland (Enterprise Ireland) and, as such, the vast majority of firms obtain funding from this one source. Additionally, given the requirement for matched funding, it is plausible to reason that funding from a private source (i.e. angels or venture capitalists) would occur within the same stage as government funding, and not subsequent stages.

- As to the impact of equity financing on funded firm performance, results suggest that equity financed firms have a higher number of patents and higher (asset and employment) growth rates than non-equity financed firms. Equity financing does not significantly impact the probability of firm survival. As to the impact across sources, venture capital financing has a positive significant impact on patenting, while the impact of angel and government-sponsored equity is insignificant. This finding echoes Conti *et al*. (2013) who report that patents are more important to venture capitalists than angels. For firm growth and survival, there is no significant difference by source.

- Finally, to entrepreneurial exit intentions, results showed that it is entrepreneurs within non-equity financed firms that are more likely to develop a plan for their own exit. This suggests that, when the entrepreneur's ownership is not diluted by equity investors, there is greater motivation to consider their exit strategy. Those entrepreneurs expecting to exit via IPO rather than sell their business are more likely to be equity financed. Those planning to exit via IPO or sale rather than cessation are more likely to be equity financed. As to the impact by source, those with venture capital are more likely to expect to exit through IPO rather than sale. Those with angel or venture capital are more likely to intend to exit via IPO or sale rather than cessation. Overall, this implies that entrepreneurs with equity investors are more likely to expect a financial harvest exit strategy and that it is the presence of private equity (angel and venture capital) that impacts choice.

The chief contributions of this thesis involved the collection of an original body of data on Irish technology-based firms, and the testing of novel hypotheses regarding equity financing on this data. The main findings presented above are judged to make a significant contribution to the existing literature on entrepreneurial financing.

8.2 Research Conclusions and Contributions

This Section summarises the key research conclusions and contributions by reference to those parts of the thesis that most embody them: Chapters 4 to 7. Essentially, the main findings, indicated in Section 8.1, are examined in greater detail herein.

In **Chapter 4**, a unique picture of the typical technology-based firm in the sample was presented. These firms are predominantly privately held, led by founders that have assumed the position of Chief Executive Officer, particularly for equity financed firms. The founder-CEOs within these firms are highly educated (over half (54.8%) are educated to degree level, over a third (37.8%) hold a Masters and almost a tenth (7.4%) a doctorate) and experienced (on average, these founder-CEOs have 18 years of industry-specific experience, along with an average of 5 years spent working abroad). Moreover, technology-based firms possess high levels of organisational human capital, with an average of 85% of the workforce in these firms holding a third-level degree or equivalent. As regards attributes of their market, firms in the sample do engage in export activity, generating, on average, 54% of turnover through exporting. Interestingly, we saw that equity financed firms appear to be more likely to cultivate market niches and emphasise product differentiation. These technology-based firms, for the most part, continuously or regularly engage in product and process innovation, although frequency of innovation is significantly higher among equity financed firms. Technology-based firms devote an average of 37% of expenditure to R&D activities. As regards intellectual property, 88 (29.6%) firms possess at least one patent while 83 (28.8%) possess copyright. Overall, this characterisation not only provides an in-depth profile of the technology-based firm but also informs on the factors to be considered in quantitative analysis in Chapters 5 and 6.

Next, attention turned to the financing patterns of technology-based firms. Financing data was categorised by three sources of internal funding (personal, directors loan, retained profits), five sources of debt (overdraft, business mortgage, short-, medium- or long-term loan), four sources of equity (independent venture capital, corporate venture capital, angel, government-sponsored equity), f-connection investment, and Government support (i.e. grants) and presented across four stages in the lifecycle (seed, early-growth, expansion, later). In general, as prescribed by the financial lifecycle (Berger and Udell, 1998), these firms utilise a changing array of sources of financing as they progress through the stages in their lifecycle. Specifically, while personal funding is prevalent during nascent years, retained profits become a key source of funds moving into expansion and later years, particularly for non-equity financed firms. Government funding in the form of grant was also a noteworthy source of funds during the seed and early-growth years. Within Chapter 4, a comprehensive description of equity financing is also presented. We saw that co-investment is commonplace with firms obtaining equity finance from, on average, two sources. Over a third (38.6%) obtained equity from all three sources examined (angel, venture capital, and government-sponsored equity). As mentioned previously, not only is co-investment a common feature of equity financing (Lockett and Wright, 2001) but, in the Irish context, government-sponsored funding is given on a matching basis (IVCA, 2012). Staging of capital injections is also a common feature of equity investment. Specifically, of those with angel financing, almost two-thirds (62.4%) obtained funding in stages, while over two-thirds (67.8%) obtained government-sponsored equity in stages. Almost three-quarters of independent (70.6%) and corporate (74.1%) investment was staged. This is consistent with the extant literature highlighting the use of staged investment as a common control and monitoring mechanism in equity financing (see Gompers, 1995; Wong *et al*., 2009; Sharma and Tripathi, 2016). Turning to demand-side perspectives, in deciding to seek equity funding issues pertaining to control are important, although risk sharing does not seem to be key. In terms of non-financial value added, entrepreneurs mainly felt that they benefit from the advice offered by investors.

Overall, Chapter 4 offers three main contributions. First, a detailed and unique characterisation of Irish technology-based firms is provided. Second, a novel profile of the sources of financing used by firms over four distinct stages in the lifecycle is presented. Finally, a detailed profile of the type of equity investors active in the financing of Irish technology-based firms, along with various features of investment and entrepreneurial attitudes towards equity financing, is presented.

Moving on, **Chapter 5** draws on both screening and signalling (Spence, 1973; 1974) literature to examine the factors that determine whether the technology-based firm is equity financed. Our analysis reveals that market-related factors are central in equity financing. Specifically, in terms of magnitude, the extent of market rivalry is the most important signal for equity financing. Results also show that exporting activity plays a significant role, with equity financed firms being more export-oriented than non-equity financed. Overall, findings are consistent with supply-side evidence, which shows that market potential is key in the screening process (see Petty and Gruber, 2011; Carpentier and Suret, 2015). In terms of human capital, the findings reveal that founder-CEO education and international experience are both significant determinants of equity financing, although educational attainment has the greater impact. This confirms the findings on the role of human capital in attracting equity investment (see Mason and Stark, 2004; Patzelt, 2010; Behrens *et al*., 2012). Additionally, organisational human capital is a significant positive signal and, within the human capital category, has the largest magnitude. This confirms the importance of employee, or firm level, human capital (Chowdhury *et al*., 2014).

The results also reveal important signals emanating from firms' innovation activity. Indeed, the frequency of innovation has the second largest (positive) impact on the use of equity financing. It appears that, by promoting the innovativeness of their venture, entrepreneurs effectively position themselves to appeal to equity investors looking to access new markets.

Additionally, R&D-intensity has a significant and positive impact on the probability of being equity financed, although the magnitude is not as large. Nonetheless, using R&D expenditure as a signal can lessen information opacity inherent in innovative projects. Specifically, because reducing information asymmetries via fuller disclosure is often of limited effectiveness in this arena (i.e. ease of imitation makes firms reluctant to reveal full details of innovative ideas), given that data pertaining to R&D expenditure is more readily available, it thus constitutes an effective and observable signal. This evidence highlights the important role of equity in funding R&D and innovation activities (see Kortum and Lerner, 2000; Hall and Lerner, 2010).

Finally, results show that financing-specific factors also play a role in the funding of technology-based firms. First, entrepreneurial financing preferences impact on capital structure. Specifically, it is those with a preference for external as opposed to internal sources of entrepreneurial financing that are more likely to be equity financed. Realistically, those entrepreneurs that favour external financing may feasibly be assumed to be more likely to search for financial resources from outside investors and, subsequently, cede the control necessary to obtain funding. Results also reveal a significant role for investment from family and friends. Personal networks not only act as a financial cushion for new and small ventures until they gain access to external sources of capital (Berger and Udell, 1998) but can also be used as a signal for external investors (see Agrawal *et al*., 2011; Conti *et al*., 2013). Finally, findings reveal that those with equity financing are less likely to also use debt financing. While this is consistent with prior results of a general lack of debt financing for technology-based firms (Coleman and Robb, 2012), it may also provide evidence of the substitutive relationship between debt and equity finance as proposed by Audretsch and Lehmann (2004).

This Chapter makes three important contributions. First, the analysis adopts a broad definition of equity finance, including both private (independent and corporate venture capital, business angels) and public (government-sponsored equity) sources, to provide novel evidence regarding the determinants of equity financing. Second, by examining an expansive set of multifaceted factors, encompassing firm-specific, human capital, innovation-specific and financing-specific attributes, this study expands on extant research and offers original evidence. Third, this work uses a unique database which spans across technology-based manufacturing and knowledge-intensive service sectors thus adding to recent sector specific studies such as biotechnology (Hoenen *et al.*, 2014), software (Hogan and Hutson, 2005b), and nanotechnology (Munari and Toschi, 2015).

Chapter 6, building on the analysis in Chapter 5, explores the extent to which the determinants of equity financing differ when examined according to source of equity (angel, venture capital, government-sponsored) obtained at three distinct stages in the lifecycle (seed, early-growth and expansion), and given the relationship between the sources of equity financing. As empirical analysis is focused solely on equity financed firms (N=153) all estimations included a Heckman two step correction for sample selection bias.

Beginning with results for angel financing, personal and f-connection investment both have a positive and significant impact on the likelihood of being angel funding at the seed stage (Table 6.6). The positive and significant impact of f-connection funding is also evident in the results for the early-growth (Table 6.7) and expansion (Table 6.8) stages of the lifecycle. These findings support Conti *et al*. (2013) and emphasise the role of founder, family and friends' investment as a signal for angel financing. Human capital is also an important determinant for angel financing over the lifecycle, although the signals switch over the stages. Specifically, while industry-specific experience has a positive and significant impact on angel funding during the seed stage, educational attainment of both the founder-CEO and workforce are the significant (positive) signals during the early-growth and expansion stages. This suggests that while signals of the entrepreneur's ability to commercialise a new product/service and navigate industry changes (via industry-specific experience) is pertinent at the seed stage, signals pertaining to the ability to achieve growth-prospects through greater innovativeness and productivity (via educational attainment) comes into play from the early-growth years (Ko and McKelvie, 2018). International experience is also a positive significant signal for angel financing, but only in the expansion stage. Overall, signals of commitment (founder, family, friends' investment) and human capital are particularly noteworthy for angel financing, although signals from the latter are somewhat temporary in nature. Innovation activity does play a signalling role for angel funding, but this is limited to the early-growth stage. Similarly, occupying a market niche is a beneficial factor but only during the seed stage.

Turning to venture capital, positive significant coefficients on firm size at the seed (Table 6.6) and early-growth (Table 6.7) stages suggest that, in line with existing evidence (see Colombo and Grilli, 2005b; Engel and Keilbach, 2007), larger firms are more likely to be venture capital financed. A particularly notable finding is that patents play a positive significant role at each stage. While we know that patents act as a key signal in attracting venture capital (see Baum and Silverman, 2004; Engel and Kielbach, 2007; Haeussler *et al*., 2009; Zhou *et al*., 2016), the evidence herein is novel in that it demonstrates how the signalling function of patenting persists over the lifecycle. Interestingly, personal investment has a negative significant impact on the probability of being venture capital financed at the seed and early-growth stages, suggesting that those obtaining venture capital in nascent years have less dependence on the funds of the founder(s). Market and product-related factors also play an important role. Specifically, the negative significant coefficient on market rivalry at the seed stage suggests that those occupying a market niche (i.e. facing less rivals) are more likely to obtain venture capital during their seed year. Moving through the lifecycle, rivalry is again negative and significant at the expansion stage (Table 6.8). Additionally, the positive and significant coefficients on exports and product differentiation suggest that greater levels of export activity along with a unique product offering are important signals for venture capital during expansion years. These results are hardly surprising, given that venture capitalists are known to consider market/product-related attributes key criterion in their investment decision-making (Petty and Gruber, 2011). Overall, we conclude that larger firms who can signal not only superior technological/innovative capability through patenting, but also the prospect of future profits stemming from a competitive market position, along with eventual internationalisation and product differentiation are more likely to be financed by venture capitalists.

Finally, we come to government-sponsored equity funding. Results emphasise the complementary relationship between government-sponsored funding and non-equity sources of finance. Specifically, founder, family and friends' investments are positively and significantly related to government-sponsored equity over the seed (Table 6.6) and early-growth (Table 6.7) years, while debt has the positive significant impact at the expansion stage (Table 6.8). Feasibly, this result can be interpreted as evidence of the co-funding aspect of this source of funding, whereby government provides a proportion of funding to lever matched funding from private sources (see Murray, 2007; Owen and Mason, 2017). However, following Conti *et al*. (2013), we may also speculate that these sources serve as a signal of entrepreneurial commitment. As per the financial lifecycle (see Roberts, 1991; Berger and Udell, 1998), by the expansion stage debt takes over from personal and f-connection funds, thereby providing the effective signal. Another particularly noteworthy result is the impact of R&D activity which is positive and significant across each stage of the lifecycle. A widely held view is that R&D and innovative activities are difficult to finance in a freely competitive market (Hall and Lerner, 2010). Notwithstanding equity investors' superior abilities to address information asymmetries, the entrepreneurial financing literature has shown that a gap remains, especially at the earliest stages of development (see Lockett *et al*., 2002; Kelly, 2011). Consequently, government-sponsored equity funds may play a particularly important part in providing equity capital to R&D-intensive firms (Guerini and Quas, 2016).

Also, in **Chapter 6**, analysis explored the relationship between the sources of financing, specifically the complementarity/substitutability between the sources of equity over the lifecycle. First, for equity financing obtained during the early-growth stage, we find considerable support for a substitute relationship with seed stage funding. Specifically, firms that obtained angel financing at the seed stage are significantly less likely to obtain angel, venture capital or government-sponsored equity funding at the early-growth stage. This substitution effect is stronger for early-growth government-sponsored equity. Additionally, government-sponsored funding at the seed stage is negatively and significantly related to subsequent angel and government-sponsored equity during early-growth, and this effect is stronger for the latter source. Generally, these findings suggest that, within the equity financing '*ecosystem*' (Hellmann *et al*., 2015, page 33), firms do not necessarily graduate from one source of equity to another over the period from the seed stage to the early-growth years. Interestingly, those with personal and debt funding at the seed stage are more likely to obtain government-sponsored funding during the early-growth stage, further confirming a complementary relationship between this source and non-equity funding. Moving to the expansion stage, the results are somewhat mixed. Specifically, those obtaining venture capital at their expansion stage are significantly less likely to have received venture capital and/or government-sponsored equity during their seed year. Conversely, those firms that obtained angel financing at the seed stage are significantly more likely to obtain venture capital funding at the expansion stage. This is also the case for those firms that obtained angel funding at early-growth stage. Furthermore, those obtaining angel finance at early-growth are also more likely to obtain new angel investment at expansion. Thus, seed and early-growth stage angel investment complement subsequent venture capital and angel financing during expansion. As regards government-sponsored funding, those obtaining government-managed investment at the expansion stage are unlikely to have obtained finance from a government-managed funds at seed or early-growth. There is also a substitute effect between government-sponsored funding obtained at the seed stage and angel financing at expansion. Overall, these results suggest a somewhat complex relationship between the sources of equity, whereby seed funding substitutes early-growth stage financing but, as the firm enters expansion, prior angel funding complements private equity financing (angel and venture capital).

The contributions of this Chapter lie in three directions: First, empirical analysis untangles the determinants of equity tested in Chapter 5 by examining determinants across the individual sources of equity. Second, empirical analysis is unique in that econometric models are estimated for distinct stages in the lifecycle, illustrating that the determinants may differ not only by source but also over time. Finally, by investigating the relationship between angel, venture capital and government-sponsored equity, empirical analysis offers original evidence of the extent to which these sources complement or substitute each other over the lifecycle.

Last, **Chapter 7** explored the impact of equity financing on funded firm performance and in influencing entrepreneurial exit intentions. This was done not only through a comparison of equity and non-equity financed firms but also through an assessment according to source of equity. Once again, those estimations based solely on equity financed firms (N=153) included the Heckman two step correction for sample selection bias. Three indicators of firm performance are considered, namely: innovative output, measured using patent counts; firm growth, measured using asset and employment growth rates; and firm survival. It was found that equity financing positively impacts on patenting activity (Table 7.6). Specifically, in terms of total patent stock, equity-financed firms hold approximately 2 more patents than their non-equity-financed counterparts, *ceteris paribus*. This is novel evidence in the Irish context and supports the findings of Engel and Keilbach (2007) for Germany, Bertoni *et al*. (2010) and

Caselli *et al*. (2009) for Italy, and Arqué-Castells (2012) for Spain. Quite interestingly, it appears that it is venture capital that effects patenting (Table 7.7), with results showing that those funded by venture capitalists possess approximately 3 more patents, *ceteris paribus*. This finding suggests that, while equity financed firms do patent more than non-equity financed, it is venture capital that makes the significant contribution in this respect. Equity financing also had a positive effect on the growth of funded firm's assets and employment (Table 7.8), although there is no significant difference by source (Table 7.9). Thus, it appears that higher growth rates are due to the firm being equity financed. Overall, the findings confirm the positive causal impact of equity financing on funded firm growth as reported by Manigart and Van Hyfte (1999) for Belgium, Engel and Keilbach (2007) for Germany, and Levratto *et al*. (2018) for France, providing new evidence in the Irish context. Thus, the first contribution of Chapter 7 is that it provides unique evidence on the impact of equity on performance.

The focus then turned to the influence of equity investors in impacting entrepreneurial exit intentions. Here, attention is on entrepreneurial exit strategy – the mode through which the entrepreneur intends to exit the firm (DeTienne *et al*., 2015). Results show that equity financing is a significant factor for entrepreneurial exit. First, being equity financed was significantly and negatively related to the development of an entrepreneurial exit plan. Thus, those entrepreneurs who have obtained equity investment for their ventures are less likely to develop a plan for their own exit. This suggests that, when the entrepreneur's ownership is not diluted by equity investors, there is motivation to consider an exit strategy. Second, results showed that entrepreneurs within equity financed firms are more likely to explore financial harvest (IPO or sale) exit paths rather than cessation. Furthermore, those who plan to exit via IPO rather than sale are more likely to be equity financed. The second set of estimations focused on the impact of the sources of equity. These results showed that those entrepreneurs that had obtained venture capital were more likely to expect to exit through IPO rather than sale. Additionally, having obtained angel or venture capital investment was significantly (and positive) related to the intention to pursue a financial harvest exit strategy (IPO or sale) rather than cessation. Government-sponsored equity has no significant impact. By way of explanation, all funds provided through Enterprise Ireland's Seed and Venture Capital scheme are independently managed by private sector fund managers (Enterprise Ireland, 2018). Thus, it is plausible that government-sponsored funders do not impact on entrepreneurial decisions and, instead, the impact is picked up by the role of private investors (i.e. angels and venture capitalists). Overall, the results suggest that equity financing is positively related to financial harvest exit strategies. This brings us to the second contribution of Chapter 7 – not only do we provide new evidence regarding the impact of equity investors on entrepreneurial exit intentions but, by taking into consideration the source(s) of equity obtained, we also provide unique evidence regarding how this impact differs by investor type.

8.3 Further Research and Recommendations

This Section concludes by proposing potentially fruitful areas for future research (Subsection 8.3.1). Following this, we make recommendations to policymakers, entrepreneurs and investors, concerning prescriptions that can enhance and improve the financing of technology-based firms (Subsection 8.3.2).

8.3.1 Further Research

Although **Chapter 4** provided a unique characterisation of technology-based firms and their financing patterns, it also highlighted a number of interesting avenues for future research. First, future research might beneficially seek data on sources of financing in percentage form, which would offer advantages not only in descriptive data but empirical investigation. Second, extending this study to technology-based firms outside of Ireland would provide an interesting comparison basis. Third, building on our enquiry into entrepreneurial perspective and opinions (for example, loss of control, risk sharing, etc.) in deciding to seek external equity financing, researchers could delve into this demand-side issue further, for example, through case studies with technology-based firms that either decide not to use external equity or those who have failed in their application for equity investment.

Chapter 5 examined how signals originating from technology-based firm and entrepreneur characteristics impact on equity financing. The results provide novel insight into demand-side determinants of equity. As a follow-on to this analysis, it would be interesting to see how equity investors rate these factors in their investment appraisal. For example, future research could survey equity investors to get their reaction to the factors identified herein (for example, how important is occupying a market niche in the investment decision) or to examine how they rate these factors in their appraisal of investment proposals. It would also be interesting to ascertain if these results are generalised to technology-based firms in other countries.

In **Chapter 6**, an in-depth empirical analysis investigated the determinants of equity financing across sources (angel, venture capital, government-sponsored equity) and stages (seed, early-growth, expansion) of financing. While this analysis provided unique and novel evidence of the changing nature of signals in the context of new sources of equity obtained during these three stages, this analysis could be extended to explore how the signals behave when investment is obtained by a repeat investor. In other words, empirical models could investigate the extent to which the impact of the signals (for example, patents, founder education, product differentiation) change after the initial investment. A natural step for the analysis of the substitutes/complement aspect would be to collect data on the amount of equity investment obtained from each source at each financing round. Employing such data would facilitate a more in-depth analysis of the interconnectedness of different equity investor types.

Although the analysis in **Chapter 7** presented compelling evidence on the impact of equity financing on funded firm innovation and growth, a fruitful avenue for future research would be to extend empirical analysis to examine whether these differences are attributable to a direct effect of equity due to monitoring and governance or from an indirect effect due to selection. It would also be interesting to investigate whether the impact on funded firm performance depends on the ownership concentration of equity investors. Furthermore, while offering a unique insight into the role of equity, and the sources of equity, in influencing entrepreneurial exit intentions, a key area for future research would be to examine the impact of the investor-entrepreneur relationship in this context in greater detail. Specifically, an investigation of the nature and social aspects of the relationship would provide a useful lens through which to explore entrepreneurial exit.

8.3.2 Recommendations

Finally, this thesis also has several practical implications. In **Chapter 4**, we saw that Irish technology-based firms finance their activities broadly in accordance with the financial lifecycle (Berger and Udell, 1998). In particular, evidence emphasised the role of founder and f-connection investment in the seed and early-growth year, providing key sources of capital to firms until retained profits take over. Consequently, **policymakers** should focus on the tax incentives or implications of entrepreneurs and private (personal) investors. For instance, the Start-up Relief for Entrepreneurs (SURE) scheme, which provides a refund of income tax paid to non-PAYE taxpayers could be extended, through an increase in the limit of this scheme or by granting tax SURE relief upfront to assist cash flow rather than retrospectively. Furthermore, the Employment and Investment Incentive Scheme (EIIS), the main tax scheme through which equity capital injections are likely to be accessed by SMEs, could be expanded. As to expansion and later stages, most Governments, the EU Commission and the European Investment Fund favour the creation of a 'fund of funds', as a vehicle to encourage private sector investment in venture capital (IVCA, 2019a). This concept could be explored in Ireland, through the development of a State-backed fund of funds.

Interestingly, analysis in **Chapter 5** showed that founder and f-connection investment positively impact on equity financing, while **Chapter 6** demonstrated how these signals are particularly important in facilitating access to angel and government-sponsored funding, particularly in the seed and early-growth stages. Findings emanating from Chapter 5 suggest that key in obtaining equity financing is the use of information that signals the firm's competitive position, export potential, innovation and R&D efforts, and human capital competencies. Recognising that different audiences look at the investment proposal from different perspectives, the findings in Chapter 6 draw out the implications of these differences for the entrepreneur so that they can differentiate their application for funding to suit the source of equity targeted within a specific stage of development. For **entrepreneurs** looking for external equity investment, this evidence provides valuable knowledge and understanding of the factors that equity investors are looking for in an investee. Knowing how to present their investment opportunity effectively to potential equity investors is an important aspect of being 'investor ready' (Mason and Kwok, 2010). As regards **policy measures**, initiatives that facilitate the development of financing know-how and capabilities, such as training in the preparation of financial documentation for applications to equity investors, the improvement in understanding of entrepreneurs relating to different financing sources, and how to produce effective business plans would be beneficial in order to provide support to entrepreneurs in successfully accessing equity finance. Delving deeper, the evidence presented in **Chapter 6** could be used to tailor these initiatives to specific types of equity and stages of development. Recognising that different audiences look at the investment proposal from different perspectives, the findings can also guide **entrepreneurs** in selecting appropriate signals, so that they can differentiate their application for funding to suit the source of equity targeted within their stage of development. Entrepreneurs have a limited amount of time and, in most cases, only one opportunity to pitch to an investor (Hsu *et al*., 2014). Understanding how signals matter differently across investor types increases the likelihood that entrepreneurs will be successful at each stage of their fund-raising campaign. Mostly, applications for funding are unsuccessful because they do not match the investor's scope of action or objectives (Carpentier and Suret, 2015). The availability of resources dedicated to helping entrepreneurs overcome the intricacies of procuring external equity investment would be beneficial. Findings in **Chapter 6** also go some way to confirming a potential complementary relationship between initial angel financing and subsequent venture capital investment. Knowing this is important for policy-makers in attempting to foster equity financing. Specifically, adopting programs to support seed and early stage angel investment should enhance access to venture capital for expansion. From the perspective of **equity investors**, these findings can be used to guide and inform practices regarding the selection and assessment of investees by affording a detailed insight into the attributes of those firms that have successfully raised equity investment, but also by delineating the factors according to source of equity and stage of the potential investee's development. Furthermore, the results may also guide equity investors in their co-investment strategies, through a deeper understanding of the potential complements and substitutes that exist within the financing ecosystem. Overall, an improved understanding of the factors used to trim the set of business opportunities seeking investment can help equity investors to improve the efficiency of their own decision heuristics.

The findings in **Chapter 7** contribute to a better understanding of the beneficial effects of equity financing on funded firm performance. As regards **public policy**, this reinforces the key policy goal of encouraging and facilitating equity investment in innovative and promising ventures. Thus, the development of a well-functioning equity market should figure prominently in the policy agenda. Design of policy schemes that attract high-quality equity investors and at the same time induce technology-based firms with future growth prospects to look for external equity capital is a crucial priority for policy makers. For **entrepreneurs,** these findings demonstrate that equity investors are potentially useful for their firm's performance which may, in turn, encourage them towards external equity as a source of funding. It is important to know the benefits equity financing can offer to investees. Analysis in **Chapter 7** also raises awareness of the factors that impact on technology-based entrepreneurs expected choice of exit mode and the role of equity investors in impacting that choice. Findings indicate that entrepreneurs that have obtained equity investment are more likely to pursue a financial harvest exit strategy. As a practical implication, it is important that **entrepreneurs** understand the influence of equity financing on their exit and how this impact may differ according to the source of equity obtained. For instance, if an entrepreneur has a high goal for their venture, such as exiting via IPO, then venture capital and angel investors can help them to achieve that goal. For **policy-makers,** an obvious focus should be on providing more attention and resources to helping promising technology-based companies prepare to float or sell. For **equity investors**, an improved understanding of the ways in which they influence and add value to their portfolio firms can help to guide them in aiding in the development of successful companies.

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Appendix 1: Survey Instrumentation

ID#

Administered Questionnaire *Equity Financed Technology-Based Firms*	
Date / Time of Interview:	
Respondent:	
Firm Name:	
Firm Address:	
Telephone:	
Email:	
Website:	

Preamble: ...

This questionnaire is divided into six sections which include questions on the characteristics of your business, the sources of financing you have utilised since start-up and your experience raising that financing, characteristics of your equity financing, innovation activity in your business, general measures of size and scope and, finally, your planned or expected exit strategy. The typical way in which we shall proceed will involve me asking a question and then noting your reply. In addition, there are a number of opportunities for you to express your own opinion of various aspects relating to the financing of your business. It is helpful to begin in a general way. This will help us to identify the main features of your business before going into detail.

May we begin with the general questions?

Section 1: Characteristics of the Business

1.1 What is your role in this business? *(e.g. founder, CEO, etc.)* ___________________

1.2 When was this business established? (*i.e. in what year)* ___________________

1.3 How is the business registered? *(Tick one)*

Sole trader	**Private company**
Partnership	**Public company**

1.4 How would you define your *main* line of business?

____

1.5 How many product/service ranges do you currently produce/supply? ______________

1.6 How many **major rivals** do you have in your main market? _________________

1.7 How would you compare products in your **main product/service group** with those of competitors?
Note: Your main group is the group which is the largest according to sales. (Tick one)

Identical	**Very Similar**	**Similar**	**Very Different**	**Different**

1.8 In the last trading year, what percentages of sales were…? *(Insert '0' if not serving the market)*

Local	**Regional**	**National**	**European**	**International**
______%	______%	______%	______%	______%

1.9 Does your business have any of the following intangible assets? *(Tick all that apply)*

Customer lists
Order or production backlog
Customer contracts and related customer relationships
Lease agreements
Construction permits
Franchise agreements
Use rights (e.g. drilling water, air, easements, user rights for data files, etc.)
Servicing contracts (e.g. mortgage servicing contracts)
Other intangible assets (please specify)____________________________

1.10 What is the **highest** level of formal education you have achieved to date? *(Select one)*

Primary
Inter-cert/junior cert
Leaving cert
Diploma (Discipline:______________________)
Degree (Discipline:______________________)
Masters (Discipline:______________________)
Postgraduate qualification (PhD) (Discipline:______________________)
Trade Qualification (Discipline:______________________)

1.11 How many years of work experience (in years/months) have you had in this sector/industry?

______________Years **_____________________ Months**

1.12 Do you have any experience of working abroad? (Select one)

Yes **____________________Years**

No

Section 2: Sources of Financing

The following questions are designed to identify the sources of finance your business has utilised. For the purpose of this study the main sources of finance are:

- **Personal finance –** the use of private capital to fund the business, for example, personal savings or mortgage.
- **Retained profits –** proportion of net income that has been retained for reinvestment in the business rather than being paid out in dividends to owners or stockholders.
- **Debt finance –** the provision of capital through borrowing from a financial institution. There are various types of debt finance, including overdraft, trade credit, leasing agreements, bank loans, etc.
- **Director's loan –** capital which a director has lent to the company.
- **Government funding – f**inancial assistance in the form of money from a government or public body with no expectation that the funds will be paid back (for example, grants from County and City Enterprise Boards, etc.).
- **Private venture capital (VC) –** the provision of capital for growth and expansion to companies by professional investors in exchange for a percentage ownership.
- **Angel finance** – the provision of capital by individuals, acting alone or in a syndicate, who invests their money directly in a company in which there is no family connection.
- **Corporate VC** – programs in established corporations which invest in businesses (for example, the Intel Capital Programme).
- **Public equity finance** – government supported equity (or venture capital) investment in businesses (for example, Enterprise Ireland's Seed & Venture Capital Programme; Business Expansion Scheme, etc.).

2.1 Please rate your overall ease of access to the following sources of external finance on a scale of 1 to 5, where '**1' is easy** and '**5' is difficult**:

	Easy				Difficult
Business overdraft	1	2	3	4	5
Business mortgage	1	2	3	4	5
Trade credit	1	2	3	4	5
Invoice discounting	1	2	3	4	5
Short-term business loan (term of less than 5 years)	1	2	3	4	5
Medium-term business loan (term of 6 to 10 years)	1	2	3	4	5
Long-term business loan (term of more than 10 years)	1	2	3	4	5
Leasing or Hire Purchase	1	2	3	4	5
Funds from family/friends	1	2	3	4	5
Director's loan	1	2	3	4	5
Share capital	1	2	3	4	5
Private venture capitalist(s)	1	2	3	4	5
Angel investor(s)	1	2	3	4	5
Corporate venture capitalist(s)	1	2	3	4	5
Public equity finance (e.g. Enterprise Ireland)	1	2	3	4	5
Government funding (e.g. County Enterprise Board)	1	2	3	4	5

2.2 Please indicate the sources of finance received during the following stages in your company's lifecycle: *(Tick all that apply at each stage)*

	Seed Stage (first year of trading)	**Early Stage (2-5 years)**	**Expansion Stage (6-10 years)**	**Later Stage (10+ years)**
Personal funds (e.g. personal savings, mortgage)				
Retained profits/earnings				
Business overdraft				
Business mortgage				
Trade credit				
Invoice discounting				
Short-term business loan (term of less than 5 years)				
Medium-term business loan (term of 6 to 10 years)				
Long-term business loan (term of more than 10 years)				
Leasing or Hire Purchase				
Funds from family/friends				
Director's loan				
Share capital				
Private venture capitalist(s)				
Angel investor(s)				
Corporate venture capitalist(s)				
Public equity finance – please specify source (e.g. Enterprise Ireland, Business Expansion Scheme, etc.)	___________	___________	___________	_______
Government funding – please specify source (e.g. County Enterprise Board)	___________	___________	___________	_______
Others (please specify sources and stage) ________________________________ ________________________________ ________________________________ ________________________________				

2.3 What percentage of your total seed stage funding came from personal (or internal) funds?

__________%

2.4 When your business requires additional finance, do you prefer to utilise internal sources of capital before resorting to external finance (e.g. debt or equity)? *(Tick one)*

Yes **Why? ________________________________**

No **Why? ________________________________**

2.5 Were any of the following assets used as collateral to guarantee debt? *(Tick all that apply)*

Personal Assets (i.e. assets owned personally or by spouse)

Business Assets (i.e. assets owned by the business, such as land, buildings, etc.)

Both Personal and Business Assets

Have not applied for debt finance to date (Skip to question 2.8)

2.6 How many financial institutions has your business (past or present) banked with?
Note: AIB + Bank of Ireland = 2 financial institutions; Two different branches of AIB = 1.

____

2.7 And for how many years have you been with your primary financial institution?

____

2.8 Should your business require additional financing in the future, from which of the following sources will you attempt to raise this finance? *(Tick all that apply)*

Personal funds (e.g. personal savings, mortgage)

Retained profits/earnings

Business overdraft

Business mortgage

Trade credit

Invoice discounting

Short-term business loan (term of less than 5 years)

Medium-term business loan (term of 6 to 10 years)

Long-term business loan (term of more than 10 years)

Leasing or Hire Purchase

Funds from family/friends

Director's loan

Share capital

Private venture capitalist(s)

Angel investor(s)

Corporate venture capitalist(s)

Public equity finance – please specify source (e.g. Enterprise Ireland, Business Expansion Scheme, etc.) Source: ___________________

Government funding – please specify source (e.g. County Enterprise Board) Source: ___________________

Other (please specify) ___________________________

2.9 When deciding to raise/utilise debt finance, how important are the following considerations in your decision? *(Tick all that apply)*

	Very Important	Important	Moderately Important	Slightly Important	Not Important at all
Interest rates payable					
Collateral requirements of lenders					
Tax deductibility of interest					
Debt limitations applicable (e.g. covenants preventing further debt issue)					
Desire for unused borrowing capacity					
Recent profits insufficient to fund activities					
Desire to maintain control of the business (by not issuing further shares through equity finance)					
Other (please specify) ____________________ ____________________					

2.10 Please indicate the extent to which you agree or disagree with the following statements: *(Tick all that apply)*

	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
Banks are willing to offer my company finance					
Banks understand my business/industry					
Banks insisted on collateral					
Long-term debt would suit my financing needs					
Banks are willing to provide overdraft facilities to my business					
Banks only lend to businesses with cash or fixed assets					
Equity investors are willing to offer my company finance					
Equity investors understand my business/industry					
The availability of equity capital is susceptible to market fluctuations					
It is easier to raise finance in foreign markets than it is in Ireland (e.g. UK, US)					
Equity financing would suit my financing needs					

Section 3: External Equity Financing

Please indicate the type of equity investor(s) involved in your business (i.e. angel, venture capitalist, corporate venture capitalist, public sector)
Note: If more than 6 investors involved please answer for the main six.

3.1

Investor 1 ______________________________
Investor 2 ______________________________
Investor 3 ______________________________
Investor 4 ______________________________
Investor 5 ______________________________
Investor 6 ______________________________

3.2 For each of your equity investors please indicate their location. *(Tick one for each investor)*

	Local (<1hr drive)	Within Region	Rest of Ireland	UK & Europe	International
Investor 1					
Investor 2					
Investor 3					
Investor 4					
Investor 5					
Investor 6					

3.3 Which investors sit (sat) on your board? *(Tick one for each investor)*

Investor 1
Investor 2
Investor 3
Investor 4
Investor 5
Investor 6

3.4 And what type of ownership did (do) these investors have? *(Tick one for each investor)*

	Ordinary shares (common stock)	Preference shares (preferred stock)	Both ordinary & preference shares
Investor 1			
Investor 2			
Investor 3			
Investor 4			
Investor 5			
Investor 6			

3.5 Did you have a referral to any of your investors? *(Tick one for each investor)*

	Investor 1	Investor 2	Investor 3	Investor 4	Investor 5	Investor 6
Yes						
If 'Yes' from whom?	________	________	________	________	________	________
No						

3.6 In the absence of a referral how did you find your investors?

Investor 1 ______________________________
Investor 2 ______________________________
Investor 3 ______________________________
Investor 4 ______________________________
Investor 5 ______________________________
Investor 6 ______________________________

3.7 Did you receive investments in…..? *(Tick one for each investor)*

	One lump sum investment	Funding rounds
Investor 1		
Investor 2		
Investor 3		
Investor 4		
Investor 5		
Investor 6		

3.8 Was the fact that investors would share some business risk with you: (*Tick one for each investor)*

	Investor 1	Investor 2	Investor 3	Investor 4	Investor 5	Investor 6
Unimportant						
Of little importance						
Moderately important						
Important						
Very important						

3.9 Please indicate the frequency of your interaction with equity investors (include face to face meetings, telephone and writing)...... *(Tick one for each investor)*

	Investor 1	Investor 2	Investor 3	Investor 4	Investor 5	Investor 6
Daily						
Weekly						
Monthly						
Less than once a quarter						
Once a quarter						
Twice yearly						
Yearly						

3.10 How have you found the process of raising equity capital?

3.11 And what was the main use of the equity capital raised?

3.12 Other than the capital provided, have equity investors provided any of the following non-financial benefits to you and your business? *(Tick all that apply for each investor)*

	Investor 1	Investor 2	Investor 3	Investor 4	Investor 5	Investor 6
Technical advice						
Managerial advice						
Marketing advice						
Financial advice						
Legal advice						
Financial contacts						
Industry contacts						
Customer/client contacts						
Government agency contacts						
Help hiring/recruiting staff						
Provision of business services						
Mentoring						

3.13 Were any of the following requested as part of the application process? *(Tick all that apply)*

	Investor 1	Investor 2	Investor 3	Investor 4	Investor 5	Investor 6
Formal application for financing						
Business financial statement						
Business plan (i.e. document specifying goals/strategy)						
Personal financial statement (i.e. financial statements that provide disclosure of financial affairs of the owner)						
Appraisals of assets to be financed (i.e. a valuation of tangible assets for collateral by qualified experts)						
Cash flow projections (i.e. projection of funds)						
Presentation to investors (e.g. containing information on the business, products, strategy, etc.)						
Letters of interest (i.e. indication of interest)						
Other documentation (please specify)______________ ____						

3.14 When you raise equity finance, how important are the following considerations in your decision to seek equity capital? *(Tick all that apply)*

	Very Important	Important	Moderately Important	Slightly Important	Not Important at all
Loss of control					
Loss of management freedom or independence					
Pressure to change management team/Bring new management team onboard					
Pressure to meet targets of investors					
Increased burden of monitoring costs					
Pressure to appoint non-executive directors					
Search costs (i.e. presentations, application process, etc.)					
Other documentation (please specify)_______ _______________________________________					

Section 4: Innovation & Technological Advancement

The following questions are designed to collect information on the innovation activities of your business. There are various types of innovation. For the purpose of this study these are:

- **Product innovation –** the introduction of a **new** or **significantly** improved good or service with respect to its capabilities, such as improved software, components or sub-systems. The innovation must be new to your enterprise but does not need to be new to your sector/market.

- **Process innovation -** introduced to improve **efficiency**, lower costs and/or increase profitability. It involves the implementation of a **new** or significantly improved production process, distribution method or support activity for your goods/services. The innovation must be new to your enterprise but does not need to be new to your sector/ market.

4.1 For each of the applicable stages in your business' corporate lifecycle, please indicate the frequency of **product** and/or **process innovation** undertaken on a scale of:

Continuously; Regularly; Rarely; Never

	Seed Stage (first year of trading/takeover)	**Early Stage** (2-5 years)	**Expansion Stage** (6-10 years)	**Later Stage** (10+ years)
Products				
Processes				

4.2 Has your business used any of the following to protect innovations? *(Tick all that apply)*

Secrecy (e.g. confined to within the business)
Complexity of design
Lead-time advantage
Registration of design
Trademarks
Confidentiality agreements
Copyright
Patents

If you have patents please answer 4.3
If not go to 4.4

4.3 How many patents has your company applied for and received?

	Patent Applications	**Patents Issued**
Irish Patents	________	________
Foreign Patents	________	________

4.4 Approximately what percentage of your workforce has a third level degree (or similar technical qualification) as their highest qualification?
Note: Here an estimate will do if you do not have the verifiable data.

______________%

4.5 To what extent does your business engage in R&D activities? *(Tick one)*

Daily	Weekly	Monthly	< Once a quarter	Once a quarter	Twice Yearly	Yearly

4.6 Has your business availed of R&D tax credits? *(Tick one)*

Yes ***Please answer 4.7***
No ***Please continue to next Section***

4.7 Has the availability/provision of R&D tax credits acted as an incentive to increase the level of R&D activity undertaken by your business? *(Tick one)*

Yes
No

Section 5: Performance

The following questions are designed to collect information on the performance of your business.

5.1 We would appreciate if you could provide the following performance measures:
(*Please indicate values in EUROs)*
Note: Here an estimate or rough figure will suffice.

	Last trading year	**End of first full year of trading or takeover**
Number of part-time employees (i.e. those who work less than 30 hours a week)		
Number of full-time employees (i.e. those who work a regular week of at least 30 hours)		
Turnover		
Total Assets (i.e. fixed plus current assets)		
Current Liabilities		
Operating Income (i.e. earnings before deduction of interest payments and taxes)		

5.2 In an average trading year, what percentage of total expenditure is devoted to....?
Note: Here an estimate will do if you do not have the verifiable data.

R&D (e.g. for products, services or processes) ______%

Personnel Training (e.g. FÁS courses, in-house training programmes) ______%

Technology acquisition/licensing (e.g. purchasing computer hardware or software) ______%

Section 6: Exit Strategies

The following questions are designed to collect information on the exit strategies of your business. An exit strategy is the way in which an equity investor or business owner intends to divest or leave the business. There are various exit routes. For the purposes of this study these include:

- **Initial Public Offering (IPO) –** the business is listed on the stock exchange for the first time
- **Trade Sale or Acquisition –** the business is sold
- **Secondary Sale –** investors' shares are sold to an outside purchaser
- **Buyback or Buyout –** entrepreneur/owner repurchases shares in the business from investors
- **Liquidation –** the business comes to an end

Please answer the following questions in light of exits either pursued to date or planned for the future.

6.1 Have any of your equity investors exited to date? *(Tick one)*

Yes	***Go to Question 6.2***
No	***Skip to Question 6.6***

6.2 Please indicate which of your equity investors have exited and the exit routes pursued. *(Tick all that apply for each investment)*

	Investor 1	Investor 2	Investor 3	Investor 4	Investor 5	Investor 6
IPO						
Trade Sale or Acquisition						
Secondary Sale						
Buyback or Buyout						
Liquidation						
Other (please specify) ____________________						

6.3 Why was this exit route chosen? *(Answer for each exit)*

Exit 1
Exit 2
Exit 3
Exit 4
Exit 5
Exit 6

6.4 How many equity investors remained in your business after the exit? *(Insert a number for each exit)*

	Exit 1	Exit 2	Exit 3	Exit 4	Exit 5	Exit 6
Total equity investors	______	______	______	______	______	______

6.5 Who chose the exit route (i.e. who decided on IPO, trade sale, etc.)? *(Answer for each investment)*

	Investor 1	Investor 2	Investor 3	Investor 4	Investor 5	Investor 6
You						
Investor						
Joint decision						

6.6 Please indicate, for current investors, if your business plans to pursue any of the following exit routes in the future. *(Tick all that apply for each investment)*

	Investor 1	Investor 2	Investor 3	Investor 4	Investor 5	Investor 6
IPO						
Trade Sale or Acquisition						
Secondary Sale						
Buyback or Buyout						
Liquidation						
Other (please specify)						

____

6.7 Why was this exit route chosen? *(Answer for each exit)*

Exit 1
Exit 2
Exit 3
Exit 4
Exit 5
Exit 6

6.8 Do you have an exit or transfer strategy for your own exit? *(Tick one)*

Yes **Go to Question 6.9**
No

6.9 Please indicate the exit route you plan to pursue in the future. (*Tick all that apply)*

Family Transfer
IPO
Trade Sale
Management Buyout
Liquidation
No exit strategy planned to date
Other (please specify) ____________________________

6.10 What, in your opinion, are the main challenges involved in the exit event?

____

____

____

If you have anything additional to add regarding your access to financing, the effect you feel the utilisation of equity financing has had on your business or your experience concerning exit of equity investors please feel free to do so. Thank you.

In your opinion, what are the main financing issues technology-based businesses face in starting and developing their business in Ireland?

Previous reports have suggested that an equity gap currently exists in Ireland of early stage seed capital, particularly in the form of angel investment. Having been involved in setting up a technology-based firm, do you feel that such a financing gap exists in Ireland?

And do you feel that this has affected you in establishing and developing your business?

This is the end of the questionnaire.

Thank you for your time and interest in this research. Your cooperation is very much appreciated.

The information you have provided will be treated with strict confidence. In no case will names of respondents be disclosed. The data will be used only for academic research.

We will be more than happy to share the results of this study with you over the coming months. We hope that our research will contribute to the success of Irish businesses. We wish you all the very best with the future of your business.

Help Available:
If you have any problems completing this questionnaire or require any further information on this research project please feel free to contact:

Jane Power
PhD Student,
Department of Economics,
University College Cork,
Western Road,
Cork.
Telephone: 021 4902632
Email: j.power@ucc.ie

ID#

Self-Administered Questionnaire *Non- Equity Financed Technology-Based Firms*	
Respondent:	
Firm Name:	
Firm Address:	
Telephone:	
Email:	
Website:	

Section 1: Characteristics of the Business

1.1 What is your role in this business? *(e.g. founder, CEO, etc.)* __________________

1.2 When was this business established? (*i.e. in what year)* __________________

1.3 Where is this business located? (i.e. in what city is the head office) __________________

1.4 How is the business registered? *(Tick one)*

Sole trader **Private company**
Partnership **Public company**
Other (please specify) ____ ___________

1.5 How would you define your *main* line of business?

____

1.6 How many product/service *ranges* do you currently produce/supply? _________________

1.7 How many **major rivals** do you have in your main market? _________________

1.8 How would you compare products in your **main product/service group** with those of competitors?
Note: Your main group is the group which is the largest according to sales. (Tick one)

Identical **Very Similar** **Similar** **Very Different** **Different**

1.9 In the last trading year, what percentages of sales were…? *(Insert '0' if not serving the market)*

Local	**Regional**	**National**	**European**	**International**
______%	______%	______%	______%	______%

1.10 Does your business have any of the following intangible assets? *(Tick all that apply)*

Customer lists
Order or production backlog
Customer contracts and related customer relationships
Lease agreements
Construction permits
Franchise agreements
Use rights (e.g. drilling water, air, easements, user rights for data files, etc.)
Servicing contracts (e.g. mortgage servicing contracts)
Other intangible assets (please specify)____________________________

1.11 What is the ***highest*** level of formal education you have achieved to date? *(Select one)*

Primary
Inter-cert/junior cert
Leaving cert
Diploma (Discipline:______________________)
Degree (Discipline:______________________)
Masters (Discipline:______________________)
Postgraduate qualification (PhD) (Discipline:______________________)
Trade Qualification (Discipline:______________________)

1.12 How many years of work experience (in years/months) have you had in this sector/industry?

_____________________Years **_____________________ Months**

1.13 Do you have any experience of working overseas or abroad? *(Select one)*

Yes **__________ Years**
No

Section 2: Sources of Financing

The following questions are designed to identify the sources of finance your business has utilised. For the purpose of this study the main sources of finance are:

- **Personal finance –** the use of private capital to fund the business, for example, personal savings or mortgage.
- **Retained profits –** proportion of net income that has been retained for reinvestment in the business rather than being paid out in dividends to owners or stockholders.
- **Debt finance –** the provision of capital through borrowing from a financial institution. There are various types of debt finance, including overdraft, trade credit, leasing agreements, bank loans, etc.
- **Director's loan –** capital which a director has lent to the company.
- **Government funding – f**inancial assistance in the form of money from a government or public body with no expectation that the funds will be paid back (for example, grants from County and City Enterprise Boards, etc.).
- **Private venture capital (VC) –** the provision of capital for growth and expansion to companies by professional investors in exchange for a percentage ownership.
- **Angel finance –** the provision of capital by individuals, acting alone or in a syndicate, who invests their money directly in a company in which there is no family connection.
- **Corporate VC** – programs in established corporations which invest in businesses (for example, the Intel Capital Programme).
- **Public equity finance** – government supported equity (or venture capital) investment in businesses (for example, Enterprise Ireland's Seed & Venture Capital Programme; Business Expansion Scheme, etc.).

2.1 Please rate your overall ease of access to the following sources of external finance on a scale of 1 to 5, where '**1' is easy** and '**5' is difficult**:

	Easy				**Difficult**
Business overdraft	**1**	**2**	**3**	**4**	**5**
Business mortgage	**1**	**2**	**3**	**4**	**5**
Trade credit	**1**	**2**	**3**	**4**	**5**
Invoice discounting	**1**	**2**	**3**	**4**	**5**
Short-term business loan (term of less than 5 years)	**1**	**2**	**3**	**4**	**5**
Medium-term business loan (term of 6 to 10 years)	**1**	**2**	**3**	**4**	**5**
Long-term business loan (term of more than 10 years)	**1**	**2**	**3**	**4**	**5**
Leasing or Hire Purchase	**1**	**2**	**3**	**4**	**5**
Funds from family/friends	**1**	**2**	**3**	**4**	**5**
Director's loan	**1**	**2**	**3**	**4**	**5**
Share capital	**1**	**2**	**3**	**4**	**5**
Private venture capitalist(s)	**1**	**2**	**3**	**4**	**5**
Angel investor(s)	**1**	**2**	**3**	**4**	**5**
Corporate venture capitalist(s)	**1**	**2**	**3**	**4**	**5**
Public equity finance (e.g. Enterprise Ireland)	**1**	**2**	**3**	**4**	**5**
Government funding (e.g. County Enterprise Board)	**1**	**2**	**3**	**4**	**5**

2.2 Please indicate the sources of finance utilised at the following stages in your company's lifecycle: *(Tick all that apply at each stage)*

	Seed Stage (first year of trading)	**Early Stage (2-5 years)**	**Expansion Stage (6-10 years)**	**Later Stage (10+ years)**
Personal funds (e.g. personal savings, mortgage)				
Retained profits/earnings				
Business overdraft				
Business mortgage				
Trade credit				
Invoice discounting				
Short-term business loan (term of less than 5 years)				
Medium-term business loan (term of 6 to 10 years)				
Long-term business loan (term of more than 10 years)				
Leasing or Hire Purchase				
Funds from family/friends				
Director's loan				
Share capital				
Private venture capitalist(s)				
Angel investor(s)				
Corporate venture capitalist(s)				
Public equity finance – please specify source (e.g. Enterprise Ireland, Business Expansion Scheme, etc.)	___________	___________	__________	_______
Government funding – please specify source (e.g. County Enterprise Board)	___________	___________	__________	_______
Others (please specify sources and stage) ____ ____ ____ ____				

2.3 What percentage of your total seed stage funding came from personal (or internal) funds?

__________%

2.4 When your business requires additional finance, do you prefer to utilise internal sources of capital before resorting to external finance (e.g. debt or equity)? *(Tick one)*

Yes **Why?** ________________________________

No **Why?** ________________________________

2.5 Were any of the following assets used as collateral to guarantee debt? *(Tick all that apply)*

Personal Assets (i.e. assets owned personally or by spouse)

Business Assets (i.e. assets owned by the business, such as land, buildings, etc.)

Have not applied for debt finance (Skip to question 2.8)

2.6 How many financial institutions has your business (past or present) banked with?
Note: AIB + Bank of Ireland = 2 financial institutions; Two different branches of AIB = 1.

____

2.7 And for how many years have you been with your primary financial institution?

____

2.8 Should your business require additional financing in the future, from which of the following sources will you attempt to raise this finance? *(Tick all that apply)*

Personal funds (e.g. personal savings, mortgage)

Retained profits/earnings

Business overdraft

Business mortgage

Trade credit

Invoice discounting

Short-term business loan (term of less than 5 years)

Medium-term business loan (term of 6 to 10 years)

Long-term business loan (term of more than 10 years)

Leasing or Hire Purchase

Funds from family/friends

Director's loan

Share capital

Private venture capitalist(s)

Angel investor(s)

Corporate venture capitalist(s)

Public equity finance – please specify source (e.g. Enterprise Ireland, Business Expansion Scheme, etc.)

Government funding – please specify source (e.g. County Enterprise Board)

Other (please specify) __________________________

2.9 In considering raising debt finance, how important are the following considerations in your decision? *(Tick all that apply)*

	Very Important	Important	Moderately Important	Slightly Important	Not Important at all
Interest rates					
Collateral requirements of lenders					
Tax deductibility of interest					
Debt limitations applicable (e.g. covenants preventing further debt issue)					
Desire for unused borrowing capacity					
Recent profits insufficient to fund activities					
Desire to maintain control of the business (by not issuing further shares through equity finance)					
Other (please specify) ___________________________ ____					

2.10 Please indicate the extent to which you agree or disagree with the following statements:

(Tick all that apply)

	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
Banks are willing to offer my company finance					
Banks understand my business/industry					
Banks insisted on collateral					
Long-term debt would suit my financing needs					
Banks are willing to provide overdraft facilities to my business					
Banks only lend to businesses with cash or fixed assets					
Equity investors are willing to offer my company finance					
Equity investors understand my business/industry					
The availability of equity capital is susceptible to market fluctuations					
It is easier to raise finance in foreign markets than it is in Ireland (e.g. UK, US)					
Equity financing would suit my financing needs					

2.11 Overall, how have you found the process of raising finance for your business?

Section 3: Innovation & Technological Advancement

The following questions are designed to collect information on the innovation activities of your business. There are various types of innovation. For the purpose of this study these are:

- **Product innovation –** the introduction of a **new** or **significantly** improved good or service with respect to its capabilities, such as improved software, components or sub-systems. The innovation must be new to your enterprise but does not need to be new to your sector/market.
- **Process innovation** - introduced to improve efficiency, lower costs and/or increase profitability. It involves the implementation of a **new** or **significantly** improved production process, distribution method or support activity for your goods/services. The innovation must be new to your enterprise but does not need to be new to your sector/ market.

3.1 For each of the applicable stages in your business' corporate lifecycle, please indicate the frequency of **product** and/or **process innovation** undertaken on a scale of:

Continuously; Regularly; Rarely; Never

	Seed Stage (first year of trading/takeover)	**Early Stage** (2-5 years)	**Expansion Stage** (6-10 years)	**Later Stage** (10+ years)
Products				
Processes				

3.2 Has your business used any of the following to protect innovations? *(Tick all that apply)*

Secrecy (e.g. confined to within the business)
Complexity of design
Lead-time advantage
Registration of design
Trademarks
Confidentiality agreements
Copyright
Patents

If you have patents please answer 3.3
If not go to 3.4

3.3 How many patents has your company applied for and received?

	Patent Applications	**Patents Issued**
Irish Patents	________	________
Foreign Patents	________	_______

3.4 Approximately what percentage of your workforce has a third level degree (or similar technical qualification) as their highest qualification?
Note: Here an estimate will do if you do not have the verifiable data.

__________%

3.5 To what extent does your business engage in R&D activities? *(Tick one)*

Daily	Weekly	Monthly	< Once a quarter	Once a quarter	Twice Yearly	Yearly

3.6 Has your business availed of R&D tax credits?

Yes

No

Section 4: Performance

The following questions are designed to collect information on the performance of your business.

4.1 We would appreciate if you could provide the following performance measures: (*Please indicate values in EUROs)*
Note: Here an estimate or rough figure will do if you do not have the verifiable data.

	Last trading year	**End of first full year of trading or takeover**
Number of part-time employees (i.e. those who work less than 30 hours a week)		
Number of full-time employees (i.e. those who work a regular week of at least 30 hours)		
Turnover		
Total Assets (i.e. fixed plus current assets)		
Current Liabilities		
Operating Income (i.e. earnings before deduction of interest payments and taxes)		

4.2 In an average trading year, what percentage of total expenditure is devoted to....?
Note: Here an estimate will do if you do not have the verifiable data.

R&D (e.g. for products, services or processes) ______%
Personnel Training (e.g. FÁS courses, in-house training programmes) ______%
Technology acquisition/licensing (e.g. purchasing computer hardware or software) ______%

Section 5: Exit Strategies

The following questions are designed to collect information on the exit strategies of your business. An exit strategy is the way in which a business owner intends to divest or leave the business. There are various exit routes. For the purposes of this study these include:

- ***Family Transfer*:** The business is transferred to a family member
- ***Initial Public Offering*:** The business is listed on the stock exchange for the first time
- ***Trade Sale*:** The business is sold
- ***Management Buyout (MBO):*** Owner repurchases shares shareholders
- ***Liquidation***: The business comes to an end (i.e. is shutdown)

5.1 Please indicate the exit route you plan to pursue in the future. (*Tick all that apply)*

Family Transfer
IPO
Trade Sale
Management Buyout
Liquidation
No exit strategy planned to date **Skip to 5.3**
Other (please specify) ______________________________

5.2 Why is this the chosen exit route(s)? *(Answer for each exit)*

____

____

5.3 In your opinion what are the main barriers in identifying a suitable exit or transfer strategy for your business? (*Tick all that apply)*

Valuing the business
Getting me (the owner) to 'let go'
Access to cost-effective advice
Conflicting vision of founders
Conflicting vision of key employees
Lack of guidance and help in identifying a viable exit option
Finding a buyer
Finding a successor
Other (please specify) ______________________________

5.4 If you do not plan on pursuing an IPO, why is this the case? *(Tick all that apply)*

Size of company
Entry criteria for the stock market
Information disclosure required in taking a company public
Ownership dilution
Expense involved in preparing for an IPO
Possibility of low market valuations
Lack of liquidity
Vetting by the exchange
Lack of sufficient revenues
Lack of guidance available of taking my company public
Other (please specify) ______________________________
Never planned on taking my company public

In your opinion, what are the main financing issues technology-based businesses face in starting and developing their business in Ireland?

If you have anything additional to add regarding your access to financing, the effect you feel financing has had on performance or your exit strategies please feel free to do so. Thank you.

This is the end of the questionnaire.

Thank you for your time and interest in this research. Your cooperation is very much appreciated.

The information you have provided will be treated with strict confidence. In no case will names of respondents be disclosed. The data will be used only for academic research.

We will be more than happy to share the results of this study with you over the coming months. We hope that our research will contribute to the success of Irish businesses. We wish you all the very best with the future of your business.

Help Available:
If you have any problems completing this questionnaire or require any further information on this research project please feel free to contact:

Jane Power
PhD Student,
Department of Economics,
University College Cork,
Western Road,
Cork.
Telephone: 021 4902632
Email: j.power@ucc.ie

Appendix 2: Correspondence

Type 1: Pre-letter Template Equity Financed Firms

Xth October 2010

Dear

I am currently undertaking a Ph.D. in the Department of Economics, University College Cork, on the financing options available to Irish technology-based businesses, with a particular focus on equity financing. My aim is to explore the sources of finance available to these indigenous businesses and the impact financing has on performance and exit strategies. In Ireland little is known about the extent of funding accessible to technology-based firms, particularly at start-up, and the exit or transfer opportunities available to entrepreneurs. This research will deliver a significant amount of knowledge in an area where little is currently known.

With your cooperation, I would like approximately an hour of your time to complete a questionnaire on your experience in obtaining financing and its impact on your business. This can be completed by meeting, or over the telephone, at your convenience. Your experience is invaluable and your participation would be very much appreciated.

I would like to assure you that any information you provide will be treated in ***complete confidence***. The identity of your business will not be disclosed and evidence will only be published in aggregated form. No individual identities will be revealed and conclusions reached will be based on average tendencies for the sample as a whole, rather than specific cases.

I would be extremely grateful if you would be willing to participate in this study, the agenda for which has received ethical approval from the Social Research Ethics Committee in University College Cork.

I will contact you in the near future to confirm receipt of this letter and, at that point, arrangements can hopefully be made for completion of the questionnaire.

If you have any queries about this study, please do not hesitate to contact me.

Thank you in advance for your cooperation.

Yours sincerely,

____

Jane Power

For every questionnaire completed a donation will be made to charity

Note: This research is generously supported by University College Cork and the Irish Research Council for the Humanities and Social Sciences (IRCHSS).

IRCHSS

Type 2: Reminder Letter Equity Financed Firms

X^th January 2011

Dear

I am currently undertaking a Ph.D. in the Department of Economics, University College Cork, on the financing options available to Irish technology-based businesses, with a particular focus on equity financing. My aim is to explore the sources of finance available to these indigenous businesses and the impact financing has on performance and exit strategies. In Ireland little is known about the extent of funding accessible to technology-based firms, particularly at start-up, and the exit or transfer opportunities available to entrepreneurs. This research will deliver a significant amount of knowledge in an area where little is currently known.

I previously wrote to you seeking your participation in this study. I understand that you may not yet have had a chance to do so, but I would be extremely grateful if you could find the time complete the questionnaire with me in the near future. This typically takes an hour and your participation would be very much appreciated.

I would like to assure you that any information you provide will be treated in ***complete confidence***. The identity of your business will not be disclosed and evidence will only be published in aggregated form. No individual identities will be revealed and conclusions reached will be based on average tendencies for the sample as a whole, rather than specific cases.

I would be extremely grateful if you would be willing to participate in this study, the agenda for which has received ethical approval from the Social Research Ethics Committee in University College Cork.

I will contact you in the near future to confirm receipt of this letter and, at that point, arrangements can hopefully be made for completion of the questionnaire.

If you have any queries about this study, please do not hesitate to contact me.

Thank you in advance for your cooperation.

____

Jane Power

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Note: This research is generously supported by University College Cork and the Irish Research Council for the Humanities and Social Sciences (IRCHSS).

Type 3: Pre-letter Non-Equity Financed Firms

Xth April 2011

Dear

I am currently undertaking a Ph.D. in the Department of Economics, University College Cork, on the financing options available to Irish technology-based businesses. My aim is to explore the sources of finance available to these indigenous businesses and the effect financing has on performance and exit strategies. In Ireland little is known about the extent of funding accessible to technology-based firms, particularly at start-up, and the exit or transfer opportunities available to entrepreneurs. This research will deliver a significant amount of knowledge in an area where little is currently known.

With your cooperation, I would like approximately ***twenty minutes*** of your time to complete a questionnaire. Your experience is invaluable and your participation would be very much appreciated.

I would like to assure you that any information you provide will be treated in ***complete confidence***. The identity of your business will not be disclosed and evidence will only be published in aggregated form. No individual identities will be revealed and conclusions reached will be based on average tendencies for the sample as a whole, rather than specific cases.

I would be extremely grateful if you would be willing to participate in this study, the agenda for which has received ethical approval from the Social Research Ethics Committee in University College Cork.

The survey can be completed electronically at the following URL: http://www.ucc.ie/en/economics/financingofbusinesses/

Alternatively, a postal survey can be sent to you upon request, or arrangements can be made to complete the survey over the telephone.

If you have any queries about this study, please do not hesitate to contact me.

Thank you in advance for your cooperation.

____

Jane Power

For every questionnaire completed a donation will be made to charity

Note: This research is generously supported by University College Cork and the Irish Research Council for the Humanities and Social Sciences (IRCHSS).

Type 4: Reminder Letter Non-Equity Financed Firms

X[th] July 2011

Dear

I am currently undertaking a Ph.D. in the Department of Economics, University College Cork, on the financing options available to Irish technology-based businesses. My aim is to explore the sources of finance available to these indigenous businesses and the effect financing has on performance and exit strategies. In Ireland little is known about the extent of funding accessible to technology-based firms, particularly at start-up, and the exit or transfer opportunities available to entrepreneurs. This research will deliver a significant amount of knowledge in an area where little is currently known.

I previously wrote to you seeking your participation in this study. If you have already completed the survey, thank you very much. If not, I understand that you may not yet have had a chance to do so, but I would be extremely grateful if you could find the time. This typically takes ***twenty minutes*** and your participation would be very much appreciated.

I would like to assure you that any information you provide will be treated in ***complete confidence***. The identity of your business will not be disclosed and evidence will only be published in aggregated form. No individual identities will be revealed and conclusions reached will be based on average tendencies for the sample as a whole, rather than specific cases.

I would be extremely grateful if you would be willing to participate in this study, the agenda for which has received ethical approval from the Social Research Ethics Committee in University College Cork.

The survey can be completed electronically at the following URL: http://www.ucc.ie/en/economics/financingofbusinesses/

Alternatively, a postal survey can be sent to you upon request, or arrangements can be made to complete the survey over the telephone.

If you have any queries about this study, please do not hesitate to contact me.

Thank you in advance for your cooperation.

____

Jane Power

For every questionnaire completed a donation will be made to charity

Note: This research is generously supported by University College Cork and the Irish Research Council for the Humanities and Social Sciences (IRCHSS).

IRCHSS

Type 5: Email Reminder Equity Financed Firms

My name is Jane Power, I am currently undertaking a Ph.D. at University College Cork, examining the sources of finance utilised by businesses in Ireland and their experiences raising capital, with a particular focus on equity finance.

I hope you received the letter which was recently sent to you outlining the nature of this project. Would you be willing to participate in the study, as requested in the letter?

I would greatly appreciate if you could find the time to meet with me. This should take approximately an hour and, of course, your replies will be treated in strict confidence.

If you would be willing to participate in this study, I will be in your area throughout February and can meet you at a convenient date/time. Alternatively, you could complete the questionnaire over the telephone.

This study will provide an understanding of the financing needs of companies in your industry and, based on the findings, recommendations will be presented to policy makers, investors, and financial institutions.

If you have any queries regarding this survey, please do not hesitate to contact me.

Your participation in this study would be very much appreciated.

Thank you very much for your time and co-operation.

Kind Regards,

Jane Power.

Ms. Jane Power,
PhD, IRCHSS Funded,
Department of Economics,
University College Cork,
Western Road, Cork.

Type 6: Email Reminder Non-Equity Financed Firms

Dear

My name is Jane Power, I am currently undertaking a Ph.D. at University College Cork examining the sources of financing available to technology-businesses in Ireland.

I hope you received the letter which was recently sent to you outlining the nature of the project. Would you be willing to participate in this study, as requested in the letter?

I would greatly appreciate if you could find the time to complete the survey. It should take approximately 20 minutes and, of course, your reply will be treated in strict confidence. I would like to assure you that absolute confidentiality will be upheld, and all data collected will remain anonymous.

If you have already completed the survey online, thank you very much. If not, I would be extremely grateful if you would now have the time to do so. The survey may be accessed online through the following link:

Financing of Businesses

Alternatively, if you would like to complete the survey in person, I will be available throughout March and could meet with you on a convenient date, or telephone you at a time that suits.

This study will provide an understanding of the financing needs of companies in your industry and, based on the findings, recommendations will be presented to policy makers, investors, and financial institutions.

If you have any queries regarding this survey, please do not hesitate to contact me.

Your participation in this study would be very much appreciated.

Thank you very much for your time and co-operation.

Kind Regards,

Jane Power.

Ms. Jane Power,
PhD, IRCHSS Funded,
Department of Economics,
University College Cork,
Western Road, Cork.