The Effects of Geography on Innovation in Small to Medium Sized Enterprises in the South-East and South-West of Ireland

Justin Doran, Declan Jordan* and Eoin O'Leary**

Abstract

This paper analyses the effects of geography on innovation by small and medium sized enterprises in the South-West and South-East regions of Ireland. Using an augmented innovation production function it estimates, both directly and indirectly, the effects of interaction with geographically proximate external agents and agglomeration economies on product and process innovation in these enterprises. The findings question the premise that geography matters for innovation in the Irish case. There is little evidence that local/regional interaction is more important for innovation and the close availability of a skilled labour pool and a range of urbanization indicators have no effect.

** Department of Economics, University College Cork, Ireland.*
E-mail: Justin.doran@ucc.ie

Introduction

This paper analyses the effects of geography on the innovative activity of small and medium sized enterprises (SMEs) in the South-East and South-West regions of Ireland. There is a burgeoning regional literature suggesting that geography matters for innovation. The work of KRUGMAN (1991), PORTER (1990) and SCOTT (1988) suggests that knowledge flows take place more easily over shorter distances, primarily due to the advantages of face-to-face interaction (GORDON and MCCANN, 2005). Thus, business innovation might benefit from geographic proximity to interaction agents, including customers, suppliers, competitors, higher education institutes (HEIs) and support agencies. Geographic proximity may facilitate increased frequency of interaction with these agents, thus promoting innovation.

However, knowledge flows from geographically proximate interaction agents may not exhaust the full range of potential benefits that might arise from the location of a business. The literature on localization economies suggests that the local or regional availability of a skilled labour pool specific to the industry may benefit the business, as knowledge is embodied in workers (MARSHALL, 1890; PORTER, 1990). Similarly, urbanization economies, which might include the availability in an urban setting of a general labour supply, efficient transport and communications infrastructure and a range of business services, may facilitate business innovation (JACOBS, 1969; GORDON and MCCANN, 2005).

In an Irish context, ROPER (2001) finds no evidence of an urban hierarchy of innovation for manufacturing businesses on the island of Ireland. JORDAN and O'LEARY (2007) find that geographic proximity to interaction agents does not increase the likelihood of innovation by Irish high-technology businesses, while population density is the only form of external agglomeration economy that has a positive affect on innovation by these businesses. This paper presents a more detailed analysis of the effects of geographic proximity and external agglomeration economies on innovation by SMEs in two of Ireland's NUTS 3 regions.

The next section presents the hypotheses being tested in the context of the innovation production function framework. This is followed in the following section by an outline of the survey, which is part of the EU funded DRIVE for growth project, and the measures used. The next section discusses the results while the final section concludes.

Modelling Innovation and Geography

The innovation production function approach stipulates that the introduction of new products and/or processes, referred to as innovation output, are a result of the development of commercially useful knowledge sources both internal and external to the business. Internal knowledge production can arise from Research and Development (R&D) activity and ideas generated by the business's human capital. In addition external sources of knowledge may be interaction with external agents such as customers, suppliers, competitors, HEIs and support agencies (JORDAN and

O'LEARY, 2007; MCCANN and SIMONEN, 2005; FREEL 2003). This is facilitated by the absorptive capacity of the workforce (COHEN and LEVINTHAL, 1990).

This paper has three contributions. The first is to introduce a measure of geographically proximate external interaction, comprising both the frequency of interaction and the location of the interaction agent. Following JORDAN and O'LEARY (2007), the measure of external interaction considers not just the incidence but also the frequency of interaction for innovation. Regular, frequent and continuous interaction with customers, suppliers, competitors, HEIs and support agencies may increase the likelihood of innovation. Combined with this is the geographical proximity to each of these agents, whether local, regional, national or international. The second contribution is to investigate the effects on innovation performance of external agglomeration economies, or more precisely localization and urbanization economies using a comprehensive range of measures. Finally, the paper not only investigates the role of geography directly on innovation performance but also indirectly through its effects on R&D activity and on interaction with other agents.

External interaction is an important source of knowledge for innovation (KLINE and ROSENBERG, 1986; LUNDVALL, 1988). Geographic proximity refers to the spatial or physical distances between economic actors. According to BOSCHMA, "*short distances literally bring people together, favour information contacts and facilitate the exchange of tacit knowledge*" (2005: 69). A large number of empirical studies have investigated whether knowledge externalities are geographically bounded (for example AUDRETSCH and FELDMAN, 2003; GALLIE, 2009; BRAMWELL, NELLES and WOLFE, 2008). The hypothesis to be tested here is that co-location with interaction agents, by facilitating more frequent interaction, promotes an increased level of innovation.

The external agglomeration economies of localisation and urbanization might also benefit business innovation (BATHELT, MALMBERG and MASKELL, 2004; AUDRETSCH and FELDMAN, 2003). Localisation economies arise from the common location of independent businesses in the same industry (MARSHALL, 1890). The benefits accruing from these agglomeration economies are industry specific. The terms innovative milieux and clusters are often applied to these areas (GORDON and MCCANN, 2005). Three elements are envisaged. The first is access to a specialized pool of skilled labour in the industry. The second is the presence of a range of auxiliary trades and specialised services. The third source of localisation economies are knowledge spillovers or the advantage to enterprises of having access (and also contributing) to information on products, processes, innovations, and market intelligence (PARR, 2002).

Urbanisation economies result from the common location of enterprises belonging to different and unrelated industries. Three factors are involved. First, there is a general pool of labour in an urban concentration. The second is the availability of a range of municipal services, public utilities and transportation and communications facilities and third, is the presence of a variety of business services (PARR, 2002).

There is overlap between geographically proximate external interaction and external localization economies. The benefits of local interaction with competitors, customers, suppliers, higher education institutes and support agencies may be considered as knowledge spillovers from the same industry or from ancillary industries. However, the movement of skilled labour (and knowledge) between businesses, which is the first element of a localization economy, may be an additional benefit to a business arising from its location that does not arise from external interaction. This paper tests this latter hypothesis.

Geographically proximate external interaction has a more tenuous link to potential benefits from urbanization economies. This might include the movement of labour, and therefore knowledge, with more diverse skills in an urban setting. In addition, enterprises may interact, whether intentionally or unintentionally, with a range of related enterprises in an urban concentration. These enterprises may be other than customers, suppliers and competitors. Finally, the availability of infrastructure and utilities in an urban environment may facilitate both local and more distant interaction. Thus, for example, intra-urban transport services might facilitate local interaction while an airport might facilitate international interaction. The hypothesis tested in this paper is that the numerous benefits of an urban location will promote innovation.

The paper begins by testing the effects of R&D activity and external interaction on innovation performance disregarding any geographic effects. Equation (1) is a logit model as follows:

$$IO_i = \delta_0 + \delta_1 R\&D_i + \delta_2 EI_{ij} + \delta_3 Z_i + \mu_i \qquad (1)$$

where IO_i are binary indicators of product and process innovation in business i, $R\&D_i$ are binary indicators of the extent of R&D in the business i; EI_{ij} are binary measures of interaction between business i and external interaction agent j and Z is a range of business specific factors. Five agents are considered: customers, suppliers, competitors, HEIs and support agencies, with the interaction measure being continuous, frequent and regular interaction compared to interaction occurring rarely or never. It is hypothesized that R&D (δ_1) and EI (δ_2) positively influence the level of innovation output in SMEs.

In order to test the effects of geography, the geographic proximity of interaction agents and external agglomeration economies are then introduced. Equation (2) presents the second logit model:

$$IO_i = \alpha_0 + \alpha_1 R\&D_i + \alpha_2 GPEI_{ij} + \alpha_3 U_i + \alpha_4 SL_i + \alpha_5 Z_i + \mu_i \qquad (2)$$

where $GPEI_{ij}$ is a series of dummy variables which indicate whether a business interacts regularly, frequently or continuously with local, regional, national or international agents with the reference category being interaction occurring never or rarely; U_i measures the degree of urbanisation in the area in which business is located and SL_i is a measure of the concentration of skilled labour in the region.

It is hypothesized that R&D (α_1) and both urbanization economies and skilled labour (α_3 and α_4), positively influence the level of innovation output in SMEs. The variable $GPEI_{ij}$ permits a geographical analysis of external interaction. It is hypothesized that for a given agent the value of α_2 is positive and greater for local or regional interaction than for national or international interaction.

Enterprises conduct R&D in the expectation of innovation output. As a result the presence of geographically proximate external interaction, skilled labour and urbanization economies, may improve the likelihood of enterprises engaging in R&D. This raises the possibility that geography may also influence innovation output indirectly through its effect on R&D. In addition, following ROPER and LOVE (2001) external interaction and R&D may be considered substitutes or complements in the innovation process. Equation (3) uses a logit model to estimate:

$$R\&D_i = \beta_0 + \beta_1 GPEI_{ij} + \beta_2 U_i + \beta_3 SL_i + \beta_4 Z_i + \varepsilon_i \qquad (3)$$

If R&D and GPEI are substitutes ($\beta_1 < 0$) enterprises may compensate for a lack of external interaction opportunities by concentrating more on internal knowledge production. However, if these inputs are complementary ($\beta_1 > 0$), then it is interesting to investigate whether local or regional interaction supports R&D. It is also hypothesized that β_2 and β_3 are positive.

Equation (4) completes the analyses by considering whether geographical proximity to other interaction agents, as well as localization and urbanisation economies increases the frequency of external interaction with each agent. It employs ordered probit to estimate:

$$EI_{ij} = \lambda_0 + \lambda_1 R\&D_i + \lambda_2 EI_{ik} + \lambda_3 GP_{ij} + \lambda_4 SL_i + \lambda_5 U_i + \lambda_6 Z_i + \omega_i \quad (4)$$

where EI_{ij} is an indicator of the interaction between business i and interaction agent j, EI_{ik} is an indicator of the interaction between business i and interaction agent k where $k \neq j$, GP_{ij} is an indicator of the geographical proximity between business i and interaction agent j and all the other variables are defined as before. The hypotheses being tested are whether λ_3, λ_4 and λ_5 are positive. In addition if $\lambda_2 > 0$ (<0) interaction between respective agents is a complement (substitute).

Description of Data

This paper uses survey data collected by the South-West and South-East Regional Authorities as part of 'DRIVE for Growth', an Interreg III B North West European Area Project [see http://www.driveproject.eu/]. The Authorities cover the NUTS 3 areas of the South-West, consisting of Cork and Kerry, and the South-East, made up of Waterford, Kilkenny, Wexford and south Tipperary. These neighbouring regions, with a combined population of just over 1 million, have two city regions in Cork, with a population of 250 thousand (ATKINS, 2008) and Waterford, with a population of over 120 thousand (SOUTH EAST REGIONAL AUTHORITY, 2006). Disposable income per capita in the South-West and South-East was 96% and 93% respectively of the national average in 2006 (CENTRAL STATISTICS OFFICE, 2006a).

As part of the project a self-administered innovation survey was circulated to 1,619 enterprises employing 250 persons or less in all sectors, excluding agriculture, forestry and fisheries and public services, during the winter of 2006/2007. Table 1 displays the number of surveys distributed in each region. A total of 223 enterprises responded, with the response rate being 14%. This compares favourably to other innovation surveys targeting a range of business sectors (see for example FREEL, 2003; OERLEMANS, MEEWS and BOEKEMA, 2001). Of the total, 21% of respondents are traditional manufacturing, 27% are in modern manufacturing and 52% are in private services (see Appendix 1 for full definition of sectors). It should be noted that the median age of enterprises is 15 years with a standard deviation of 28 years. The median number of employees is 17 (standard deviation of 98) and the average number of employees with third level education is 35 % (standard deviation of 34%).

[Table 1 around here]

Product and process innovation are defined in line with similar studies such as JORDAN and O'LEARY (2007) and ROPER (2001) and are based on SCHUMPETER'S (1934) definition of innovation. Product innovation is defined as the introduction of new or improved goods/services, which may be either new to the market or to the business, in the preceding two years. Process innovation is (i) the introduction of a new method of production, (ii) the opening of a new market, (iii) the acquisition of a new source of supply or (iv) the re-organization of management or distribution channels. Enterprises ranked the frequency with which they implemented new processes over the previous two years on an ordered scale as follows: continuously, frequently, regularly, rarely or never.

[Table 2 around here]

Table 2 presents the levels of product and process innovation of respondents. 56% of the businesses introduced a new product within the reference period. 65% are process innovators, defined as having introduced new process innovations regularly, frequently or continuously in the last two years. Enterprises were asked to indicate whether they performed R&D and whether they had a dedicated R&D department. 63% see themselves as performing R&D, with 32% of these possessing a dedicated R&D department.

Respondents classified their frequency of interaction as continuously, frequently, regularly, rarely or never. Table 3 presents the frequency of interaction for product and process innovation by interaction agent. For a clear majority of enterprises, regular, frequent or continuous interaction occurs for both product and process innovation with suppliers (79% for both) and customers (88% and 72% respectively). This strong interaction is in contrast to the weaker interaction for both product and process innovation with competitors (41% and 30% respectively), HEIs (36% and 28%) and agencies (35% and 33%). These differences are significant at the 99 % level.

[Table 3 around here]

Turing to geography Table 4 presents the location of the enterprises' most important interaction agent for both product and process innovation. Nearly 80% of enterprises indicate their most important supplier for product and process innovation is located outside their own region (ie either international or national). For customers and competitors this percentage is approximately two thirds. For HEI's it is 64% for product and 57% for process while for support agencies closer to 50% of enterprises engage in these forms of distant interaction for product and process innovation. These differences are also significant at the 99 % level.

[Table 4 around here]

The availability of a skilled labour (SL), which is a form of localization economy, is proxied as the percentage of total regional employment in the same sector as the responding SME (CSO, 2006b). A total of 22 sectors are used, which is the greatest possible sectoral disaggregation available, for each of the NUTS 2 regions. Table 5 shows that the mean percentage of skilled labour is 5.5%, with a standard deviation of 3.2.

Eight indicators of urbanization economies (U) are employed, descriptive statistics for which are reported in Table 5. Population density is calculated as the number of persons per square kilometer in the electoral district of the business (CSO, 2006c). For enterprises located in the cities of Cork and Waterford the average population density in the city is applied. The mean density is 1,286 persons per square kilometer. In order to capture the general pool of labour the percentage of the labour force in technical and professional occupations (CSO, 2006d) and the percentage of individuals with a third level degree (CSO, 2006e) in the electoral district of the business is used. Again for enterprises located in the cities average are applied. The means are 25% and 18% respectively.

The next set of urbanization indicators is the distance of responding enterprises to the nearest Institute of Technology, University and international airport. The South-West region has Institutes of Technology in Cork and Tralee and a university in Cork while the South-East has Institutes of Technology in Waterford and Carlow. The distance to the nearest Institute of Technology and university is used irrespective whether these institutions are in the same regions as the responding business. The only airports in the regions are Cork International Airport and Waterford Airport. However, Dublin and Shannon airports are closer for some enterprises. These distances are calculated using AA Roadwatch [available at http://www.aaireland.ie/routes/]. The minimum distance between a business and the nearest of these key infrastructural facilities is 2 kilometers and the maximum distance is 150 kilometers.

Whether the business is located in an industrial estate is also included. Industrial estates are present in cities and many towns in both regions. According to IDA Ireland industrial estates are designed to a high standard of services infrastructure for both manufacturing and international services sectors (IDA IRELAND, 2008). One third of responding enterprises are located in an industrial estate.

The final urbanization proxy included is the availability of broadband. This is a key infrastructure that is more likely to be available in urban settings in Ireland, which has a low broadband penetration rate by international standards (EUROPEAN

COMPETITIVENESS TELECOMMUNICATIONS ASSOCIATION, 2007). The availability of broadband is determined through the use of two broadband comparison websites; Get Broadband [available at http://www.getbroadband.ie] and Try Switch [http://www.tryswitch.ie]. The availability of mobile internet providers is not considered due to relatively poorer quality and slower speeds.

[Table 5 around here]

Empirical Results

Table 6 presents the estimations for equation (1), which excludes the effects of geography on innovation[i]. It can be observed that for both product and process innovation only one form of interaction is significant. For product innovation interaction with customers and for process innovation interaction with suppliers increases the likelihood of innovation by 40% and 28% respectively. It is important to note that these interaction agents are significant regardless of their location.

These findings are intuitively appealing in that frequent communication with customers might facilitate the development of new products while repeated contact with suppliers might be important for the introduction of new processes. It is important to note that external interaction with suppliers (for product), customers (for process) and with competitors, HEIs and agencies (for both product and process) has no significant effect on the likelihood of innovation.

Performing R&D and possessing a dedicated R&D department both increase the likelihood of a business engaging in product and process innovation. It can also be noted that the larger the business, measured as the number of employees, the more likely it is to introduce both product and process innovation. Overall, these results confirm that both R&D activity and external interaction have positive effects on innovation performance.

[Table 6 around here]

Table 7 presents the results for Equation (2). It is noticeable that for product innovation the geographic proximity of interaction with customers, who were found in Table 6 to be the only interaction agent to increase the likelihood of introducing new products, is not significant. Clearly this form of interaction is important regardless of geography. The finding of a positive and significant coefficient on interaction with local competitors is an important finding as it only emerges when the GPEI measure is considered. This form of interaction increases the probability of product innovation by 34%.

For process innovation, interaction with international suppliers is significant, increasing the likelihood by 19% relative to not interacting at all. This is a notable result as it was seen in Table 6 that interaction with suppliers is the only form of external interaction that matters for process innovation. It implies that international interaction matters more than local, regional or national interaction for this form of innovation. It is notable that interaction with international competitors decreases the likelihood of process innovation by 36%. Table 7 also shows that interaction with regional or national support agencies matters more than either local or international support agencies, with the marginal effect being 23% and 25% respectively. Once again this is an important result as interaction with agencies does not register as significant in Table 6.

Regarding skilled labour and the urbanisation indicators there is no evidence that these factors influence the likelihood of a business engaging in either product or process innovation. A Wald test of the complete set of urbanization measures is jointly insignificant. This analysis, based on more detailed measures, reinforces ROPER's (2001) finding of no urbanization effects on innovation in Ireland. Overall there is little evidence to support the direct effect of geography on innovation performance in these enterprises.

[Table 7 around here]

Turning to R&D, it is clear that performing R&D and possessing a dedicated R&D department increases the likelihood of a business engaging on both product and process innovation. These measures of R&D have consistently positive effects in both Table 6 and 7, thus confirming the importance of formal and informal R&D for new products and processes.

The importance of R&D points to the need to investigate a possible indirect role for geography through its impact on this activity. Accordingly, Table 8 presents the estimation of Equation (3). Due to a problem of perfect co-linearity the local/regional and national/international GPEI categories are combined. It can be observed that enterprises are 21% more likely to perform R&D if they interact with local/regional suppliers for process innovation. This indicates that local interaction with suppliers is a complement to performing R&D. The only other form of local/regional interaction to register as significant is with competitors for product innovation. This has a negative effect indicating a substitution relationship. Local/regional interaction with competitors decreases the probability of performing R&D by 34%.

National/international interaction with customers registers as complementary to the performance of R&D for both product and process innovation, with marginal effects being 34% and 19% respectively. In addition, national/international interaction with agencies is also significant for process innovation only, increasing the innovation probability by 21%. Overall these results suggest that local/regional interaction have both positive and negative effects on R&D, with national/international networking being at least as important. The results contrast with ROPER and LOVE (2001) who find that R&D and networking are substitutes. By investigating the proximity of interaction with five different interaction agents, this paper shows the effect to be complementary for three of the agents and a substitute for only one.

Table 8 offers no support for the hypothesis that the availability of skilled labour in the region or the presence of urbanisation economies increases the probability of a business performing R&D. A Wald test indicates that jointly urbanisation economies have no significant affect. These results concur with KLEINKNECHT and POOT (1992) who found that urban areas have no effect on R&D performance in the Netherlands.

It is notable that the proportion of the workforce with third level education positively influences the likelihood of a business performing R&D. It can be seen in Tables 6 and 7 that this measure for the absorptive capacity of the workforce had no significant effect on innovation performance. These results therefore suggest that it may have a positive indirect effect. Finally, it can be observed that enterprises in the service sector are less likely to see themselves as R&D active relative to enterprises in traditional manufacturing.

[Table 8 around here]

Turning to the effects of geography on the frequency of interaction Table 9 presents the estimations of equation (4). Geography has limited effects on the frequency of interaction with the 5 different interaction agents. There are only 5 significant relationships out of a possible 30. Enterprises are more likely to interact more frequently for product innovation with internationally based suppliers. Given that it was found in Table 7 that international suppliers matter for process innovation, this reinforces the importance of international interaction with suppliers.

However, Table 9 shows that enterprises are less likely to interact frequently for product innovation with international, national or regional customers relative to local customers. Similarly, they are less likely to interact with international HEIs relative to local HEIs for product innovation. In the case of customers it was found earlier that while external interaction matters the location of customers does not have any effect on the probability of innovation. This implies that although enterprises are more likely to interact with local customers this local interaction does not translate into an increased likelihood of innovation relative to business which interact with non-local customers. There is also no evidence that HEI interaction has any effect on the innovation performance of these enterprises.

[Table 9 around here]

These results are similar to JORDAN and O'LEARY (2007) who find that interaction for product and process innovation is not geographically constrained. Once again Table 9 clearly shows that skilled labour and urbanisation economies exert no influence on the frequency of external interaction. Overall it is clear that geography plays a limited role in explaining the frequency of external interaction by these enterprises.

These results also suggest that interaction between a range of external agents for both product and process innovation is complementary in 19 out of a possible 40 cases. Commentary now concentrates on those cases which were found in Tables 6 and 7 to have a significantly positive effect on innovation performance. These were customers (regardless of their location) and local competitors for product innovation and suppliers (especially international) and regional/national agencies for process innovation. Table 9 shows that enterprises are more likely to interact with customers for product innovation if they interact with suppliers and competitors. Similarly they are more likely to interact with competitors if they interact with suppliers, customers and agencies. Regarding process innovation, enterprises are more likely to interact with suppliers if they interact with customers and competitors. They are more likely to interact with agencies if they interact with customers and HEIs. Overall these findings reveal the greater importance of market-based interactions with customers, suppliers and competitors rather than interaction with HEIs or agencies for these enterprises. However, the earlier evidence suggests that these effects are not strongly mediated by geography. Overall these results are similar to those of JORDAN and O'LEARY (2007).

Conclusions and Implications

This paper tests the effects of geography on the innovative activity of small and medium sized enterprises (SMEs) in the South-East and South-West regions of Ireland. Using an augmented innovation production function it has estimated, both directly and indirectly, the effects of geographically proximate interaction agents, a skilled labour pool and urbanization economies on the levels of product and process innovation in these enterprises.

For geography to be important one would expect to find a stronger reliance on interaction with local or regional customers, suppliers, competitors, HEIs and support agencies. In addition there would be an expectation that the presence of a skilled labour pool and the benefits of urbanization such as a general labour pool, the availability of education, transport and communication infrastructure and a variety of business services in an urban setting would increase the likelihood of product and process innovation in these enterprises.

Overall the findings suggest a very limited role for geography. While interaction with customers and suppliers increase the likelihood of innovation, there is no evidence to suggest that local/regional interaction is more important. These results are similar to those of OERLEMANS and MEEUS (2005) for the Netherlands. Only interaction with local competitors and regional/national support agencies matter for product and process innovation respectively. However, while local/regional interaction with suppliers improves the chances that these enterprises engage in R&D, local interaction with competitors for product innovation is seen as a substitute for this important activity. Significantly, there is no evidence of a role for interaction with HEIs, while a skilled labour pool and the range of urbanization indicators are found to play no direct or indirect roles in explaining the innovation performance of these enterprises.

To some extent the importance of national/international linkages is not surprising given the limited size of the Irish domestic market and the overriding importance of international markets especially for successful SMEs. What is perhaps surprising is a lack of evidence that HEI interaction, a skilled labour pool and urbanization economies make any difference to the innovation performance of these enterprises. The absence of any significant role for HEIs should be seen in the context of the Irish governments now well established strategy of developing a knowledge and innovation-based economy based on public investment in science and technology, the majority of which has been in HEIs. This result suggests that the substantial public investment on research in Irish HEIs is having little effect on Irish SME innovation (see JORDAN and O'LEARY, 2007 for a fuller discussion). This concern has been noted by policymakers in the South-West region (SOUTH-WEST REGIONAL AUTHORITY, 2008).

Although there is no evidence to suggest that the presence of a skilled labour pool increases the likelihood of innovation, the importance of local competitors and local/regional suppliers (through their effects on the conduct of R&D) is limited evidence in support of localization economies. Policy prescriptions, since the CULLITON REPORT (1992) and more recently the ENTERPRISE STRATEGY GROUP have stressed the importance of local or regional clusters involving industry, academic and public sector co-operation to drive the development of knowledge and expertise (2004: 53). These findings suggest that clusters may exist in limited form, although without significant HEI impact. The negative effect of interaction with local/regional competitors on R&D performance is worrying as this might undermine innovation performance by these SMEs.

The absence of any positive innovation effects from urbanization economies implies a lack of well developed urban spaces conducive to SME innovation. It might also be that the presence of urbanization diseconomies, which are not measured in this paper, over-shadow any positive urbanization effects. Either way, the implication is that local/regional policymakers need to think more in terms of creating the conditions for a vibrant 'local buzz' (STORPER and VENABLES, 2002) in the urban centres in these regions.

In addition the findings of important national/international linkages with customers, suppliers and support agencies points to policymakers devoting attention to building connectivity, or what BARTHELT, MALMBERG and MASKELL (2004) referred to as effective 'global pipelines' both nationally and internationally to promote business innovation. The evidence in this paper echoes the emerging evidence that distance may not be a barrier to knowledge flows (GALLIE, 2009) and that global interaction is important for innovation (BRAMWELL, NELLES and WOLFE, 2008).

These findings are based of a survey of 223 SMEs in the South-West and South-East a regions of Ireland. The approach taken should be employed in larger samples of SMEs or indeed other Irish enterprises. It would also be interesting to investigate whether Ireland is a special case or whether businesses in other countries also experience such a limited role for geography. In addition, it is important to probe deeper into the reasons for the limited role for geographically proximate external interaction, skilled labour and urbanization economies. This might involve investigating, using interview and case study as well as econometric methods, the local/regional institutional contexts, the incentives and barriers to local interaction and the extent to which agglomeration diseconomies are present.

References

ATKINS W.S. (2008) Update of the Cork Area Strategic Plan 2001 – 2020, Cork [available at http://www.corkcity.ie/casp/strategicplan/CASP_update_1-2.pdf];

AUDRETSCH D. and FELDMAN P. (2003) Knowledge Spillovers and the Geography of Innovation in HENDERSON J. V. and THISSE J. F. (Eds) Handbook of Regional and Urban Economies, United States of America;

BATHELT, H., MALMBERG, A. and MASKELL, P. (2004). "Clusters and knowledge: local buzz, global pipelines and the process of knowledge creation" Progress in Human Geography, 28(1):31-56.

BOSCHMA R. (2005) Proximity and Innovation: A Critical Assessment, Regional Studies 39, 61-74;

BRAMWELL A., NELLES J and WOLFE D (2008) Knowledge, Innovation and Institutions: Global and Local Dimensions of the ICT Cluster in Waterloo, Canada, Regional Studies, 42, 1 101-116.

CENTRAL STATISTICS OFFICE (2006a). County Incomes and Regional GDP 2006, Government Publications Office, Dublin. [available at http://www.cso.ie/releasespublications/pr_natacc.htm]

CENTRAL STATISTICS OFFICE (2006b). Census of Population 2006, Volume 7, Government Publications Office, Dublin. [available at http://beyond2020.cso.ie/Census/TableViewer/tableView.aspx?ReportId=75548]

CENTRAL STATISTICS OFFICE (2006c). Census of Population 2006, Small Area Population Statistics, Theme 1 subgroup 2, Government Publications Office, Dublin. [available at http://beyond2020.cso.ie/Census/TableViewer/tableView.aspx?ReportId=54815]

CENTRAL STATISTICS OFFICE (2006d). Census of Population 2006, Small Area Population Statistics, Theme 9 subgroup 1, Government Publications Office, Dublin. [available at http://beyond2020.cso.ie/Census/TableViewer/tableView.aspx?ReportId=54861]

CENTRAL STATISTICS OFFICE (2006e). Census of Population 2006, Small Area Population Statistics, Theme 10 subgroup 3, Government Publications Office, Dublin. [available at http://beyond2020.cso.ie/Census/TableViewer/tableView.aspx?ReportId=54859]

COHEN W. and LEVINTHAL D. (1990) Absorptive Capacity: A New Perspective on Learning and Innovation, Administrative Science Quarterly 35, 128-152;

CULLITON J. (1992). A Time for Change: Industrial Policy for the 1990s: Report of the Industrial Policy Review Group, Dublin.

ENTERPRISE STRATEGY GROUP (2004). Ahead of the Curve: Ireland’s Place in the Global Economy. Forfas, Dublin [available at www.forfas.ie];

EUROPEAN COMPETITIVENESS TELECOMUNICATION ASSOCIATION (2007) Broadband Scorecard 2007 Q3 [available at http://www.ectaportal.com/en/upload/File/Broadband_Scorecards/Q3_2008/Telefonica_bb_scard_release_020309_final.pdf];

FREEL M. (2003) Sectoral Patterns of Small Firm Innovation, Networking and Proximity, Research Policy 32, 751-770;

GALLIE E. (2009) Is Geographical Proximity Necessary for Knowledge Spillovers, Regional Studies 43, 1, 33-42;

GORDON I. and MCCANN P (2005). Innovation, Agglomeration and Regional Development, Journal of Economic Geography 5(5), 523-543;

I.D.A. IRELAND (2008) Business and Technology Parks, Dublin, Ireland [available at http://www.idaireland.com/home/index.aspx?id=2089];

JACOBS, J. (1969). The Economy of Cities, Pelican, London.

JORDAN D. and O'LEARY E. (2007) Is Irish Innovation Policy Working? Evidence from Irish High-Technology Businesses, Paper presented at a Meeting of the Statistical and Social Inquiry Society of Ireland, Dublin, 25th October;

KLEINKNECHT A. and POOT T. (1992) Do Regions Matter for R&D, Regional Studies 26, 221-232;

KLINE J. and ROSENBERG N. (1986) An Overview of Innovation, in LANDAU R. and ROSENBERG N. (Eds) The Positive Sum Strategy: Harnessing Technology for Economic Growth, National Academy Press, Washington;

KRUGMAN P. (1991) Geography and trade, MIT Press, Cambridge, MA;

LONG S. and FREESE J. (2001) Regression Models for Categorical Dependent Variables Using Stata, Texas, United States of America;

LUNDVALL B.E. (1988). "Innovation as an interactive process: From user-producer interaction to the national system of innovation" in DOSI G., FREEMAN C., NELSON R., SILVERBERG G. and SOETE L., (Eds). Technical Change and Economic Theory, Pinter Publishers, London

MARSHALL, A. (1890). Principles of Economics, Macmillan, London;

MCCANN P. and SIMONEN J. (2005) Innovation, knowledge spillovers and local labour markets, Papers in Regional Science 84, 465-485;

OERLEMANS L. and MEEUS M. (2005) Do Organizational and Spatial Proximity Impact on Firm Performance?, Regional Studies, 39, 1, 89-104.

OERLEMANS L. MEEUS M. and BOEKEMA F. (2001). Firm Clustering and Innovation: Determinants and Effects, Papers in Regional Science, 80, 337-356;

PARR J. (2002) Missing Elements in the Analysis of Agglomeration Economies, International Regional Science Review 25, 151-168;

PORTER M. (1990) The competitive advantage of nations, The Free Press, United States of America;

ROPER S. (2001) Innovation, Networks and Plant Location: some evidence from Ireland, Regional Studies 35, 215-228;

ROPER S. and LOVE J. (2001). Location and Network effects on Innovation Success: Evidence for UK, German and Irish manufacturing plants, Research Policy 30(4): 643-661;

SCHUMPETER J. (1934) The Theory of Economic Development, Harvard University Press, Cambridge, U.S;

SCOTT A. (1988) New Industrial Spaces, Pion, United States of America;

SOUTH EAST REGIONAL AUTHORITY (2006) Submission to the Department of Finance on the Preparation of a National Development Plan 2007-2013, Clonmel, Tipperary [available at http://www.sera.ie/SERA%20Submission%20for%20NDP%202007-2013%20-%20Final.pdf];

SOUTH WEST REGIONAL AUTHORITY (2008) Linkages for Innovation between the Higher Education Institutes and Indigenous Firms in the South West Region. Discussion Paper DRIVE FOR GROWTH Project, South West Regional Authority, Cork [available at http://www.driveproject.eu/index.cfm/page/surveys];

STORPER M. and VENABLES A. (2004) Buzz: face to face contact and the urban economy, Journal of Economic Geography 4, 351-370;

Tables

Table 1: Survey Response Details

	South-East	South-West	Total
No. of Firms to which the Survey was addressed	542	1077	1619
Number of Respondents	61	162	223
Response Rate	11%	15%	14%

Table 2: Product and Process Innovators

	Product Innovation	Process Innovation
	Percent (%)	Percent (%)
Non innovators	44	35
Innovators	56	65

Table 3: Frequency of Interaction for Product and Process Innovation (%)

Frequency of Interaction	Supplier		Customer		Competitor		HEIs		Agency	
	Product	Process	Product	Process	Product	Process	Product	Process	Product	Process
Never	13	16	10	20	34	48	39	49	39	44
Rarely	8	6	3	8	26	22	25	23	24	24
Regularly	18	29	19	22	20	17	17	14	17	15
Frequently	34	34	30	28	17	9	13	9	13	14
Continuously	27	15	39	22	4	4	6	5	5	4

Table 4: Proximity to Interaction Agents for Product and Process Innovation (%)

	Supplier		Customer		Competitor		HEIs		Agency	
	Product	Process	Product	Process	Product	Process	Product	Process	Product	Process
International	46	45	29	34	27	32	24	23	6	10
National	32	34	36	33	41	39	40	34	44	48
Regional	11	12	20	17	19	18	23	28	31	28
Local (>1 hour drive)	11	9	15	16	13	11	13	15	19	14

Table 5: Descriptive Statistics on External Localization and Urbanization Economies

	Mean	Median	Standard Deviation	Minimum	Maximum
Skilled Labour (%)	5.5	5.4	3.2	0.2	13
Population Density (pop/km^2)	1286	1100	1146	7	3918
Professional and Technical (%)	25.44	25.06	5.71	15.03	45.57
Degree/Population (%)	17.98	18.56	3.20	9.73	27.54
Distance to IT (km)	28.04	18.99	28.10	1.29	120.06
Distance to University (km)	61.05	60.84	47.33	2.09	147.10
Distance to Airport (km)	34.53	18.19	30.52	1.45	127.47
Industrial Estate (1,0)	0.33	0.00	0.47	0.00	1.00
Broadband (1,0)	0.86	1.00	0.34	0.00	1.00

Table 6: Logit Model: Probability of a Business Innovating with Interaction, R&D and Geography.

	Product Innovation		Process Innovation	
	Coef.	**dy/dx**	**Coef.**	**dy/dx**
Constant	-1.890 (0.660)		-1.758 (0.590)	
External Interaction (EI)				
Suppliers	-0.876 (0.553)	-0.177	1.239*** (0.519)	0.278
Customers	1.700*** (0.723)	0.401	-0.126 (0.469)	-0.025
Competitors	0.606 (0.395)	0.132	-0.476 (0.481)	-0.101
HEI	-0.085 (0.426)	-0.019	0.025 (0.537)	0.005
Support Agency	0.703 (0.458)	0.150	0.475 (0.522)	0.093
R&D				
Perform R&D	0.624* (0.386)	0.136	1.506*** (0.425)	0.283
Dedicated R&D Department	2.077*** (0.594)	0.363	2.181*** (0.588)	0.333
Control Variables (Z)				
Number of Employees	0.005* (0.002)	0.001	0.004* (0.002)	0.001
Third Level Education	0.006 (0.006)	0.001	0.011 (0.006)	0.002
Sector[2]				
Modern Manufacturing	0.253 (0.490)	0.055	0.353 (0.586)	0.069
Services	-0.024 (0.522)	-0.006	-0.785 (0.525)	-0.175
R2		0.2105		0.2376
N		181		174
Chi2		32.14		40.68
		0.0007		0.000
Log Likelihood		-94.97		-84.95

Notes 1: *** signifies statistical significance at the 1% level; ** at the 5% level and * at the 10% level.

2: Traditional Manufacturing is the reference category. See Appendix 1 for definitions.

Table 7: Logit Model: Probability of a Business Innovating with Proximity of Interaction Agents, R&D and Geography.

	Product Innovation		Process Innovation	
	Coef.	**dy/dx**	**Coef.**	**dy/dx**
Constant	-2.619 (1.960)		-1.777 (2.359)	
Geographic Proximity of External Interaction (GPEI)[2]				
Suppliers				
Local (<1 hour drive)	-0.809 (1.002)	-0.199	1.659 (1.105)	0.211
Region	-0.201 (0.966)	-0.048	0.628 (0.885)	0.106
National	0.688 (0.726)	0.152	0.473 (0.641)	0.085
International	0.575 (0.603)	0.131	1.150** (0.568)	0.196
Customers				
Local (<1 hour drive)	-1.323 (1.204)	-0.319	-1.128 (0.733)	-0.253
Region	0.018 (0.778)	0.004	-0.9507 (0.730)	-0.210
National	0.765 (0.551)	0.170	-0.835 (0.667)	-0.177
International	-0.101 (0.676)	-0.024	-1.146 (0.732)	-0.248
Competitors				
Local (<1 hour drive)	2.205** (0.983)	0.341	-0.982 (1.016)	-0.222
Region	0.314 (0.936)	0.071	-0.602 (0.916)	-0.129
National	0.980 (0.651)	0.207	-0.548 (0.698)	-0.115
International	0.459 (0.741)	0.102	-1.585** (0.717)	-0.363
HEI				
Local (<1 hour drive)	-0.346 (1.284)	-0.084	0.323 (1.198)	0.058
Region	0.827 (0.935)	0.173	-0.126 (0.946)	-0.025
National	1.054 (0.860)	0.215	-0.375 (1.004)	-0.077
International	0.506 (1.137)	0.112	1.223 (1.103)	0.176
Support Agencies				
Local (<1 hour drive)	0.733 (0.801)	0.155	1.156 (1.280)	0.165
Region	-0.637 (0.868)	-0.155	1.817** (0.801)	0.230
National	-0.059 (0.758)	-0.014	1.787** (0.895)	0.247
International	-1.027 (1.997)	-0.251	0.050 (1.545)	0.010

R&D				
Perform R&D	0.923** (0.412)	0.208	1.895*** (0.426)	0.323
Dedicated R&D Department	2.556*** (0.788)	0.444	2.949*** (0.718)	0.375
Control Variables (Z)				
Number of Employees	0.003 (0.002)	0.001	0.005** (0.002)	0.001
Third Level Education	0.005 (0.006)	0.001	0.014* (0.008)	0.003
Sector[3]				
Modern Manufacturing	0.459 (0.553)	0.104	-0.350 (0.651)	-0.070
Services	0.129 (0.432)	0.030	-0.497 (0.553)	-0.102
Skilled Labour (SL)				
Labour Share	1.684 (5.426)	0.396	0.025 (6.158)	0.005
Urbanisation Economies (U)				
Broadband	0.095 (0.653)	0.023	0.373 (0.620)	0.076
Population Density	-0.001 (0.001)	0.000	-0.001 (0.001)	0.000
Distance to IT	-0.014 (0.016)	-0.003	-0.001 (0.017)	0.000
Distance to University	-0.005 (0.005)	-0.001	0.002 (0.006)	0.001
Distance to Airport	0.006 (0.016)	0.002	-0.016 (0.015)	-0.003
Degree/Population	0.0185 (0.099)	0.004	0.025 (0.116)	0.005
Professional and Technical	0.026 (0.047)	0.006	0.005 (0.053)	0.001
Industrial Estate	0.6781 (0.452)	0.154	0.608 (0.464)	0.111
R2	0.266		0.3231	
N	195		195	
Chi2	47.58		79.77	
	0.0762		0	
Log Likelihood	-97.39212		-84.9181	

Notes 1: *** signifies statistical significance at the 1% level; ** at the 5% level and * at the 10% level.

2: External interaction occurring never or rarely is the reference category.

3: Traditional Manufacturing is the reference category. See Appendix 1 for definitions.

Table 8: Logit Model: The Likelihood of a Business Performing R&D with the Proximity of Interaction Agents and Geography.

R&D and Geography				
	Product Innovation		Process Innovation	
	Coef.	**dy/dx**	**Coef.**	**dy/dx**
Constant	0.634 (1.137)		0.051 (0.065)	
Geographic Proximity of External Interaction (GPEI)[2]				
Suppliers				
Local/Regional	1.016 (0.680)	0.205	1.035* (0.574)	0.212
National/International	-0.045 (0.448)	-0.011	0.224 (0.410)	0.052
Customers				
Local/Regional	0.963 (0.641)	0.204	0.582 (0.515)	0.129
National/International	1.513*** (0.516)	0.339	0.849** (0.432)	0.193
Competitors				
Local/Regional	-1.436** (0.664)	-0.344	-0.719 (0.686)	-0.175
National/International	-0.686 (0.497)	-0.163	-0.430 (0.494)	-0.103
HEI				
Local/Regional	0.974 (0.664)	0.197	0.005 (0.703)	0.001
National/International	0.704 (0.486)	0.152	-0.487 (0.600)	-0.117
Support Agency				
Local/Regional	-0.076 (0.532)	-0.018	0.303 (0.623)	0.069
National/International	0.333 (0.542)	0.075	1.016* (0.552)	0.213
Control Variables (Z)				
Number of Employees	0.001 (0.001)	0.000	0.001 (0.001)	0.000
Third Level Education	0.014** (0.006)	0.003	0.014*** (0.005)	0.003
Sector[3]				
Modern Manufacturing	-0.661 (0.561)	-0.158	-0.639 (0.492)	-0.154
Services	-0.834* (0.436)	-0.201	-0.690 (0.437)	-0.167

Skilled Labour (SL)				
Labour Share	-1.062	-0.246	-5.199	-1.216
	(5.115)		(4.797)	
Urbanisation Economies (U)				
Population Density	-0.001	0.000	-0.001	0.000
	(0.001)		(0.001)	
Degree/Population	0.019	0.005	-0.062	0.012
	(0.068)		(0.041)	
Professional and Technical	-0.055	-0.013	0.783	-0.015
	(0.041)		(1.080)	
R2		0.1664	0.1171	
N		197	197	
Chi2		31.37	27.05	
		0.0261	0.0781	
Log Likelihood		-109.888	-116.379	

Notes 1: *** signifies statistical significance at the 1% level; ** at the 5% level and * at the 10% level.

2: External interaction occurring never or rarely is the reference category.

3: Traditional Manufacturing is the reference category. See Appendix 1 for definitions.

Table 9: Ordered Probit Model: The Effects of Proximity to External Agents on the Frequency of Interaction for Product Innovation.

	Supplier		Customer		Competitor		Academic		Agency	
	Product	**Process**	**Product**	**Process**	**Product**	**Process**	**Product**	**Process**	**Product**	**Process**
Geographic Proximity (GP)[2]										
Region	1.445	0.578	-1.766*	0.029	-0.357	-0.223	-1.086	-1.004	0.869	0.925
National	0.342	0.071	-1.176*	-0.034	-0.551	-0.760	-0.354	-0.397	0.474	0.579
International	1.308*	0.439	-1.969**	-0.785	0.181	-1.060	-1.758*	-1.142	-0.950	0.302
External Interaction (EI)										
Suppliers			0.486**	0.603***	0.526**	0.662*	-0.200	0.144	0.502**	0.437
Customers	0.869***	0.551***			0.663**	0.243	0.314	0.047	0.770**	0.522*
Competitors	0.398*	0.521**	0.431***	0.221			0.211	0.455**	0.268	0.415
HEI	0.025	-0.070	0.159	-0.060	0.248	0.047			0.496**	0.386*
Support Agency	0.116	-0.042	0.258	0.619***	0.550**	0.609**	0.556	0.076		
R&D										
Perform R&D	0.389	-0.175	-0.114	-0.108	-0.056	-0.270	0.225	0.092	0.392	0.085
Dedicated R&D Department	-0.570	0.002	0.134	-0.132	-1.098	-1.068	0.564	1.892**	1.822**	2.231**
Control Variables (Z)										
Number of Employees	0.001	0.001	-0.003	-0.001	0.002	0.002	0.002	-0.008	0.001	-0.004
Third Level Education	-0.001	0.001	0.007	0.003	0.000	0.000	0.023	0.011	-0.020*	-0.014
Sector[3]										
Modern Manufacturing	-1.274*	-0.527	-0.227	0.177	-0.540	-0.946	-1.161	-2.178**	1.933**	1.435
Services	0.191	-1.287**	-0.256	0.683	-0.677	-0.505	-1.413*	-0.299	1.235*	1.401

Skilled Labour (SL)										
Labour Share	-0.165	1.808	-6.677	-9.017	-3.587	-15.794	3.128	3.764	-7.401	1.704
Urbanisation Factors (U)										
Population Density	0.001	0.001	0.001	0.001	0.001	0.001	-0.001	0.001	0.001	0.001
Degree/Population	-0.047	-0.011	0.045	-0.018	-0.105	-0.131	-0.029	-0.163	0.115	-0.102
Professional and Technical	-0.002	0.046	-0.079	0.005	0.075	-0.023	-0.059	-0.079	-0.075	-0.098
/cut1	0.885	0.487	-4.209	-0.203	2.941	-2.731	-2.938	-6.872	4.928	-1.318
/cut2	1.993	1.245	-2.949	0.705	4.987	-0.683	-0.811	-4.356	6.887	1.687
/cut3	3.447	3.651	-0.641	2.384	6.980	1.267	0.647	-2.679	8.610	2.998
/cut4	5.517	5.696	1.286	4.307	9.442	3.578	2.520	-0.301	10.827	6.250
R2	0.1477	0.1036	0.158	0.1365	0.1697	0.1906	0.155	0.2108	0.2025	0.2417
N	117	116	132	110	82	67	60	58	67	61
Chi2	46.69	34.17	42.8	58.34	49.24	34.59	32.6	66.59	42.9	43.7
	0.0001	0.0080	0.0005	0.0000	0.0001	0.0070	0.0127	0.0000	0.0005	0.0004
Log Likelihood	-138.82	-140.83	-134.85	-140.47	-99.30	-78.34	-78.42	-68.84	-82.75	-97.45

Notes 1: *** signifies statistical significance at the 1% level; ** at the 5% level and * at the 10% level.
2: Local interaction is the reference category.
3: Traditional Manufacturing is the reference category. See Appendix 1 for definitions.

Appendix 1: Definitions of Sectors in Survey and Estimations

Sectors in Survey:	Sectoral Dummies in Estimations:
Mining and Energy	Traditional Manufacturing
Food, Drink and Tobacco	Traditional Manufacturing
Textiles and Clothing	Traditional Manufacturing
Pharmaceuticals, Chemicals, Rubber and Plastic Products	Modern Manufacturing
Electronics	Modern Manufacturing
Transport Equipment	Modern Manufacturing
Other Manufacturing (including equipment)	Modern Manufacturing
Construction	Services
Wholesale and Retail	Services
Financial Services	Services
Hotels and Restaurants	Services
Transport and Communication	Services
Other Market and Professional Services	Services
Software	Services

ENDNOTES

[i] As this paper utilises cross sectional data all standard errors are calculated using White's Heteroskedastic Consistent standard errors. These estimates are robust in that they provide correct standard errors in the presence of violations of the assumption of homoskedasticity (Long and Freese, 2001).