Firms' Skills as Drivers of Radical and Incremental Innovation

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Highlights

- We use a novel dataset with information on the different skill sets possessed by firms.
- We distinguish between the impact of skills on radical and incremental innovation.
- We distinguish between internally and externally sourced skills.
- We estimate two innovation production functions using a multivariate probit model.
- One of the few papers to analyse the impact of different skill sets on innovation.

Abstract:

Using firm level data from the Irish Community Innovation Survey 2008-2010 we analyse the importance of eight skill sets for the innovation performance of firms. We distinguish between radical and incremental innovation. Our results suggest that there is substantial heterogeneity in the importance of skills for different types of innovation and that some skills are best sourced from outside the firm while others are best developed in-house.

Keywords: Skills, Innovation, In-house, Outsource, Multivariate Probit

JEL codes: O15, O31, O32, O33

1. Introduction

There is little doubt that an organisation's ability to innovate is key to its performance, productivity and export capabilities (Chen, 2012; Damijan et al., 2012). The ability of a firm to innovate resides in the knowledge, skills, and abilities of its employees. While a considerable literature has accumulated on the subject of innovation and concurs that competitive success is built upon people skills, little emphasis has been placed on the specific skills required for innovation (Roper et al., 2008; Toner, 2011). This paper fills this gap by assessing the impact of eight different skill sets on the likelihood of a firm engaging in innovation using micro-level data from a unique and novel element of the Irish Community Innovation Survey (CIS) 2008-2010.

Toner (2011) argues the relative importance of skills depends on the originality of the innovation with radical innovation requiring scientific, engineering and design skills, while incremental innovation requires problem-solving skills. The decision to develop these skills in-house or to outsource them can be jointly explained by Transaction Cost Theory (Williamson, 1979) which argues that a firm should outsource if market costs are lower, and the Resource Based View of the Firm (Penrose, 1995) which argues that a firm should outsource non-core competencies. As cost savings are realised through outsourcing these savings can be reinvested in innovation activities which shift firms' technological frontiers outward (Görg and Hanley, 2011).

The key contributions of this paper are threefold. Firstly, we empirically test the importance of eight different skill sets for the innovation output of firms (these skill sets are listed in Table 1). Secondly, we distinguish between whether these skills are sourced internally or externally. Finally, we consider whether the importance of these skills depends on whether the innovation is radical or incremental in nature.

2. Methodology

When considering the impact of innovation inputs on innovation outputs the standard approach in the literature is to use an innovation production function (Crépon et al., 1998). We specify our innovation production function in equation (1).

$$IO_i = \alpha_0 + IS_i\alpha_1 + ES_i\alpha_2 + R\&D_i\beta + N_i\chi + Z_i\lambda + \varepsilon_i \quad (1)$$

Where IO_i is a binary indicator of whether firm *i* innovated. We consider two types of innovation; new-to-market and new-to-firm innovation. New-to-market innovation is defined as a new or significantly improved good or service which was released onto the market before a firm's competitors, however, it may have already been available in other markets. New-to-firm innovation is the introduction of a new product to the market by the firm, however, the product is already being sold onto the market by competitors (OECD, 2013). Following Garcia and Calantone (2002), in this paper new-to-market innovation is taken to be a radical innovation (although, it should be noted that it may have existed on other markets previously) while new-to-firm innovation can be deemed an incremental/imitative innovation, as the product is already available from competitors.

α_0 is a constant term, IS_i is a N*8 matrix of variables indicating the type of internal skills utilised by firm *i* to produce innovation output. ES_i is a N*8 matrix of variables indicating the type of external skills utilised by firm *i*. α_1 and α_2 are 8*1 vectors of coefficients showing the impact of these factors on the likelihood of a firm innovating.

Specifically we are interested in two questions. Firstly, which skill sets are important for each type of innovation and, secondly, whether it is better to possess these internally or to source them externally. We anticipate that, if significant, the effects will be positive, with these skills facilitating innovation.

We also include the expenditure of the firm on intramural and extramural R&D performance ($R\&D_i$), as well as controls for firm networking with customers, suppliers, competitors, public research units and universities (N_i). Z_i represents firm specific factors which might explain heterogeneity in innovation performance while λ is the vector of associated coefficients. Z_i contains information on firm size, whether the firm is owned indigenously and the sector in which firm i operates. These variables have all been previously shown to have an impact on the innovative performance of firms (Crépon et al., 1998; Roper et al., 2008).

Since we consider new-to-market and new-to-firm innovation we begin by estimating two distinct probit models. However, it is likely that individual heterogeneity not captured by the independent variables could impact on the likelihood of firms engaging in numerous forms of innovation simultaneously. This upward/downward bias in innovation likelihood will manifest in the error terms, ε_i, being correlated across the two regression equations. This may result in biased estimates of our model. In order to take account of this potential bias we also estimate a multivariate probit model, which estimates the two equations taking account of potential correlation across the error terms (Cappellari and Jenkins, 2006).

3. Data

The data used by this paper is derived from the Irish CIS 2008-2010. The survey is conducted as part of the European wide CIS project and is completed every two years.

The novel element of our data, which facilitates this research paper, is based around whether, during the three years 2008 to 2010, the firm employed individuals internally with distinct skills, or obtained these skills from external sources. The eight skills identified by the Irish CIS along with their descriptive statistics are displayed in Table 1.

Table 1: Descriptive Statistics of Skill Sets

Skills	% of firms sourcing the skill internally	% of firms sourcing the skill externally
Graphic arts/layout/advertising	19.2	34.51
Design of objects or services	23.76	20.77
Multimedia	13.9	23.11
Web design	18.67	43.33
Software development	18.95	35.1
Market research	19.82	23.14
Engineering/applied sciences	21.73	10.94
Mathematics/statistics/database management	19.45	10.26

Data Source: Irish Community Innovation Survey 2008-2010

4. Empirical Results

A summary of our results are presented in Table 2. The results of the individual probit models and the multivariate probit are similar and therefore we only discuss the latter. We note that out of 32 coefficients 12 are significant; five of these are skills which are internal to the firm and seven are externally sourced skills. This suggests that both internal and external skills are important for the innovative performance of a firm. However, there is heterogeneity in the importance of the various types of skills across innovation types.

Our results indicate that radical innovators benefit from sourcing scientific and engineering skills internally which, according to Toner (2011), are core competencies for this type of innovation. In addition, they benefit from both internal and external access to *Design of objects or services* skills. Since these radical innovators are likely to be involved in risky, experimental projects this is not surprising as it will allow them to share risks, access new markets and technologies, speed up product delivery, pool complementary skills and compensate for capabilities they have yet to master. By creating a synergy between their own processes and externally available ideas and expertise they can assimilate and co-develop new products and services. Lastly, these firms benefit from outsourcing non-core business skills (i.e. multimedia, web design and market research). By outsourcing these non-core skills firms can become more innovative and agile in their core domain, while also lowering costs and improving quality (Görg and Hanley, 2011).

Table 2: Extract of Results of the Estimation of Equation (1)

	Probit		Multivariate Probit	
	Radical Innovation	Incremental Innovation	Radical Innovation	Incremental Innovation
Internal Skills				
Graphic arts/layout/advertising	-0.0162	-0.1193	-0.014	-0.125
Design of objects or services	0.1844**	0.1202	0.184**	0.119
Multimedia	0.0198	0.062	0.029	0.067
Web design	0.0458	0.0819	0.050	0.079
Software development	0.1785**	0.0109	0.171**	0.017
Market research	0.09	0.2086***	0.087	0.206***
Engineering/applied sciences	0.1905**	0.0065	0.197**	0.011
Mathematics/statistics/database management	-0.0409	0.1515**	-0.046	0.154**
External Skills				
Graphic arts/layout/advertising	0.0761	0.1203	0.085	0.139*
Design of objects or services	0.1449*	0.1242*	0.145**	0.131*
Multimedia	0.1406*	-0.0033	0.136*	0.002
Web design	0.2124***	0.0953	0.224***	0.093
Software development	-0.0895	0.0807	-0.081	0.081
Market research	0.1545**	0.3185***	0.153**	0.306***
Engineering/applied sciences	-0.1397	0.0056	-0.136	0.006
Mathematics/statistics/database management	0.0623	-0.0205	0.061	-0.014
No. Of Obs	3245	3245	3245	
chi2	916.34	821.37	1298.74	
Prob>Chi2	0.0000	0.0000	0.000	
Log likelihood	-1126.05	-1355.59	-2437.96	

Note 1: ***, ** and * indicate significance at the 99, 95 and 90 percentage level.
2: Estimates control for intra- & extra-mural R&D, external networking, ownership, employment size & sector.

Incremental innovators benefit from internally sourced *Mathematics/ statistics/ database management* skills. These skills are likely to be core to these firms as competitor analysis and business/product positioning are essentially for incremental innovation (Toner, 2011). Since this type of innovation is likely to involve less idiosyncratic transactions than radical innovation, Transaction Cost Theory suggests that these firms are more likely to benefit from collaborating and outsourcing. In particular, we find that these firms benefit from collaborating with external sources for *Market research skills* and from outsourcing *Graphic arts/layout/advertising* skills.

5. Conclusion

From a firm's perspective it appears that a blanked development of skills in-house or a total outsourcing of skills may be counterproductive. Our results suggest that specific skills are better suited to different types of innovation and that some skills are more conducive to being outsourced. This implies that firms should focus on developing skills which best suit their innovation needs while also cultivating links with external specialists which can provide the skills not available/suited to internal development.

Our results suggest that there is substantial heterogeneity in the effectiveness of skills at generating different kinds of innovation output. Moreover, different skill sets appear to be required for radical innovation as opposed to incremental innovation. There appears to be more of a need for design and development skills for radical innovation while market research and management skills appear to be more important for incremental innovation. It seems that firms should develop their core competencies in-house, whilst collaborating on and outsourcing other non-core/ risky aspects of their business.

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