Firm Location, Corporate Structure, R&D Investment, Innovation and Productivity

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Abstract

This study elucidates how firm characteristics, innovation-system collaboration, market extension and firm location influence economic performance, innovation efforts and innovation output. Firm characteristics include corporate structure, size, capital and knowledge assets, R&D persistence etc. The location variable separates Sweden into five areas, one of which is the Stockholm metropolitan region. The study is based on 2,083 Community Innovation Survey firm level observations for Sweden. The first stage of the empirical analysis shows that the propensity to be an innovative firm (making innovation efforts) is an increasing function of size, profitability, human capital, and extensive markets. For the subgroup of innovative firms, return to product innovations is positively related to location in the Stockholm region, multinational firms, R&D investment and persistence, and negatively related to firm size. For the same subgroup, total sales per employee follow a similar pattern, but value added per employee does not. The paper also reports about firms' R&D investment, external collaboration on innovation, and non-imitation innovations across the same regions. The results suggest that a firm's R&D- embeddedness in scientific, horizontal and vertical innovation systems is primarily determined by its corporate structure, not geographic location.

Keywords: Regional economy, multinational companies, R&D, innovation, innovation system
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1. INTRODUCTION

This paper examines how firm location and corporate structure relate to innovation and productivity. The propensity for firms to agglomerate is associated with the benefits that large urban regions can afford, both proximity advantages and special qualities of regions in fostering innovation and economic growth. Large urban regions can be expected to have higher rates of innovation and adopt innovations more rapidly. See, for instance, Acs (1994) Glaeser (1999) and Harhoff (1999). However, the negative effects of congestion in very dense, poorly connected regions may temper innovation benefits from agglomeration.

Regional features can capture proximity externalities in the innovation process. What then is the role of corporate structure? A multinational firm is a multi-unit network in which knowledge can flow with small friction also over long distances. When located in a metropolitan region, such a firm can combine proximity advantages with network advantages.

This paper adds to the literature on innovation and localization in two respects. First, we include the issue of corporate ownership and structure in the analysis. R&D has become increasingly internationalized in recent decades. Studying 32 multinationals with headquarters in the US, Japan, Germany, France and the Netherlands, Kuemmerle (1999) reports that the share of R&D carried out outside a firm's home country boundaries was 6.2 percent in 1965. In 1995, the corresponding figure was nearly 26 percent. Zander (1994), Cantwell (1998) and others report similar findings.

Sweden's R&D activity reflects growing globalization and the proliferation of multinationals. Foreign-owned firms have increased their share of Swedish manufacturing production from 21 percent in 1985 to 34 percent in 2001. In addition, foreign-owned firms increased their share of R&D investments in Sweden to 40 percent in year 2001. In the same year Swedish firms produced almost half of their R&D efforts abroad (Lööf, 2005).

There is widely held agreement in the modern literature that an R&D facility's capacity to exploit and augment its technological competency is a function not just of its own resources, but of the efficiency with which it can utilize complementary resources (formal and informal linkages) and complex interdependencies among small local geographical units. Our analysis looks closely at ownership as it related to local embeddedness in innovation systems in light of the globalization trends in R&D.

Second, the paper is one of the first attempts ever to use the Community Innovation Survey data for regional analysis within one country. The survey data has been merged with register data derived from annual accounts. The analysis includes both manufacturing and service firms.

This study highlights the importance of firm localization and corporate structure for technological improvement and innovation performance. The Swedish capital region (Stockholm) is compared with four other Swedish regions: East Central Sweden, South Sweden, West Sweden and North Sweden. The Stockholm region is distinguished from other Swedish regions in several respects. First and

foremost, the Stockholm region is a functional urban region proper. None of the other areas comprise a single (and integrated) agglomeration in the same way. Moreover, the concentration of multinational enterprises (MNEs) and universities is higher, and the share of innovative firms larger, in the Stockholm region than in other Swedish regions. The average firm in Stockholm has both a higher R&D-intensity and a higher human capital intensity compared to firms in other regions. Among innovative firms, the Stockholm region's share of newly established firms and of firms launching non-imitation innovations is larger compared to other regions. Notably, we observe that innovative firms in Stockholm are more self-sufficient than elsewhere in Sweden, in the sense that they participate less in formal cooperation on innovation activities with universities and public and private R&D laboratories.

In sum, the Stockholm region has a denser and richer economic environment than other parts of Sweden. Urban economic theory tells us that this should result in higher floor-space costs in Stockholm, and we would expect innovative firms in the Stockholm region to have higher sales value per employee than similar firms elsewhere in Sweden. The paper tests these hypotheses using empirical evidence. We also analyse whether or not the return to product innovations, measured as increased sales value per employee for new products, is higher in Stockholm.

This study uses an econometric framework to analyse the relationship between regional location, intellectual capital, corporate ownership and innovation activities. The study is based on 2 083 enterprise-level observations of which 43 percent are non-affiliated enterprises, 36 percent uninational enterprises and 21 multinational corporations. Thus, more than half of the enterprises are multi-unit firms.

This presentation is structured as follows. In section 2 we elaborate on the key questions posed in this study and relate them to recent literature. Section 3 introduces the data used. The methodology is discussed in Section 4. Section 5 presents the empirical analysis. Section 6 concludes**.**

2. BACKGROUND AND PREVIOUS RESEARCH

2.1 Innovation Activities and Knowledge Flows

In innovation processes, both knowledge and information are important inputs. In empirical studies such as this it may be difficult to know how, or if, respondents to innovation surveys are drawing distinctions between knowledge and information. However, many studies of innovation processes have focused on knowledge as a critical innovation input. In other words, non-innovative businesses can use information, but innovation requires knowledge as well.

Knowledge is an input to an innovation process, which – if successful – generates new products and new production routines used by the innovating firm. Knowledge for innovation takes several forms: (i) scientific knowledge in the form of basic principles, (ii) technological knowledge in the form of

"technical solutions", and (iii) entrepreneurial knowledge about product attributes, customer preferences and market conditions, business concepts etc. (Karlsson and Johansson, 2004). With these distinctions it becomes clear why knowledge networks may have many different participants representing different types of knowledge (Batten, Kobayashi and Andersson, 1989). Therefore, it is also useful to identify types of firm interactions (internal and external) used to obtain and generate information and knowledge for innovation activities.

The first type of interaction for innovation knowledge is that internal to the firm. This may be the result of formal knowledge transfer processes or "water cooler conversations." Several studies have noted the importance of both firm organization and of key individuals. An effective organization can facilitate the transfer of codified information among knowledge workers and also provide (or thwart) opportunities for sharing ideas and collaborating on new projects. Because knowledge has a strong tacit component, it is embedded in the firm's "knowledge workers". These workers are often mobile, so their role in diffusing knowledge includes both interacting with others in one firm and also imparting some of the knowledge gained during that tenure to future employers. Several studies have analyzed the mobility of knowledge workers and their role in diffusing knowledge among firms, and some have shown that firm hiring of key individuals is an effective knowledge transfer strategy supporting innovation. (see Karlsson and Johansson, 2004 for a review).

Firms also derive information and knowledge for innovation from their participation in external professional networks, often called regional innovation networks or regional innovation systems. A single firm will often simultaneously participate in a range of discrete or interlinked networks of suppliers, customers, or neighboring firms. (Karlsson and Johansson, 2004) This study uses the distinctions offered by Cox, Mowatt and Prevezer (2003) between a firm's horizontal and vertical innovation systems. Firms are embedded in horizontal innovation network relationships with similar firms (competing, consulting and collaborating) and in vertical innovation network relationships with suppliers and customers.

Finally, interaction with the scientific community is considered crucial for firms' innovation activities. Innovative firms are highly dependent on knowledge generated by local university R&D. The knowledge transfer between universities and industry may use many different links or mechanisms, (see Johansson and Karlsson, 2004 for a review) These channels of knowledge flows inclued (i) A flow of newly trained graduates from universities to industry. (ii) Technological spillovers of newly created knowledge from universities to industry. (iii) Industrial purchases of newly created university knowledge or intellectual property. (iv) University researchers consulting to industry or serving on company boards. (v) University researchers leaving universities to work for industry. (vi) University researchers creating new firms, i.e. academic entrepreneurship[1]

[1] Slaughter & Leslie (1997) provide a comprehensive overview of the phenomenon in question.

In addition, universities may create incubators, enterprise centres and science parks to improve interaction with industry and to facilitate university knowledge transfers.

The specific role played by each these different links for the development of industry are not well understood (Karlsson & Manduchi, 2001). Moreover, the actual links between universities and industry have proved in many cases difficult to detect. However, recent studies have shown strong evidence of knowledge transfers and spillover flows, as demonstrated by joint distributions of university capacity and high technology sectors (Varga, 1997 & 2002).

The figure below summarises some of the most important knowledge and information flows for an individual firm's innovation processes. In the relation to the figure it may be argued that information about both customers and technical solutions flows with smaller friction when actors are in proximity to each other. The same conclusion can be drawn with regard to interaction with external knowledge providers. A multinational firm can benefit from proximity each of its several locations. However, empirical observations indicate that knowledge interaction within a multi-company concern may be much less dependent on the proximity principle (Andersson and Ejermo, 2004). The suggestion is that multinational firms internalize the knowledge interaction process, which may partly explain the very existence of multinationals.

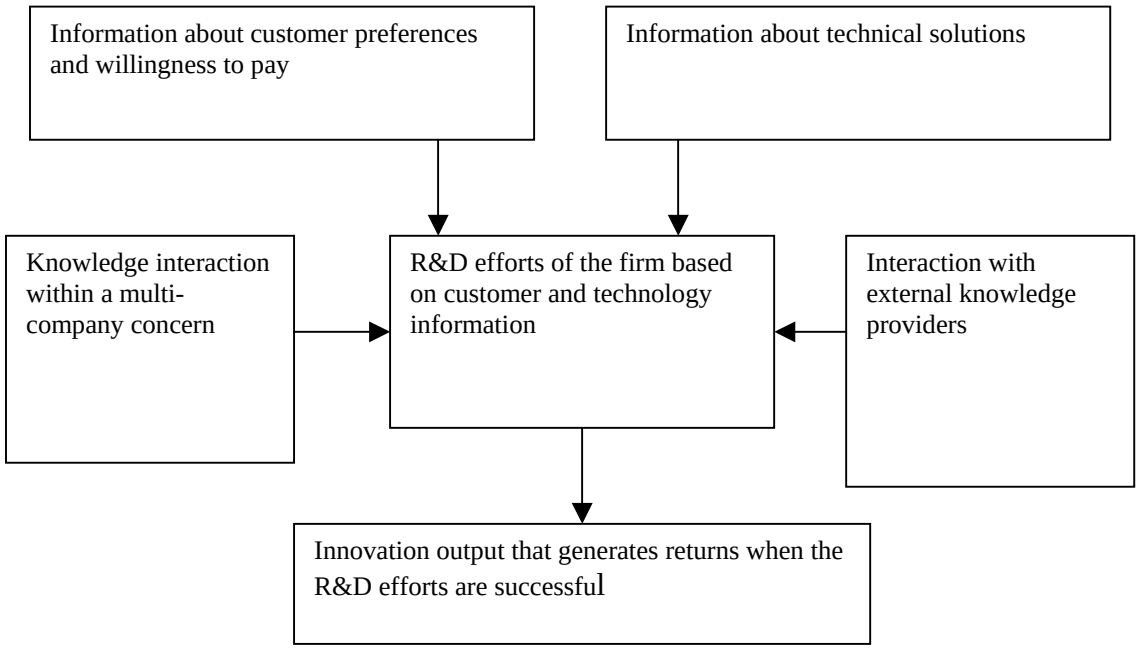

Figure 2.1: Knowledge and information flows in a firm's innovation process

2.2 Regions and innovation

A vast majority of scholars now agree that the proximity afforded by locating in large urban regions creates an advantage for firms by facilitating information and knowledge flows, following arguments presented early in Artle (1959) and Vernon (1962), and later in Glaeser (1999) and Feldman and Audretsch (1999). The nature of this phenomenon may be classified as a proximity-based communication externality (Fujita and Thisse, 2002).

The propensity for economic actors to agglomerate has encouraged many scholars to seek a better understanding of the special qualities of regions in fostering industrial growth. Variations in economic activity, income and productivity are apparent across geographic space, and the recent focus on knowledge flows, transactions and spillovers has prompted regional scientists and economic geographers to analyze the proximity and accessibility benefits of regions to innovating firms. Much of this analysis has been inspired by Marshall (1920) who identified the exchange of ideas as a type of externality leading to the agglomeration of economic activity. The exchange of ideas as embodied in technology spillovers have also been used by Henderson (1974) to account for the clustering of economic activity across space. Karlsson and Johansson (2004) argue that proximity is essential for all of the many types and forms of knowledge flows critical in innovation processes. Within a functional region, delimited by housing and labour market perimeters, firms have better accessibility to customers, input suppliers, the scientific community, and competing firms—all important sources for intellectual capital and innovation–relevant knowledge and information. As noted earlier, labour mobility (often within a functional region) is also an importance source for both knowledge transfer and internal firm activities leading to growth and maintenance of intellectual capital. Some studies have estimated that proximity of within one hour's travel time from the firm location is sufficient to enjoy the positive externalities associated with agglomeration (e.g. Johansson, Klaesson and Olsson, 2002).

The literature presents a steady progression of methods and frameworks to investigate these relationships. These range from a general knowledge production function that embodies broad forms of distance-sensitive knowledge flows, including tacit as well as formal knowledge inputs, to more precisely specified models of knowledge flows and spillovers (particularly localized knowledge spillovers, LKS) through patents, patent citations and product innovations (Varga, 2002). LKS studies occasionally, but not always, distinguish clearly between pecuniary and technological externalities, their public and club good features, and various forms of private intellectual property. Mowery & Ziedonis (2001), for example, find knowledge flows from universities through market transactions to be more geographically localised than those operating through non-market "spillovers". This indicates that intense contact intensity is especially important when knowledge must be specified as a commodity for which property rights are clearly defined.

The size of the functional region is also considered relevant to its ability to invite, support and sustain innovative firms. Large regions offer special advantages to innovative firms in terms of knowledge flows and spillovers, since they offer both clusters in specific industries as well as a diverse range of industries. They combine the advantages of industrial clustering to knowledge transfer and spillover associated with Marshall, Arrow and Romer with the advantages of firm diversity for fostering and incubating innovative ideas as described by Jacobs (1969). Metropolitan regions thus represent areas of geographic space offering both network opportunities and agglomeration externalities beneficial to knowledge transfer. Network opportunities within a metropolitan region like Stockholm cover both local networks inside the region and global networks including electronic communication and air traffic.

Regions are also an important geographic level at which to study innovation processes and systems because they often represent the arena at which larger and smaller scales meet. At the scale of the metropolitan region, compromises are mediated among participants in the innovation system, and property rights issues are easier to solve for collaborating firms. In other words, urban regions may be the best scale at which to observe innovation systems at work, because they reflect processes of knowledge and information transfer at a variety of scales. (Lagendijk, in Fischer and Fröhlich, eds., 2001).

The Community Innovation Survey used as a basis for this and many empirical studies of innovation in European areas identifies sources of information for innovation as well as collaboration with national scientific, vertical and horizontal innovation systems. Firms responding to these surveys were not asked to specify the proximity of contacts and collaborators important to their innovation processes. However, we argue that cooperation with national level innovation systems is often manifested within regional borders and can therefore also be understood as approximating firms' embeddedness in regional innovation systems. Universities, for example, are an important part of a nation's innovation system, but many university-firm relations occur in proximity. Research universities have been identified by firms as location factors of growing importance (Hendersson, Jaffe and Trajtenberg 1995; Zucker and Darby 1998; Adams 2002; Hall, Link and Scott 2003; Zucker and Darby 2005). It has been suggested that regions with strong research universities have better opportunities to attract and support high technology industry than regions without such universities. Extending this idea, regionally based university research-parks can institutionally integrate university and firm resources (Luger & Goldstein, 1991). Several authors note the growing importance of network-type innovation interactions among firms, and private and public research institutions (Lundvall, 1992, Ed.; Nelson, 1993, Ed.; Etzkowitz & Leydersdorff, 2000; Charles, 2003).

2.3 Corporate Structure and Ownership

A firm's corporate structure can contribute both to the generation and transmission of knowledge and therefore to its stock of intellectual capital. Although these processes are complex and not completely understood, it is generally accepted that multinational firms may have advantages over uninational and unaffiliated firms in both the creation and transmission of knowledge for innovation (Pfaffermayer and Bellak 2002). Multinational firms, with many affiliated locations in several countries, have both the "reach" to access new information and the closed system necessary to protect temporary monopolies on intellectual capital.

Followers of Schumpeter argue that firms' incentive to innovate is their ability to enjoy at least temporary monopoly profits from their innovations. Multinational corporations thus seem to provide the best of both "worlds," both access to a large stock of external knowledge (due to the number of locations, including international locations) and the ability to share and develop proprietary information within the corporation. For a detailed discussion, see Dunnings (1993), Cantwell and Janne (1999), Kuemmerle (1999) and Criscuolo, Narula and Verspagen (2002).

This could indicate that formal incorporation of strategic partners within a multinational corporation is an attempt to appropriate their innovation output. Multinationals may also be more skilful in their interactions with R&D organizations, increasing their likelihood of benefiting from embeddedness in regional innovation systems. Moreover, multinationals tend to have a larger average size than other firms and can thereby attract knowledge providers and specialized input suppliers. They have access to a richer base of customer and technological information and use the structure of the firm as a network for knowledge flows between the different units of the company.

Recent studies have confirmed the advantages of multi-location firms for innovative activities. Anderstig and Karlsson (1989) have shown that both advanced process innovations and all product innovations are positively correlated with the size of customer networks. A recent study by Ebersberger and Lööf (2004), using data from Swedish firms, indicates that multinational firms have a significantly larger probability of patenting and introducing radical innovations than uninational firms. Ebersberger and Lööf (2004) also notes an important distinction between Swedish-owned multinational firms (domestic multinationals) and foreign-owned multinational firms. Domestic multinationals tended to be more embedded in their home country's innovation systems and had a higher value of R&D investments. However, the advantage of higher R&D intensity and possible technological knowledge spillover does not manifest itself in superior innovation output or productivity performance (the "return" on the innovation input investment). The tentative explanation offered is that domestic multinationals are using the home country for developing technological capacity exploited in affiliates abroad. Correspondingly, the innovation and productivity performance in foreign multinationals are partly returns on activities created in their home countries.

2.4 The Stockholm region: preconditions for innovation

The literature reviewed above highlights several reasons why regions may be an important scale at which to study innovation and why innovation activities vary across regions. The Stockholm region has many of the preconditions identified in the literature as essential to the creation of regional innovation systems supporting innovative firms. Compared to other Swedish regions, the Stockholm region has a higher share of R&D workers in the local labour supply, as well as a higher share of persons with university education (higher than average knowledge intensity). One in three multinational companies with facilities in Sweden are located in the Stockholm region; one in two are in the Mälar Valley (which includes Stockholm). Since multinationals account for approximately 60 percent of industrial output and overall export, and almost 90 percent of Sweden's industrial R&D spending in 1990 (Fors and Svensson, 2002), the Stockholm region has by far Sweden's most significant concentration of R&D spending. As stressed in previous sections, the region can also offer multinationals an international air transport network.

The Stockholm region has better conditions than other Swedish regions for both short and long-distance interaction with R&D institutions and knowledge providers in general. As a large region with good connections, both among regional clusters and agglomerations and with other regions (both Swedish and international), Stockholm offers the agglomeration and network advantages described earlier as important to knowledge creation, transfer and spillover.

3. DATA

3.1 Data

This study uses data from the Community Innovation Survey (CIS) III for Sweden. The survey was conducted in 2001 and covers the period 1998-2000 for both the manufacturing sector and business services. The CIS has become a popular data source for statistical studies regarding innovation, since it allows for broad comparisons across firms and countries. However, its usefulness in assessing the importance of R&D and other innovation engagement in a regional perspective is somewhat limited. As noted above, firms are for instance not asked to report on the proximity of their domestic collaboration on innovation with external partners. The reporting units are firms, whose geographical locations are known, but R&D and production activities in plants located in other geographical areas are also included in data for the reporting unit. In order to reduce – but not eliminate – these problems, we have disaggregated the Swedish economy into five large regional areas (but see note regarding regional divisions below). In addition, we have assumed that the firms' plants as well as their collaboration in innovation processes, mostly are limited to the same localization areas as the reporting firm.

3.2 Variables

Table 1 introduces the selection variable "innovative firms" and the eight dependent variables posited as potential determinants for each specific variable. We define a firm as innovative if it satisfies one or more of the following criteria during the most recent 3-years period: it has introduced a new product, it has carried out a process innovation, or it has ongoing innovation activities. The study considers four different categories of innovation characteristics and their determinants. The four categories of characteristics are defined as follows: (i) *innovation input* measures the firms' expenditures on R&D and other innovation activities per employee, (ii) embeddedness in the domestic *science base* is a composite dummy variable indicating firms collaboration with universities, and private and public R&D laboratories, (iii) embeddedness in the domestic *vertical innovation system* is a composite variable indicating firm collaborate on innovation with customers and suppliers and (iv) embeddedness in the domestic *horizontal innovation system* is intended to capture a firm's collaboration on innovation with competitors or consultancies.

The study uses four different measures of firm output performance. The first is *non-imitation innovations*, a dummy variable that indicates if a firm has introduced a product partly or completely new to the market. The second measure is *innovation sales*, that is, sales income from new products. The variable *innovation sales* is expressed in intensity terms (per employee). The third output measure is *total sales per employee*, or gross labour productivity. Finally, we report *value added per employee*.

Table 2 describes the definitions of the explanatory variables. It should be noted that some of the endogenous variables presented in Table 1, also are used as explanatory variables in various equations. In the study the Stockholm region is compared with the rest of Sweden, divided into the four areas East Central Sweden, South Sweden, West Sweden and North Sweden.

Based on findings by Doms and Jensen (1999), Pfaffermayer and Bellak (2002), Bellman and Jungnickel (2002), Criscuolo and Martin (2004), Ebersberger and Lööf (2005) and others, we also control for differences in corporate structure when exploring the relationship between innovative activities and location. In order to do this we divide our sample into four separate categories of ownership: non-affiliate enterprises (firms not belonging to a group), uninational enterprises (firms belonging to a group with only domestic affiliates), domestic multinationals and foreign-owned multinationals.

The main firm characteristics in the study are firm size, gross labour productivity, human capital (university educated/total employment), physical capital, knowledge capital (current and recurrent R&D), process innovation and the firms' recent history (establishment, merger and acquisition). In order to control for industry-specific factors, six sector dummies are included in the analysis, as well as information about the firm's most significant market.

3.3 Summary descriptive statistics

Tables 3-9 present descriptive and comparative statistics for all firms and innovative firms, respectively in the Swedish sample.

The sample contains 2 083 firms manufacturing and service enterprises with 10 or more employees, of which 875 (43 percent) are non affiliated enterprises, 733 (36 percent) uninational enterprises and 430 (21 percent) multinationals. See Table 3**.** The Swedish capital Stockholm (Reg 1) has a smaller share of non affiliated enterprises compared to other regions, and a larger share of multinationals. Nearly 50 percent of all multinational enterprises (MNE) in Sweden are located in Stockholm or its close neighbour-region East central Sweden (Reg 2).

The Stockholm region has a larger share of innovative firms (56 percent) compared to the other four regions (48-53 percent). A decomposition of the average figures in Table 4 shows that the relatively higher share of innovative firms in Stockholm is due to the region's lower share of non affiliated and uninational enterprises. Somewhat surprisingly, the share of innovative firms among multinationals is considerably smaller in Stockholm than in the four other Swedish regions.

Table 5 shows the distribution of firm size by region and corporate structure/ownership. Stockholm firms have on average more than twice the number of employees compared to firms in other parts of Sweden. MNE tend to be larger than other types of firms, but in Stockholm multinational and multi-location uninational firms are not significantly different in size.

Tables 6-7 outlines the characteristics of firms regarding key economic variables. Table 6 is an exposition of sales values. First, we see that innovation sales per employee, expresses in mean as well as median value, are larger in Stockholm than in the rest of Sweden for non-affiliate firms and uninational firms. Second, in all five regions we find that multinational firms have higher average and median sales than other firms. Third, among multinationals, the highest ration of sales to employees, is found in West Sweden (Reg 4).

The most significant difference between Table 6 (sales per employee) and Table 7 (value added per employee) is that MNE firms in Stockholm are more productive than all other categories of firms and in all other areas when the mean value is considered. When value added is compared in terms of the median value, we see that MNE in Stockholm and West Sweden are superior to other firms. The overall pattern of Table 6 and Table 7 indicate that some local characteristics that attract multinationals to Stockholm in a bigger extent relatively to other Swedish regions, such as presence of high quality labor force, large local markets, good infrastructure, good administration, also enhance the productivity of other firms in this region. For similar

Table 8 displays summary descriptive statistics on main firm characteristics for the typical firm (mean) if the five geographical areas. Panel A reports the statistics for all firms and Panel B only for the subgroup of innovative firms.

The typical firms in Stockholm is distinguish for the typical firm in other parts of Sweden in several respects; the number of employees is bigger, the share of newly established firms is larger, the human capital intensity is about twice as high as in Sweden as a whole, while the capital intensity is considerable lower. In addition, the share of firms with global market orientation is smaller in Stockholm than in other parts of Sweden, and the occurrence of Mergers and acquisition is somewhat more common.

The average innovative firm in Stockholm is clearly more R&D intensive than the average firm in other Swedish regions (Table 8, panel B). Firms in Stockholm on average participate less with the Swedish scientific and vertical innovation systems, whereas the difference between all regions is small with regard to the horizontal innovation system. This is somewhat surprising given the literature on regional innovation systems, which assumes that such systems influence innovation activity and productivity in a positive way. In this study the better performance in the Stockholm region in innovation output cannot be attributed to conscious participation by firms in the regional innovation system. There are a number of reasons for this, one being the prevalence of multinational firms that can utilise a broad base of intra-corporate knowledge. Note again that the Community Innovation Survey data does not distinguish between regional and national innovation systems.

Innovation output, measured as new product sales per employee, is larger for the typical Stockholm firm. Non-imitation innovations are somewhat more common in Stockholm and West Sweden than in other regions. Notable is that the average innovative firm in Stockholm applies for patent in a smaller extent than other firms. The explanation is that Stockholm is a considerable more service-intensive region than other parts of Sweden. In particular, Stockholm has a far higher share of knowledge intensive services.

Among innovative firms, the ratio of sales to employees as well as the ratio of value added to employees (labor productivity) is bigger in Stockholm compare to other areas in Sweden.

Table 8, panel B notes that the pattern of other firm characteristics for innovative is similar to those reported for all firms.

4. METHODOLOGY

A simple econometric model is used to determine the relationships among factors affecting firms' innovation activities. For estimation purposes we apply a two-step estimation procedure. A generalized Tobit model, comprising the selection equation (1) and a performance-equation (2), is consistently estimated by means of full maximum likelihood techniques, using observations on both innovative and non-innovative firms. The estimation procedure aims to solve the econometric problem of selection bias. Our approach takes into account that not all firms are engaged in innovative

activities. When only the innovation sample is used in some part of the model, the firms are not randomly drawn from the larger population, and selection bias may arise. The two-step model used in the analyses accounts for this possible problem by formulating a specific choice structure. In the first step firms decide whether to engage in innovation activities or not (selection equation). Given that a firm has decided to invest in innovation projects, the 8 different performance variables are estimated. More specifically, we use the following model:

$$y_{0i} = \begin{cases} 1 & \text{if} \quad y_{0i}^{*} = X_{0i}\beta_0 + \varepsilon_{0i} > 0 \\ 0 & \text{if} \quad y_{0i}^{*} = X_{0i}\beta_0 + \varepsilon_{0i} \le 0 \end{cases} \tag{1}$$

$$y_{1i} = y_{1i}^{*} = X_{1i}\beta_1 + \varepsilon_{1i} \quad \text{if} \quad y_{0i} = 1 \tag{2}$$

where y_{0i}^{*} is a latent innovation decision variable measuring the propensity to innovate, y_{0i} is the corresponding observed binary variable being 1 for innovative firms and zero for others. y_{1i} signifies the 8 performance variables. X_{0i} and X_{1i} are vectors of various variables explaining innovation decision and innovation performance. The β -vectors contain the unknown parameters for each equation. ε_{0i} and ε_{1i} are independent and identically distributed drawings from a normal distribution with zero mean, jointly correlated.

5. RESULTS OF THE ECONOMETRIC ANALYSIS

In accordance with the Oslo manual that guides the CIS (OECD, 1997), *innovative firms* in this paper are defined as shown in Table 1 (ongoing innovation, new products and processes). Our regression results indicate that the propensity to be innovative is an increasing function of firm size (see the bottom part of Column 1, Table 9). However, an average newly-established firm does not necessarily have a greater likelihood of being innovative than other firms. The incidence of merger or acquisition in a firm's recent history is positively associated with innovativeness and profitability (expressed in value added per employee). In other words, large firms may be "buying innovation" by acquiring small, innovative firms. Moreover, both physical capital (per employee) and human capital (share of the workforce with three years university education or more) are positively associated with innovativeness. Finally the bottom part of Column 1 reports that innovativeness is related the firm's market profile and perspective, which is a classic result (e.g. Fischer and Johansson, 1994). A firm that recognizes the global market as its most important market has a significantly greater likelihood of being engaged in innovative activities compared to a firm selling on a local market.

5.1 Innovation investment and national innovation collaboration

The upper part Column 1, Table 9, presents log-values of the innovation determinants 1. All else being equal, the average domestic multinational enterprise invests considerably more on R&D and on other innovation activities compared to firms with other corporate structures. None of the point estimates for both embeddedness and regions are significantly different from zero, implying that neither external collaboration nor the location of the firm *per se* influence the size of R&D investments. However, persistent R&D expenditures are positively and closely associated with the size of innovation investments. This may be interpreted as a learning-by-doing effect in innovation processes. These results also confirm previous studies regarding the sign of the firm size variable; innovation investment per employee is a decreasing function of firm size.

Columns (2)-(4) in Table 9 show a starkly consistent pattern regarding collaboration on innovation with universities, vertical partners and horizontal partners: Swedish-owned multinational firms have a significantly greater propensity to collaborate with domestic innovation systems than all other categories of firms in Sweden. There was no significant correlation between collaboration propensity and foreign-owned multinationals. Both domestic and foreign owned multinational firms are predominantly found in metropolitan regions like Stockholm.

At the same time, there is also a regional factor, such that firms – in general – located in Stockholm and in Southern Sweden have a *lower* propensity to utilize domestic innovation systems, compared to (nearly) identical firms in other Swedish regions. As noted, this is surprising given the wealth of literature on the importance of innovation systems in vibrant metropolitan regions. Either these firms are utilizing internal resources (at home and abroad) or they are enjoying the benefits of regional innovation systems in a typically Marshallian fashion; where pure spillover effects generate agglomeration externalities that “are, as it were, in the air.” (Alfred Marshall, 1920). Moreover, collaboration on innovation is an increasing function of both current and persistent R&D-investments as well as firm size.

5.2 Innovation output and productivity

As described in Table 10 Column (1), none of the regional variables are significant when non-imitation innovations (products new to the market) are considered. In a sense this indicates that possible influences from the regional milieu are already taken into account by other determinants in the model. However, there is a corporate structure effect, reflected by a highly significant and negative point estimate for uninational firms. There is also a path-dependence effect, such that enterprises reporting that they are engaged in R&D at a regular basis have a larger propensity to launch non-imitation innovations than other firms. The estimated relationship between non-imitation innovation and collaboration with the scientific innovation system is positive and significant. Evidence is also given that non-imitation innovation is a decreasing function of firm size. Process innovation is positively related to non-imitation innovations.

Table 10, Column 2 describes the relationship between the log value of new product sales per employee and its determinants. Interestingly, there is a strong relationship between company location and this form of innovation productivity. The estimate for Stockholm is highly significant and quite sizable, 0.5. This means that, all other things being equal (such as firm size, industry classification, human capital, corporate owner structure and R&D-investment), a firm's research productivity is superior if it is located in Stockholm rather than other regions in Sweden. In other words, the return on R&D investment in terms of new product sales is evidently greatest for firms in the Stockholm region.

In accordance with the innovation literature, the point estimate for R&D and other innovation investments is closely associated with innovation output, and the order of magnitude, 0.09, is within the range of reported results from most other studies. There is also a corporate structure effect, such that the income from innovations is larger for multinational firms than for other firms. However, the pertinent point estimate is significant only at the 10% level for domestic multinationals. Somewhat unexpectedly, the three embeddedness variables are not significantly associated with innovation sales per employee, everything else equal.

Columns 3 and 4 report productivity estimates and distinguish between total sales per employee (gross productivity) and value added per employee (labor productivity proper). Column 3 describes one significant regional effect – the average innovative firm in Stockholm has higher sales per employee compared to a corresponding firm in other Swedish regions. No significant difference in gross productivity can be established between foreign multinationals, domestic multinationals and uninational firms. However, non-affiliated firms have significantly lower gross productivity than other firms. R&D-investment and knowledge flows from the scientific systems of innovation are closely associated with sales per employee. One might say that knowledge inputs affect the quality of innovations.

Though our findings support a "regional advantage" regarding gross labour productivity, we find no evidence on regional differences in net value added per employee for similar firms (*ceteris paribus*). We already know that firm characteristics influence labor productivity, and firms with favourable characteristics are to a large extent located in the Stockholm region; when this taken into consideration there is no additional regional effect. Corporate structure is a firm characteristic, and foreign-owned multinationals are significantly more productive than all types of Swedish-owned firms. Other firm characteristics are also significant. In particular, value added per employee is an increasing function of both R&D-investments and firms' capital stock. The point estimates for new establishments and mergers and acquisitions are both negative and highly significant.

6. SUMMARY DISCUSSION

This study highlights how corporate ownership and structure, knowledge flows and location influence innovation activities among firms in Swedish regions. It attempts to illuminate some of the many complex relationships within firms and between firms and their interface with innovation systems (other firms, universities, public actors, etc). The data set contains extensive information on the characteristics of firms with ten or more employees. The survey-based data set has been merged with register data derived from annual accounts. The discussion below first examines observations and conclusions from the descriptive statistics. These conclusions are further scrutinized using the results of the econometric analysis.

6.1 Descriptive statistics

A major observation is that the Stockholm region satisfies widely accepted criteria regarding what characterizes a functional urban region (Cheshire and Gordon, 1995). In particular, a functional region is integrated in such a way that frequent face-to-face contacts are possible, which facilitates knowledge flows that can stimulate innovation activities and knowledge interaction. The other four "regions" are not functional in the above sense; though West Sweden and South Sweden contain the metropolitan regions of Göteborg and Malmö respectively, they also comprise areas outside these metropoles. As a consequence, our subsequent observations essentially compare a functional region with the rest of Sweden, decomposed into four areas. Our conclusions are focused on (i) corporate structure, (ii) R&D and knowledge intensity, and (iii) innovative firms.

Corporate structure: We can compare a typical firm in the Stockholm region with a similar firm in the rest of Sweden, first with regard to an average non-affiliated firm and second with regard to an average uninational firm. In both these cases we conclude that the Stockholm region is associated with larger sales and value added, but also higher production costs and wage costs per employee. Higher costs of labour and intermediary inputs such as floor space in Stockholm counteract the higher sales per employee such that profits remain approximately equal in all five Swedish geographical areas. This observation is also compatible with the proposition that the location dynamics of firms equalize profit across locations, reflecting long-term capital mobility. Accordingly, no significant difference between regions with regard to profit level can be found. However, domestic (Swedish-owned) multinationals in the Stockholm region have significantly higher profits than domestic multinationals in other parts of Sweden. No such difference can be observed for foreign-owned multinationals. Thus, for domestic multinationals we do not observe any tendency of profit equalization.

R&D and knowledge intensity: Our first observation is that the Stockholm region is characterized by high R&D intensity. Both the average non-affiliate enterprise and the average uninational enterprise in Stockholm have a considerably higher R&D-intensity than corresponding firms in other parts of Sweden. However, among multinationals, no such difference is evident. Obviously, the R&D intensity of multinationals is almost unaffected by location.

Our second observation is that the Stockholm region has also a significantly higher intensity of human capital than other parts of Sweden. This should imply that the possibility to internalize R&D efforts is greater for firms located in Stockholm. Moreover, knowledge provision via the market is facilitated in the Stockholm region, because the service firms in Stockholm are more knowledge intensive than elsewhere in Sweden.

Innovative firms: The share of firms classified as innovative is larger in Stockholm than elsewhere. In particular, this conclusion applies to the average uninational firm. The same does not apply to multinationals.

6.2 Econometric analysis

The econometric analysis employs the two-stage Heckman election model to address the following questions: how do corporate structure and firm location affect (i) innovation behaviour, (ii) innovation output and (iii) productivity performance? The following tentative conclusions can be drawn from the study.

Innovation behaviour: First, the propensity to be an innovative firm is an increasing function of a firm's size, profitability, human capital and orientation towards larger markets. M&A are also positively associated with innovative firms. Second, corporate structure has a strong and significant impact on R&D intensity, but location appears to have no effect. R&D intensity is higher for domestic multinationals than for all other firms (foreign multinational, uninational firms and non-affiliate firms.) Third, corporate structure has an impact on the cooperation in the scientific and vertical innovation systems, such that domestic multinationals display a higher and significant propensity to engage in this form of cooperation. At the same time, the econometric results show only one robust location impact: location in the Stockholm region has a significantly negative effect on cooperation. How can this be interpreted? Is appropriation and knowledge-asset protection a greater concern for firms in Stockholm? As discussed earlier, Stockholm offers greater opportunities to internalize R&D efforts, because of the region's greater knowledge intensity. It may also be that the innovation milieu in Stockholm allows for informal knowledge spillovers that are not captured in the CIS-survey. In summary: domestic multinationals are more likely to cooperative with innovation systems, and there are more domestic multinationals in the Stockholm region than elsewhere in Sweden, but when all firm characteristics are taken into account, the remaining regional effect of locating in Stockholm is negative regarding cooperation propensity.

Innovation output and productivity: The average firm in Stockholm has a significantly higher level of innovation sales and total sales per capita than similar firms located in other Swedish regions. As regards corporate structure, we also find a tendency for innovative foreign-owned firms to outperform Swedish firms in these both respects. Finally, looking at labor productivity proper, i.e., value added per employee, no regional differences can be found. However, foreign-owned firms in Sweden are

more productive than other firms when we control for factors such as firm location, R&D-intensity, human capital intensity, physical capital intensity and industry effects. Evidently, these firms benefit from entrepreneurial and knowledge assets developed in units of the firm outside Sweden. One may conjecture in line with Ebersberger and Lööf (2004) that a reciprocal condition applies to Swedish multinationals.

The econometric findings with regard to corporate structure support recent findings in the innovation literature, suggesting that innovation and productivity performance in foreign multinationals are partly returns on activities created in their home countries. Correspondingly, domestic multinationals are using the home country for developing technological capacity exploited in affiliates abroad. We find evidence that the Stockholm region generates more successful innovations than other Swedish regions, but this does not manifest itself – *ceteris paribus* – in productivity and profitability.

These observations suggest further research in several dimensions. We have already pointed at one aspect that is ambiguous in the survey-based CIS-data, namely the lack of information about the location of innovation collaborators. Conclusions about proximity to collaborators in an innovation system cannot be drawn without such information. Neither do we have a complete understanding of the collaboration that takes part between units in the same multi-location firm. A third issue for further research is a deeper analysis of the determinants of intermediary costs, wage costs and profits.

The Stockholm region is successful in hosting multinationals that have comparatively high levels of value added, sales and profits per employee. In our analyses these superior firm performance indicators can be explained by firm characteristics but not by location. Thus, a remaining question is: why are these firms – to such a large extent – located in Stockholm?

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TABLES

Table 1: Variables, explained.

Dependent variables	**Definition**
Innovative firm	Innovative firms are firms reporting a product and/or process innovation and/or report ongoing innovation activities.
Innovation input	The firms expenditures on R&D and other innovation activities per employee, log.
Embeddedness in the regional science base	Composite dummy variable indicating if the firms collaborate on innovation with universities and private and public R&D laboratories
Embeddedness in the regional vertical innovation system	Composite dummy variable indicating if the firms collaborate on innovation with customers or suppliers
Embeddedness in the regional horizontal innovation system	Composite dummy variable indicating if the firms collaborate on innovation with competitors or consultancies
Non-imitation innovations	Dummy variable, indicates if the firm has introduced a product with is new or significantly improved to the market
Innovation sales	The firms sales incomes from new products per employee, log
Gross labour productivity	Sales per employee, log
Net labour productivity	Value added per employee, log

Table 2: Variables, explanatory

Explanatory variables	**Definition**
Regional localization	
Stockholm	
East Central Sweden	Uppsala, Sörmland, Örebro, Östergötland
South Sweden	Blekinge, Skåne
West Sweden	Västra Götaland, Halland
North Sweden	Småland, Öland, Gotland, Värmland, Dalarna, Gävleborg, Västernorrland, Jämtland, Västerbotten, Norrbotten
Firm structure	
Non Affiliated Enterprises	Domestically-owned firms without affiliates
Uninational Enterprises	Domestically-owned firms belonging to a group with only Swedish affiliates
Domestically-owned Multinational Enterprise	Domestically-owned firms belonging to a group with foreign affiliates
Foreign-owned Multinational Enterprises	Foreign-owned firms (belonging to a group) with
Firm characteristics	
Size	Number of employees
Productivity	Turnover per employee
Human capital	Share of the employment with a university degree
Physical capital	Tangible assets
Innovation input	See table 1
Persistent R&D	Dummy for continuously R&D engagement
Process innovation	Dummy variable indicate whether the firms has introduced onto the market a new or significantly improved process
Newly established	The enterprise has been established during the last three years
Recent history of merging and acquisition	The enterprise has been involved in M&A during the last three years
Collaboration on innovation	
Embeddedness in the regional science base	See table 1
Embeddedness in the regional vertical innovation system	See table 1
Embeddedness in the regional horizontal innovation system	See table 1
Market	
Significant market area - local	The firms' most significant market
Significant market area - national	The firms' most significant market
Significant market area - global	The firms' most significant market
Sector	
High technology manufacturing sector	Nace 353, Nace 2423, Nace, 30, Nace 32, Nace 33
Medium high technology manuf. sectors	Nace 24 excl Nace 2423, Nace 29, Nace 31, Nace 34, Nace 352, Nace 359
Medium low technology manuf.sectors	Nace 23, Nace 25, Nace 26, Nace 37, Nace 28, Nace 351, Nace 354
Low technology manufacturing sectors	Nace 15, Nace 16, Nace 17, Nace 18, Nace 19, Nace 20, Nace 21, Nace 36, Nace 37
Knowledge intensive services	Nace 64, Nace 65, Nace 66, Nace 67, Nace 71, Nace 72-74
Other services	Other services than Knowledge intensive services

DESCRIPTIVE STATISTICS

Table 3: Number of observations and the share of innovative firms

	REG 1	REG 2	REG 3	REG 4	REG 5	SWE
Non Affiliate	186	110	131	193	255	875
Uninational	171	110	100	135	217	733
Multinational	139	67	61	80	83	430
Total	496	287	292	408	555	2 083

Table 4: The share of innovative firms[2]

	REG 1	REG 2	REG 3	REG 4	REG 5	SWE
Non Affiliate	0.48	0.45	0.41	0.40	0.38	0.42
Uninational	0.63	0.48	0.44	0.47	0.47	0.50
Multinational	0.58	0.75	0.74	0.71	0.78	0.69
Total	0.56	0.53	0.49	0.49	0.48	0.50

Table 5: Number of employees, mean.

	REG 1	REG 2	REG 3	REG 4	REG 5	SWE
Non Affiliate	311	103	48	48	50	111
Uninational	573	191	155	254	151	275
Multinational	616	381	310	553	409	409

[2] Innovative firms are firms reporting a product and/or process innovation and/or report ongoing innovation activities.

Table 6: Sales per employee, in 1000 Euro. Log. All firms.

	REG 1		REG 2		REG 3		REG 4		REG 5		SWE	
	A	B	A	B	A	B	A	B	A	B	A	B
Non Affiliate	4.84	4.84	4.79	4.73	4.74	4.80	4.78	4.73	4.63	4.68	4.74	4.73
Uninational	5.08	5.09	5.06	4,91	5.00	4.93	4.96	4.89	4.99	4.94	5.02	4.94
Multinational	5.35	5.35	5.18	5.16	5.32	5.45	5.39	5.38	5.28	5.26	5.31	5.28

Note: A = Mean, B = Median

Table 7: Value added per employee, in 1000 Euro. Log. All firms.

	REG 1		REG 2		REG 3		REG 4		REG 5		SWE	
	A	B	A	B	A	B	A	B	A	B	A	B
Non Affiliate	4.40	4.03	4.24	4.12	3.96	3.84	4.01	3.89	3.96	3.92	4.03	3.92
Uninational	4.31	4.17	4.23	4.16	4.17	3.97	3.93	3.95	3.98	3.96	4.09	4.00
Multinational	4.45	4.19	4.33	4.17	4.15	4.04	4.15	4.20	4.17	4.07	4.21	4.12

Note: A = Mean, B = Median

Table 8: Firm characteristics Mean and Standard deviation.

Panel A: All firms

	REG 1	REG 2	REG 3	REG 4	REG 5	SWE
Firm size	4.22 (1.67)	4.08 (1.45)	3.85 (1.29)	3.87 (1.39)	3.83 (1.28)	3.97 (1.44)
Newly established, share	0.11 (0.31)	0.05 (0.22)	0.06 (0.23)	0.06 (0.24)	0.04 (0.20)	0.07 (0.25)
M&A	0.11 (0.31)	0.08 (0.26)	0.11 (0.31)	0.09 (0.29)	0.10 (0.30)	0.10 (0.30)
Human capital, share	0.19 (0.21)	0.08 (0.13)	0.09 (0.13)	0.10 (0.16)	0.06 (0.10)	0.11 (0.16)
Physical capital, log	1.75 (1.71)	2.63 (1.72)	2.63 (1.69)	2.62 (1.68)	2.99 (1.53)	2.51 (1.72)
Global market, share	0.25 (0.43)	0.30 (0.46)	0.32 (0.46)	0.32 (0.47)	0.26 (0.4)	0.28 (0.45)

Panel B: Innovative firms

	REG 1	REG 2	REG 3	REG 4	REG 5	SWE
Innovation input, log	1.48 (2.05)	1.29 (1.65)	1.07 (1.87)	1.04 (1.68)	1.04 (1.62)	1.20 (1.80)
Scientific IS collaboration	0.19 (0.39)	0.29 (0.45)	0.19 (0.39)	0.25 (0.43)	0.23 (0.42)	0.23 (0.42)
Vertical IS collaboration	0.27 (0.44)	0.37 (0.48)	0.25 (0.44)	0.29 (0.45)	0.31 (0.46)	0.30 (0.45)
Horizontal IS collaboration	0.21 (0.40)	0.20 (0.40)	0.17 (0.38)	0.22 (0.42)	0.24 (0.42)	0.21 (0.41)
Non-Imitation innovations	0.39 (0.48)	0.36 (0.48)	0.31 (0.46)	0.39 (0.48)	0.35 (0.48)	0.37 (0.48)
Patent application	0.23 (0.42)	0.38 (0.48)	0.36 (0.48)	0.33 (0.47)	0.31 (0.46)	0.31 (0.46)
Innovation sales, log	2.40 (2.15)	1.88 (1.82)	2.07 (1.88)	2.14 (1.76)	1.98 (1.81)	2.12 (1.91)
Total sales, Log	5.20 (1.24)	5.04 (0.76)	5.06 (0.92)	5.01 (0.74)	5.04 (0.91)	5.08 (0.97)
Value added, log	4.26 (1.14)	4.01 (0.96)	4.04 (0.62)	4.06 (0.71)	4.10 (0.75)	4.12 (0.88)
Firm size, log	4.45 (1.74)	4.51 (1.50)	4.20 (1.37)	4.33 (1.55)	4.19 (1.42)	4.33 (1.55)
Physical capital, log	1.84 (1.66)	2.80 (1.54)	2.88 (1.53)	2.63 (1.52)	3.08 (1.55)	2.59 (1.64)
Global market, share	0.31 (0.46)	0.44 (0.49)	0.44 (0.50)	0.40 (0.49)	0.39 (0.49)	0.38 (0.49)
Newly establishments	0.09 (0.28)	0.05 (0.21)	0.07 (0.26)	0.09 (0.28)	0.03 (0.17)	0.06 (0.25)
M&A	0.14 (0.35)	0.10 (0.30)	0.12 (0.32)	0.12 (0.33)	0.14 (0.35)	0.13 (0.33)
Process innovation, share	0.55 (0.50)	0.51 (0.50)	0.51 (0.50)	0.48 (0.50)	0.49 (0.50)	0.51 (0.50)
Persistent R&D, share	0.48 (0.50)	0.53 (0.50)	0.50 (0.50)	0.47 (0.50)	0.48 (0.50)	0.49 (0.50)

REGRESSION RESULTS

Table 9: Innovation investment and collaboration on innovation

Equation	(1)		(2)		(3)		(4)	
	R&D and other innovation input per employee, log		Collaboration on innovation within scientific IS		Collaboration on innovation within vertical IS		Collaboration on innovation within horizontal IS	
	Coeff	St.err.	Coeff	St.err.	Coeff	St.err.	Coeff	St.err.
Regions								
Stockholm	0.167	0.142	- 0.381**	0.147	- 0.142	0.152	- 0.187	0.140
East Central	0.157	0.157	0.059	0.140	0.173	0.159	- 0.347**	0.151
South	- 0.011	0.159	- 0.155	0.157	- 0.160	0.173	- 0.214	0.161
West	- 0.039	0.144	0.089	0.133	- 0.136	0.155	- 0.115	0.138
North	Ref		Ref		Ref		Ref	
Corp Struc								
Uninational	Ref		Ref		Ref		Ref	
Multinational D	0.615**	0.245	0.425**	0.201	0.994***	0.260	0.074	0.190
Multinational F	0.112	0.132	0.113	0.119	0.201	0.136	0.016	0.127
Non Affiliate	- 0.077	0.115	0.095	0.116	0.133	0.127	0.106	0.118
Knowledge								
R&D invest	-	-	0.200**	0.100	0.228**	0.094	0.126	0.097
Persistent R&D	1.019	0.115	0.720***	0.140	0.701***	0.111	0.339***	0.118
Characteristics								
Firm size	- 0.445***	0.039	0.214***	0.054	0.116***	0.043	0.169***	0.040
Newly establish.	- 0.086	0.210	- 0.251	0.226	0.057	0.193	- 0.020	0.205
M&A	- 0.191	0.160	- 0.324**	0.155	0.025	0.144	0.323**	0.139
Process innov	0.203**	0.096	0.200**	0.100	0.228***	0.094	0.126	0.097
Selection var								
Firm size	0.149***	0.021	0.170***	0.023	0.171***	0.023	0.170***	0.023
Sales/emp	0.164***	0.028	0.200***	0.040	0.195***	0.040	0.194***	0.040
Newly establish.	0.013	0.120	0.050	0.129	0.050	0.129	0.047	0.129
M&A	0.322***	0.100	0.285***	0.106	0.282***	0.106	0.279***	0.106
Physical cap	0.055***	0.018	0.256	0.204	0.273	0.205	0.321	0.210
Human cap	1.096***	0.177	1.026***	0.247	0.895***	0.253	0.871***	0.252
National market[a]	0.357***	0.073	0.376***	0.079	0.406***	0.078	0.414***	0.078
Global market[a]	0.641***	0.087	0.657***	0.094	0.696***	0.092	0.704***	0.092

Note: Significant at the <1% (***), <5%(**) and (*) <10% level of significance. Six sector dummies are included: High technology manufacturing (HI-M), high medium technology manufacturing (HM-M), low medium technology manufacturing (LM-M), low technology manufacturing (LO-M), knowledge intensive services (KI-S) and other services (O-S). (a) Reference is local market

Table 10: Innovation investment and collaboration on innovation

Equation	(5)		(6)		(7)		(8)	
	Non-Imitation innovations		Innovation sales/ empl		Total sales/ emp		Value added/ emp	
	Coeff	St.err.	Coeff	St.err.	Coeff	St.err.	Coeff	St.err.
Regions								
Stockholm	0.106	0.125	0.392***	0.149	0.297***	0.081	0.056	0.079
East Central	- 0.019	0.138	- 0.284*	0.166	0.024	0.087	- 0.105	0.085
South	- 0.138	0.142	0.001	0.164	0.044	0.089	- 0.046	0.086
West	0.126	0.126	0.115	0.153	0.030	0.081	- 0.027	0.079
North	Ref		Ref		Ref		Ref	
Corp Struc								
Uninational	Ref		Ref		Ref		Ref	
Multinational D	0.580***	0.203	0.593**	0.281	- 0.055	0.133	- 0.031	0.132
Multinational F	0.207**	0.115	0.521***	0.143	0.116	0.073	0.076	0.071
Non Affiliate	0.334***	0.103	0.186	0.130	- 0.146**	0.065	0.026	0.063
Knowledge								
R&D invest	0.025	0.029	0.131***	0.031	0.093***	0.015	0.065***	0.015
Persistent R&D	0.456***	0.110	0.167	0.134	- 0.048	0.055	0.099*	0.055
Human capital					0.217	0.189	0.296	0.183
Science IS	0.353***	0.135	- 0.130	0.163	0.144**	0.071	0.133*	0.072
Vertical IS	0.167	0.124	0.171	0.155	- 0.046	0.065	- 0.050	0.066
Horizontal IS	- 0.062	0.129	0.258*	0.163	- 0.032	0.066	- 0.106	0.067
Characteristics								
Firm size	- 0.104	0.040	- 0.399***	0.055	- 0.010	0.021	0.020	0.019
Physical cap	-		-		0.323*	0.189	0.573***	0.188
Newly establish.	0.193	0.173	- 0.177	0.275	- 0.166*	0.093	- 0.328***	0.092
M&A	- 0.013	0.138	0.018	0.218	0.010	0.071	- 0.197***	0.069
Process innov	0.456***	0.110	0.033	0.102	0.049	0.044	0.053	0.045
Selection var								
Firm size	0.170***	0.023	0.129***	0.021	0.168	0.023	0.177***	0.023
Sales/emp	0195***	0.023	0.279***	0.030	-	-	-	
Newly establish.	0.057	0.130	0.067	0.123	0.000	0.128	0.018	0.128
M&A	0.283***	0.106	0.265***	0.100	0.304***	0.106	0.296***	0.106
Physical cap	0.287	0.205	- 0.022	0.015	0.375*	0.204	0.394*	0.203
Human cap	0.909	0.249	0.312*	0.165	1.015***	0.248	1.032***	0.247
National market[a]	0.402***	0.077	0.364***	0.072	0.440***	0.075	0.428***	0.077
Global market[a]	0.694***	0.092	0.596***	0.110	0.788***	0.088	0.764***	0.090

Note: Significant at the <1% (***), <5%(**) and (*) <10% level of significance. Six sector dummies are included: High technology manufacturing (HI-M), high medium technology manufacturing (HM-M), low medium technology manufacturing (LM-M), low technology manufacturing (LO-M), knowledge intensive services (KI-S) and other services (O-S). (a) Reference is local market