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The Geography of External Knowledge Search: The International Breadth of R&D Cooperation

Mirbella Gallareta
University of Caribe, Cancún, México
Departament of Basic Sciences and Engineering
mgallareta@ucaribe.edu.mx

Francesco D. Sandulli
Complutense University, Madrid, Spain
Department of Business Administration
sandulli@ccee.ucm.es

Abstract

This paper explores the impact of the diversity of R&D international partners on the innovative performance. The research studies how the geographical location of research partners, the cognitive distance and the regulatory distance define the impact of external knowledge search breadth on radical and incremental innovation. The hypotheses are tested on a sample of 2.606 Spanish firms that established research cooperation agreements with different partners. The results show that a more heterogeneous network of international partners will benefit radical innovation, while a more heterogeneous network of local partners will benefit incremental innovation. The impact on radical innovation of the degree of heterogeneity of international partners will increase with cognitive distance between partners while will diminish with regulatory distance between the countries where the partners are located.

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Abstract

This paper explores the impact of the diversity of R&D international partners on the innovative performance. The research studies how the geographical location of research partners, the cognitive distance and the regulatory distance define the impact of external knowledge search breadth on radical and incremental innovation. The hypotheses are tested on a sample of 2.606 Spanish firms that established research cooperation agreements with different partners. The results show that a more heterogeneous network of international partners will benefit radical innovation, while a more heterogeneous network of local partners will benefit incremental innovation. The impact on radical innovation of the degree of heterogeneity of international partners will increase with cognitive distance between partners while will diminish with regulatory distance between the countries where the partners are located.

Keywords: Open Innovation, Cognitive Distance, Internationalization, Social Capital

1. Introduction

This paper explores the impact of the diversity of R&D international partners on the performance of the innovation process. Contrary to the traditional view that links the creation of new knowledge to firm's internal R&D efforts, researchers in evolutionary economics suggested that the organization should look outside the boundaries of the firm for new knowledge that would lead them to gain a new set of abilities to develop new products (Cyert & March, 1963). Previous research have shown that the openness for innovation of organizations as an explanatory variable to justify why some firms gain better innovative performance results than others who are not as open to innovate (Grimpe & Sofka, 2009; Katila, 2002; Katila & Ahuja, 2002; Köhler, Sofka, & Grimpe, 2012; Laursen & Salter, 2006). The search for new partners is one of the first steps in the process of exploring and exploiting external knowledge. This search may involve significant resources from the firm and thereby firms must define a search strategy for potential R&D partners. Traditionally, firms typically searched for new knowledge within their set of previous partners with whom they have had past successes (Christensen, 1998; Cyert & March, 1963). These search patterns based on past experiences become part of the routines of the organization mainly because they have demonstrated to have favorable results (Nelson & Winter, 1982). However, there is empirical evidence that firms attain better innovation results when they search broadly for knowledge within a variety of domains and geographic locations (Katila & Ahuja, 2002; Laursen & Salter, 2006; Leiponen & Helfat, 2010; Rosenkopf & Almeida, 2003). One of the main dimensions analyzed by this stream of research is the diversity of relationships the organizations engage in to innovate, namely their search breadth strategy (Laursen & Salter,

2006). The model of ‘open innovation’ introduced by Chesbrough (2003) suggests that firms should exploit the knowledge of a diverse number of partners in order to sustain their innovative advantage. However, searching distant and unfamiliar knowledge involves higher costs and uncertainty (March, 1991) related to a larger number of potential knowledge sources considered in an innovative relationship. Therefore, some researchers argue that even if diverse sources of knowledge can lead to radical innovation, there exists a decreasing returns relationship whereas the increased search efforts (over-search) results become unproductive (Laursen & Salter, 2006). Furthermore, a wide diversity of knowledge sources requires new abilities for the organization to absorb and convert this variety of knowledge domains into new innovative ideas (Cohen & Levinthal, 1990).

Evolutionary economics argues that partner diversity characterized as the number of agents with different knowledge domains who are involved in a relationship of innovation by interaction, represents a crucial condition to yield a Shumpeterian type of innovation (Nelson & Winter, 1982). Accordingly, diversity can be measured in two dimensions, the number of partners (search breadth) and the degree of similarity or dissimilarity among the resources, capabilities and knowledge (Wuyts, Colombo, Dutta, & Nooteboom, 2005) of different type of partners. The latter bears the concept of 'cognitive distance' as part of the 'cognitive theory of the firm' proposed by Nooteboom (2000, 2009). Cognitive distance has different dimensions, thus, it can increase or decrease depending on different factors such as organizational, social, institutional, technological, or geographic differences (Wuyts et al., 2005). Firms should search for 'optimal cognitive distant' partners in order to achieve a higher novelty value of a partner's knowledge. Firms have a natural cognitive tendency to search for different type of knowledge sources among their previous partners such as customers, suppliers, universities or even competitors because previous interactions can shorten the cognitive distance between partners. Networks are particularly valuable to firm’s innovative efforts as sources of novel ideas and providers of fast and more easily available complementary resources. Social network theorists argue that a diverse network of repeated ties breeds familiarity, creates trust (Gulati, 1995), reduces search costs and the risk of opportunism (Gulati & Gargiulo, 1999) and increases the level of understanding between the partners thus fostering positive firm performance. Hence, social capital is important to the firm’s openness to external innovation (Tether & Tajar, 2008) by enabling the firm to forge effective relationships with optimal cognitive distant partners and this can be useful while searching geographically distant allies. Searching for partners in the International arena can provide access to diverse knowledge bases (Rosenkopf & Almeida, 2003), but there are greater coordination costs involved because of differences government laws and regulations differences between the international partner country and the firms' country of origin. According to institutional theorists (North, 1990), the regulatory unfamiliarity between partners conveys an institutional distance measured as the extent of dissimilarity between the institutional

environments of partners' countries (Kostova, 1999). Thus, a firm can expect diminishing benefits from its innovation efforts as it establishes relationship with increasingly regulatory distant partners, because the coordination costs and risks associated with greater distance can outweigh the benefits of accessing a more extensive knowledge base (Añón Higón & Manjón Antolín, 2012).

In this paper we examine the relationship between the firm's search strategy for partners to engage on international knowledge exchanges and its innovation performance. We analyze the breadth of the firms' international networks and its impact on the achievement of product innovation. We argue that firms search outside their local markets for a large variety of partners (search breadth) with different type of knowledge domains such as its supply chain partners (customers and suppliers), competitors or science experts (Universities, consultants, science centers. Additionally, we test on the international R&D partnerships context the Laursen and Salter (2006) hypothesis that the returns on external knowledge search breadth have an inverted U-shape since the selection of an excessively wide partner breadth involves high transaction costs resulting from large cognitive and regulatory distances with international partners. The moderating effect of the firms networking capabilities and social capital are studied as means of lowering the transactions costs of firm's search strategies.

The next section explores the influence of the search for international partners on innovative performance. The third section studies the regulative dimension of the international institutional environments of the firms' partners and its influence on performance. In section four we address the relationship between cognitive distance and innovation performance. In Section five we present our empirical method and data. In section six we report results and section seven concludes.

2. International Search Breadth

The generation of new knowledge has traditionally been connected to a firm's in-house research and development (R&D) activities. Due to the increasing complexity of technologies and research activities firms, the 'open innovation' model (Chesbrough, 2003a, 2003b) suggests that many innovative firms now spend little on internal R&D and yet they are able to successfully innovate by drawing in knowledge and expertise from a wide range of external sources. This approach suggests that firms must integrate external knowledge into their internal processes and competitive strategy in order to succeed in their open innovation strategy (Chesbrough, 2003b). Consequently, searching for external sources of knowledge has become a central activity for a large number of firms (Katila & Ahuja, 2002; Landry and Amara, 2002). External search follows a multidimensional strategy engaging in a variety of partners. Firms can search for diverse number of partners (Katila & Ahuja, 2002; Laursen & Salter, 2006), partners with different knowledge domains (Rosenkopf & Almeida, 2003) or partners in distant locations (Zahra, Ireland, & Hitt, 2000). Some studies suggest that a greater exposure to diverse external sources has a positive impact on the innovation capability of the firm (Katila, 2002; Katila & Ahuja, 2002;

Laursen & Salter, 2006; Un, Cuervo-Cazurra, & Asakawa, 2010) and influences its realized absorptive capacity development (Zahara & George, 2002). For instance, Katila (2002) posits that searching for a limited number of alternatives can be risky especially when the focal firm is not familiar with external knowledge

However, a more complex network of partners will increase coordination costs (Pisano, 1990; Powell, Koput, & Smith-Doerr, 1996) and will require larger amounts of resources such as time, money, and capabilities to absorb, create and recombine new knowledge from a large number of sources (Katila & Ahuja, 2002; Laursen & Salter, 2006). For a large variety of sources, these costs can create search diseconomies that explain the curvilinear relationship (taking an inverted U-shape) between the variety of partners and the firm's innovative performance (Katila & Ahuja, 2002). Laursen & Salter (2006) develop the concept of search breadth referring to the number of different search channels that a firm draws upon in its innovative activities and find an inverted U-shape relationship between firm's search strategies and its innovation performance, showing that when firms search for too many external knowledge sources (over-search) there are decreasing returns on its innovative performance.

Knowledge can be geographically dispersed forcing firms to search for knowledge partners in distant locations. By entering research partnerships abroad, firms augment their overall technological competence base through accessing to foreign technological knowledge (Florida, 1997; Zander, 1997; Singh, 2008; Chen, Huang & Lin, 2012). Dutta & Weiss (1997) show that the number of both local and foreign research partners has a positive relationship with the number of citations of the patents developed by the firm. This research also shows that the impact on this measure of technological innovativeness is greater for local partners than for foreign partners. However, searching internationally raises coordination costs due to uncertainty of partner performance and the opportunistic behavior risks (Baum, Rowley, Shipilov, & Chuang, 2005). Furthermore, as pointed out by Singh (2008), the real challenge to firms trying to exploit foreign knowledge is to integrate it into internal R&D operations. Therefore, firms have to consider the number of international partners they are capable to coordinate and integrate versus the costs implied in doing so when searching to engage in international knowledge exchanges to innovate. Because of these trade-offs between the benefits and costs of international search for research partners, we may hypothesize that the inverted U-shape relationship between innovation performance and partner breadth will apply to the search for international partners. Thus, we hypothesize that:

Hypothesis 1. Firms engaged in external knowledge exchanges will be more likely to succeed in product innovation if they have a moderately large network of international partners.

3. Regulatory Differences

When firms engage in knowledge exchanges abroad, the regulatory laws may have great influence on the returns on their partnerships.

The existing differences between institutional environments of two countries can be critical for the firm international innovative performance. These differences depicts the concept of institutional distance (Gaur & Lu, 2007) developed by Institutional theorists based on Scott's (1995) conceptualization of national institutional environments. According to Scott (1995) the pillars of the institutional environment comprise three types of institutions: regulatory, cognitive and normative.

The regulatory dimension is composed of regulatory institutions and is represented by rules, laws and coercive measures reflected by a series of regulations on a national or regional environment, that promote certain types of behaviors and restrict others. When firms engage in knowledge exchanges abroad, the regulatory dimension may have greater influence than the other pillars of the institutional distance. Differences in regulatory environments which include elements such as constitutions, laws, property rights, etc. vary in different countries, trading blocks, regions or group of countries which leads to a 'regulatory distance' between the firms' country of origin and the partners' country, group or region. Lavie and Miller (2008) explore the impact of national differences on the effectiveness of collaboration with foreign partners and how firms learn to bridge national differences in their alliance portfolios and show that over-internationalization has a negative relation on firm performance, because the firm's collaborative routines are ineffective in bridging geographical, cultural, institutional differences at very high levels of cross-national distances. This means that the costs increases in partners with large regulatory distances from the firms' home country, and beyond certain levels, these costs associated with larger regulatory differences may outweigh the benefits of a more diverse knowledge base (Añón Higón & Manjón Antolín, 2012; Lavie & Miller, 2008).

In summary, the regulatory component of the institutional distance can influence the decision to engage in knowledge exchanges with foreign partners. Therefore, we suggest that moderate levels of international search breadth will have a positive impact on innovation performance as long as the firm does not have to handle relationships with partners in countries with strong regulatory differences. Thus, we hypothesize that:

Hypothesis 2: Firms engaged in external knowledge exchanges will be more likely to succeed in product innovation if they have a broader variety of international partners located in countries with a relatively lower regulatory distance.

4. Cognitive Distance Between Partners

When defining external knowledge search strategies firms should define the technological boundary spanning (Rosenkopf and Nerkar, 2001). Some firms will prefer to engage on exchanges within familiar technological domains while others may search for unfamiliar technological domains when their expectations are set on greater innovation performance. These differences on knowledge domains have implications for firms' ability to create novel recombinations of internal and external new knowledge in order to develop new products

(Nelson & Winter, 1982).

Resource heterogeneity of firms that engage in knowledge exchanges can be interpreted in terms of the cognitive distance between them (Nooteboom, Van Haverbeke, Duysters, Gilsing, & van den Oord, 2007). Cognitive distance can be represented as the relative value of knowledge exchanges amid partners measured by existing distance between them owed to differences in diverse factors, e.g., knowledge, organizational, social, geographical or institutional differences (Wuyts et al, 2005).

Firms that pursue an open innovation strategy develop routines and learning skills through repeated relationships of cooperation, building relation-specific linkages with different type of partners. Consequently, investing on repeated links can lead to decreased cognitive distance and contribute to create co-dependencies that allow reducing the risks of opportunistic behavior minimizing coordination costs. Also, familiarity and trust are incremented as a result of repeated knowledge exchanges (Gulati, 1995), creating a mutual learning and innovation partnership dependency.

Thus, social capital facilitates joint learning for innovation and reduces the search and transaction costs of the interaction leading to a higher propensity to innovate (Laursen, Masciarelli, & Prencipe, 2012). Because coordinating a large and diverse network involves high transaction cost and potential for opportunism, firms usually search among prior partners to innovate (Dosi, 1988) in order to take advantage of relation-specific assets, complementary partner resources, and informal safeguards (Dyer & Singh, 1998; Kale et al., 2000). Prior experience with the same partners, that is, partner-specific experience generates value creation when firms balance familiarity with novelty (Gulati et al., 2009). In sum, prior ties create social networks and they become an important source of information that helps firms to learn about new potential partners (Gulati, 1995). Firms embedded on networks rich on social interaction can gain easier access to international external sources of knowledge (Phelps, 2010; Rosenkopf & Almeida, 2003) and facilitate knowledge exchanges (Granovetter, 1985; Gulati et al., 2000; Uzzi, 1997; Inkpen & Tsang, 2005).

Apparently, organizations will follow search strategies based on reciprocity, experience and previous' ties performance (Li & Rowley, 2002) and expected results, e.g., exploitative or explorative innovation (March, 1991). Accordingly, in international environments where coordination costs, uncertainty and risk of opportunistic behavior are high, firms should establish partnerships with better known partners such as customers or suppliers. However, the evidence suggest that intra-industry partnerships hurt innovation performance (Nieto & Santamaria, 2007; Katila, 2002) and that more diverse research partners with broader cognitive distance will have a positive effect on innovative performance (Wuyts et al., 2005; Sampson, 2007; Nooteboom et al., 2007; Tether & Tajar, 2008). Following these arguments we suggest that a moderately wide search breadth of international partners with high cognitive distance will have a positive impact on innovation performance. The

following hypothesis can be stated as:

Hypothesis 3: Firms engaged in external knowledge exchanges will be more likely to succeed in product innovation if they have a higher number of international partners with high cognitive distance.

5. Data and Methods

Our main source of information is the PITEC (Technological Innovation Panel) database. This database is managed by INE (Spanish National Statistics Institute), with the support of the FECYT (Spanish Science and Technology Foundation) and Cotec (Foundation for Technological Innovation). The PITEC database contains detailed information on the technological innovation activities of Spanish firms. This research employed the last available data from 2010. The survey is very similar to the UK Innovation Survey employed by Laursen and Salter (2006). The sample consists of 12,817 firms, however for the purpose of this research we only considered the 2,606 firms with formal research cooperation agreements with external partners, corresponding to the 20.3% of the whole sample.

We use two dependent variables to measure innovative performance: *Radinno* and *IncremInno*. *RadInno* is our proxy for radical innovation and it is measured as the fraction of the firm's turnover relating to products new to the world market, while *IncremInno* is our proxy for incremental innovation and expresses the fraction of firm's turnover pertaining to products new to the firm. As determinants of innovative performance, we introduce *Breadth* which is constructed as a combination of 21 types of external partners in formal collaboration relationships including 7 types of partners, namely suppliers, customers, competitors, consultants, universities or higher education institutes, commercial laboratories or R&D enterprises, government research organizations, private research institutes for each of the three types of geographical category of the partner: local, EU (European Union) and extraEU; *Local Breadth* which considers only the 7 types of local partners; *International Breadth* which considers 14 types of EU and ExtraEU partners; *European Breadth* which is the proxy for narrow regulatory distance and considers 7 types of EU partners; *ExtraEuropean Breadth* which is the proxy for wide regulatory distance and considers 7 types of EU partners; *Supply Chain Breadth* which is the proxy for narrow cognitive distances and considers 4 types of international partners in the supply chain; *Extra Supply Chain Breadth* which is the proxy for wide cognitive distances and considers 10 types of international partners not operating in the supply chain. All these variables have Cronbach's alpha coefficients above 0.80.

We included a number of controls. Firm's R&D capabilities are measured by the number of R&D employees expressed in logarithms*(R&D Labor)*. Firm's size is measured by the number of employees expressed in logarithms *(Size)*. Firm's age is measured by the years from the creation of the firm expressed in logarithms (*Age)*. Firm's technological stock is measured by the number of patents expressed in logarithms (*Patents)*.Finally, we also controlled for the exposure of the firm to international markets

with the variable *Market* which measures in which markets the firm is operating and takes the values 1 to 4, with 1 corresponding to regional markets, 2 corresponding to national markets, 3 corresponding to EU markets and 4 corresponding to Extra EU markets.

The two dependent variables in the model are double censored since they range between 0 and 100. Accordingly, the same econometric approach followed by Laursen and Salter (2006) is adopted for this research, applying a log-transformed Tobit analysis with a multiplicative error term. This approach will solve the problems related to the significant skewness of the two dependent variables. The model will estimate the two dependent variables transformed using the expression ln(1+x).

6. Results

The descriptive statistics in Table 1 show that on average 16.35 percent of firms' revenues can be attributed to new products for the world market, while 15.15 percent of firms' output results from new products for the firm. Firms have on average 3.35 different external knowledge partners. Half of these partners are not located in the EU. Only 13% of the international partners are from the supply chain. The mean firm in the sample is 20 years old, has 73 employees, 1.5 R&D employees, 1 patent and sells its products in EU markets.

Insert Table 1 about here

Table 2 shows the results of the Tobit estimation for the dependent variable *RadInno*. Model 1 includes only the control variables. Stronger R&D Capabilities, wider technological stocks and international market exposure, lower age and size are positively related to innovative performance. These findings hold for the other four models in Table 2. As shown in Model 2 and if we don´t take into account partners' location, we find support for the inverted-U shape relationship between external knowledge breadth and innovative performance found in Laursen and Salter (2006). The coefficient for *Breadth* is positive and significant, while the coefficient for *Breadth* squared is negative and significant. Similarly to Laursen and Salter (2006) the tipping point is quite high. In this case the maximum return to partner breadth is attained with 15 different partner sources.

Model 3 analyses our first hypothesis regarding the impact of international partner breadth on innovative performance. *International Breadth* is positive and significant, the coefficient for *International Breadth* squared is negative but not statistically significant. Therefore, we must reject the curvilinear relationship between innovation performance and international partner breadth. These results suggest that increasing the variety of international partners will always produce increasing returns. Interestingly, the coefficient for *Local Breadth* is not statistically significant. This finding provides some evidence that international research cooperation is more effective than local research cooperation in terms of radical innovation.

The second hypothesis is tested by Model 4. We find support to this hypothesis and to the fact

that regulatory distance may impact the breadth of international partners. Both the coefficients for *European Breadth* and *ExtraEuropean Breadth* are positive and statistically significant. However, a richer variety of partners from the EU have a stronger impact on the revenues from radical innovation than the breadth of partners located outside the EU. The regulatory and institutional similarities between EU countries might be favoring a wider variety of research partners from the EU.

Model 5 studies the impact of cognitive distance on international partner breadth. The results confirm the third hypothesis since the coefficient for international search breadth for partners with higher cognitive distances is positive and significant, while the coefficient for search breadth related to partners within the supply chain is positive but not statistically significant.

Insert Table 2 about here

Table 3 describes the relationship between search breadth and incremental innovation. The main result regarding this relationship is that international partner breadth has not any impact on the revenues from incremental innovations. However and differently from the results for radical innovations, the breadth of local partners has a positive impact on the revenues from incremental innovations. Regarding the control variables, both R&D capabilities and international market exposure have a positive impact on revenues from incremental innovations.

Insert Table 3 about here

7. Discussion and Conclusions

Firms' innovative activities increasingly depend on external and distant knowledge sources. Former research suggest that cooperating with a wide variety of partners can provide knowledge that help firms to discover and exploit new business opportunities. However, knowledge can be located far away from the firm. When defining their knowledge search strategies, firms should define a geographical search range. However, international knowledge search and integration is not costless. Establishing R&D cooperation relationships with too many foreign partners may consume excessive resources and hurt firms' performance. This paper digs deeper into the concept of knowledge search breadth by focusing on it from a global perspective. First, we examined the impact of the location and variety of research partners on the innovative performance. Results show that radical innovation is associated with a wide breadth of international partners, while incremental innovation is more related to a wide breadth of local partners. Thus, the knowledge needed to develop and exploit radical innovations seems to be geographically dispersed requiring stronger efforts and resources in terms of establishing a network of heterogeneous and distant partners. On the other hand, knowledge for incremental innovation is more geographically concentrated requiring lower coordination and integration efforts with the network of partners. Furthermore, our results reject the curvilinear relationship

between radical innovation and international partner breadth. According to our results, firms will always benefit from increasing the variety and heterogeneity of foreign knowledge sources. Cognitive distance will tend to be broader in international partnerships. The paper explored the role of cognitive distance on international search breadth. We found that radical innovation will benefit from a variety of heterogeneous and cognitively distant foreign partners. Our results suggest that firms should take the risk of establishing cooperative relationships with partners from different knowledge domains and with different organizational backgrounds. The benefits in terms of new breakthrough ideas from diversity outweigh the higher costs related to the search and integration of foreign knowledge. Our research studied the role played by regulatory distance on search breadth. The results show that firms should take into account the effects of the regulation on the expected results of partnerships with foreign organizations. Our results show that the costs derived from wider regulatory distances may diminish the contribution of search breadth to radical innovation. Overall, our research has demonstrated that local and international breadth have different effects on innovative performance. Firms involved in radical innovation processes should establish broad networks of heterogeneous partners which are cognitively distant, while prioritizing heterogeneous relationships in countries with more similar regulations. Firms competing in more mature markets through incremental innovation should build an heterogeneous network of local partners. From a research policy point of view, this research seems to confirm the validity of the current EU strategy in terms of the prioritization of international cooperation but within EU boundaries, but also reveals the need for networks of more heterogeneous partners where universities, consultants, competitors, customers or public research bodies interact in the quest for radical innovations.

Both the methodology and data employed in this research poses some questions that need further research. More fine-grained measures for both cognitive and regulatory distances would be needed. The measure of geographical diversity of search breadth provides too aggregated information and further analysis measuring specific country level differences would provide more detailed arguments. Furthermore, firms evolution through knowledge domains and the corresponding reshaping of technological trajectories has not been considered in this research, while crucial in explaining the specific choice of research partners.

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Table 1. Summary Statistics

	Mean	S.D.	Min.	Max.
Radinno	16.35	27.18	0	100
IncremInno	15.15	26.26	0	100
Size	4.29	1.75	0	10.61
Market	3.04	1.02	1	4
R&D Labor	1.52	1.29	0	6
Age	3.02	0.74	0	6.30
Patents	1.19	8.87	0	278
Breadth	3.35	3.09	1	21
Local Breadth	0.88	1.06	0	7
International Breadth	2.47	2.56	0	14
European Breadth	0.75	1.07	0	7
Extra European Breadth	1.72	1.85	0	7
International Supply Chain Breadth	0.33	0.82	0	4
International Not Supply Chain Breadth	2.14	2.03	0	13

Table 2. Radical Innovation and International Search Breadth

	Model 1	Model 2	Model 3	Model 4	Model 5
Size	-0.2483*** (0.039)	-0.2606*** (0.039)	-0.2547*** (0.039)	-0.2517*** (0.041)	-02553*** (0.041)
Market	0.2231*** (0.058)	0.2122*** (0.058)	0.2145*** (0.058)	0.2159*** (0.058)	0.2179*** (0.058)
R&D Labor	0.5280*** (0.051)	0.4201*** (0.054)	0.4198*** (0.055)	0.4233*** (0.055)	0.4214*** (0.055)
Age	-0.2672** (0.084)	-0.2526** (0.084)	-0.2511** (0.084)	-0.2509** (0.084)	-0.2510** (0.084)
Patents	0.4428*** (0.108)	0.3526** (0.111)	0.3421** (0.111)	0.3252** (0.118)	0.3354** (0.111)
Local Breadth			0.1742 (0.112)	0.0739 (0.059)	0.1825 (0.113)
European Breadth				0.1390* (0.062)	
Extraeuropean Breadth				0.1033** (0.036)	
International Breadth			0.1715** (0.055)		
Local Breadth Square			-0.0249 (0.026)		-0.027 (0.026)
International Breadth Square			-0.053 (0.004)		
Breadth		0.1968*** (0.047)			
Breadth Square		-0.0067* (0.003)			
International Supply Chain Breadth					0.0829 (0.158)
International Extra Supply Chain Breadth					0.1635* (0.076)
International Supply Chain Breadth Square					0.0038 (0.041)
International Extra Supply Chain Breadth Square					-0.0051 (0.009)
Pseudo R^2	0.0238	0.0274	0.0272	0.0274	0.0271
LR Chi2	204.88	236.36	234.59	236.17	233.83
N	2606	2606	2606	2606	2606

*** p<0.001; ** p<0.01; * p<0.05

Table 3. Incremental Innovation and International Search Breadth

	Model 1	Model 2	Model 3	Model 4	Model 5
Size	-0.0182 (0.035)	-0.0231 (0.035)	-0.0609 (0.037)	-0.0607 (0.037)	-0.0603 (0.037)
Market	0.2757*** (0.053)	0.2699*** (0.053)	0.2636*** (0.053)	0.2623*** (0.053)	0.2679*** (0.053)
R&D Labor	0.1995*** (0.046)	0.1573*** (0.049)	0.1801*** (0.050)	0.1812*** (0.050)	0.1781*** (0.050)
Age	0.0014 (0.076)	0.0071 (0.076)	0.0040 (0.076)	0.0055 (0.076)	0.0038 (0.076)
Patents	0.0281 (0.101)	0.0013 (0.105)	0.0162 (0.104)	0.0234 (0.105)	0.0154 (0.105)
Local Breadth			0.305** (0.102)	0.307*** (0.104)	0.317** (0.103)
European Breadth				0.0595 (0.115)	
Extraeuropean Breadth				0.0596 (0.065)	
International Breadth			0.0773 (0.051)		
Local Breadth Square			-0.0228 (0.024)		
International Breadth Square			-0.0086 (0.004)		
Breadth		0.0943* (0.044)			
Breadth Square		-0.0040 (0.003)			
International Supply Chain Breadth					-0.0527 (0.147)
International Extra Supply Chain Breadth					0.1061 (0.071)
International Supply Chain Breadth Square					-0.0035 (0.039)
International Extra Supply Chain Breadth Square					-0.0129 (0.009)
Pseudo R^2	0.0069	0.0076	0.0092	0.0092	0.0092
LR Chi2	62.57	68.73	83.50	82.95	83.56
N	2606	2606	2606	2606	2606

*** p<0.001; ** p<0.01; * p<0.05