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The Global-Local Interplay of MNE and Non-MNE Firms

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Abstract

During a sequence of decades we can observe a co-evolution of globalization through network formation of multinational (MNE) firms and concentration in specific places due to agglomerative forces. First, innovation ideas arrive at a faster speed to firms with past experience of innovation activities and with established export market contacts. Second, innovativeness is strongly dependent on corporate and ownership structure. Third, the returns to innovation efforts are positively influenced by firms' capability to exploit extended markets. All these phenomena can be theoretically explained by MNE's capacity to coordinate global supply chains and orchestrate localized R&D activities and knowledge flows. The paper illuminates how attributes of MNEs and non-MNEs differ, and how these differences affect the productivity and export intensity. It also shows how agglomeration economies affect MNEs and non-MNEs

Keywords: globalization, agglomeration, corporate ownership structure, innovation, exports, productivity

JEL: C16, F14, L25, O33, R30, R12,

1. Introduction

The last few years have seen importance advances in the literature on globalization and international trade coupled with geographical concentrations. Part of this literature has stories to tell that go beyond the contributions by Dunning (1983), Hartner and Jones (1986). Steps in new directions are exemplified by Lipsey (2002), and one of these directions is to recognize that the globalization has two basic dimensions, where one is the role the networks of multinational companies, and where the other is the concentration of multinational companies in large urban agglomerations around the world.

As a consequence of globalization, the intra-national conditions for firm growth are diverging and the importance of agglomerations and corporate ownership structure appear to have increased (McCann 2008). Urban agglomerations in advanced economies have larger stocks of human capital and their activities are more knowledge intensive. In particular, the economies of large urban agglomerations specialize in advanced business services and knowledge production, generating knowledge output in the form of patents, licenses, product innovation, other commercial exchange of knowledge assets, etc.

At the firm level the development is reflected in higher productivity of multinational firms and higher wage levels in firms dwelling in large urban regions. At the same time the global firms increase their presence in foreign markets as producers and sellers via export. The productivity and export gains can be explained by agglomeration economies enabling clustering, proximity and scale as well as scope phenomena. In such regional milieus we observe local knowledge spillovers, a variety of non-traded local specialist inputs, local pool of skilled workers, and formation of new global inter-firm networks and constant reshaping of multinational firms. In this context the presence of multinational enterprises (MNEs) functions as a catalytic factor.

In this paper we draw attention to the issue on globalization, localization, innovation and growth by a systematic analysis of how attributes of MNEs and non-MNEs differ, and how these differences affect innovativeness, productivity and export intensity. We report results from a series of studies based on extensive Swedish firm-level data. The presentation has a two-pronged approach by recognizing both agglomeration and corporate structure, emphasizing how they facilitate knowledge flows and generation of innovation ideas. Thus

we ask: how do agglomeration economies influence innovation, productivity and export performance. At the same time we investigate whether non-MNEs can harvest benefits from local tacit knowledge, non-traded local specialized inputs and skills, and the presence of MNE by locating in large urban agglomerations.

Another question discussed is the difference between domestic MNEs and foreign-owned multinationals. MNEs are better able to coordinate global activities with more skillful designs and tighter integration of global supply chains, long-distance trading relationships, and an ongoing renewal of the mix of product varieties supplied. However, with regard to R&D-investments and embeddedness in various innovation systems, the MNEs are biased towards their home-countries. The purpose of the subsequent overview of research results is to show how domestically owned multinational firms and foreign-owned firms differ with regard to the catalyst function of MNEs. A second purpose is to show how the location of both MNEs and non-MNEs affect firm performance in different dimensions. One such observation should be stressed already here: Many small firms in large urban regions perform excellent in terms of R&D intensity, innovativeness and sales. These small firms are characterized by belonging to an MNE company group.

The paper is organized as follows. In section 2, we outline a theoretical view on (i) innovation ideas and product development, (ii) innovativeness and corporate structure, and (iii) market extension and capacity to trade over long distances. Section 3 provides a set of conclusions about important characteristics of MNEs and non-MNEs in terms of location, knowledge flows, and innovativeness. Section 4 extends the perspective by characterizing innovation strategies of firms, patenting activities and choices of export and import strategies. The paper ends with a summary of our main findings and a reflection on how this may give rise to new policy considerations.

2. INNOVATIONS, CORPORATE STRUCTURE AND MARKET – THEORY PERSPECTIVES

2.1 Innovation Ideas and Development of new Products

Frequent product development can be associated with firms supplying differentiated varieties belonging to a given product group. Such firms innovate with different frequencies and some of them supply only a single variety, whereas others supply a diverse set of varieties.

Moreover, some firms concentrate their variety sales only to their domestic market and other firms have a spectrum of destination markets. The virtue of this focus on the development of export products is that new product varieties can be recorded in fine-detail trade statistics.

As shown in Andersson and Johansson (2008), the pertinent distributions are skewed: many firms are associated with few varieties and a small number of firms supply many varieties; many firms sell only to the domestic or to a few foreign markets and a very limited set of firms is associated with multiple destination markets. These observations relate to previous observations of skewed distributions of firm size (Ijiri and Simon, 1977; Klette and Kortum, 2004), with the addition that in our formulation size is primarily determined by the number of varieties and destinations. Why are the distributions so markedly skewed?

Properties of the Innovation Process

The skewed distributions imply a picture of heterogeneous firms, which is the result of simultaneous exit and entry of product varieties. A reasonable assumption is that entry of a variety can take place only as a consequence of an innovation idea that has arrived to an individual firm (including novel firms). Empirical observations suggest that the generation of ideas follows a stochastic process which is specific for each firm. Such an idea comprises a specific variety in combination with a destination market, reflecting the Schumpeter observation that innovations include both a variety and a market novelty, recognizing that a product innovation must find its way to customers (Schumpeter, 1934).

In two recent contributions Andersson and Johansson (2008, 2009) introduce a theoretical framework for analyzing product development as a stochastic process, where firms innovate by investing in development of new product varieties and export channels. In this framework each country's market is characterized by monopolistic competition as developed by Dixit and Stiglitz (1977), and there is a variety-specific negatively sloping demand curve in each market to which the product is exported, which implies that we can define an optimal price-setting behavior of innovating firms (Krugman, 1980). Earlier contributions that study export of product varieties in a setting of monopolistic competition include Feenstra (1994) and Broda and Weinstein (2006).

Contrary to established models of monopolistic competition, the present model can host firms that benefit from scope economies, which arise as a consequence of a firm supplying

more than one variety and delivering to more than one geographic market. Thus, a given market channel investment can serve several export varieties, and a given variety can be sold to several markets, although the realization of such options is governed by a stochastic process. In each market at each point of time, the number of varieties is constrained to not exceed the number of past innovation ideas.

An early attempt to model the introduction of new product varieties can be found in Krugman (1979), based on a deterministic arrival process for novel variety ideas. In Klette and Kortum (2004) an individual firm acquires new product varieties at a Poisson rate that depends on the R&D investments made by the firm. Since other firms introduce new varieties, incumbent firms experience that these new products bring about a Poisson process of exit – such that product varieties disappear from a firm's product mix (in creative destruction). In Andersson and Johansson (2008, 2009), one stochastic process cause the exit of ageing varieties and another state dependent Poisson process which generates innovation ideas, and these two processes can be combined into a Markov process, depicting the transition of firms between different states (in terms of number of destination-specific varieties). Under given conditions this process has a stationary distribution where firms of different size co-exist, and varieties enter and exit simultaneously.

Regional Characteristics and Product Innovation

In the empirical analysis of Anderssson and Johansson (2008) the arrival rate of innovation ideas is related to the characteristics of the functional region (labour-market region) in which a firm has its location. With data for 81 Swedish functional regions it is shown that firms in a region accumulate knowledge and innovation capacity as a result from past innovation activities. This implies that for each specific industry (product group), the stock of existing varieties, of existing export firms, of export-destination channels and the absorption capacity of all firms in a region predicts the future innovation rate of firms in the region. Additional regional characteristics that predict future innovation behavior are localization economies, urbanization economies and proximity to a metropolitan region. The findings are summarized in Table 2.1.

Table 2.1: Regional characteristics which stimulate the product-variety innovation rate

Knowledge resources in the region	• Variety knowledge, recorded as the number of export varieties in an industry of a region. • Knowledge spillover from co-located export firms, recorded as the number of exporting firms in an industry of a region. • Foreign-market knowledge, recorded as the number of destination markets in an industry of a region
Communication opportunities in the region	• Localisation economies, recorded as export specialisation of an industry in a region. • Urbanisation economies, recorded as the size of a region • Metropolitan proximity, recorded as the region's distance to the nearest metropolitan region
Absorption capacity in the region	• Knowledge intensity, recorded as the share of the workforce with university education (3 years) of an industry in a region.

Firm Attributes and Product Innovation

The explanatory variables in Table 2.1 influence with high statistical significance the arrival rate of innovation ideas for all Swedish firms during the time period 1997-2004. Inspired by this result, Andersson and Johansson (2009) introduce an alternative perspective, where the historical experiences and accumulated innovation capacity from the past are recorded for each individual firm. In line with assumptions of the formal model, the arrival rate is shown to depend on (i) a firm's present stock of innovations, (ii) its export intensity, (iii) its exploitation of size economies due to economies of scope, and (iv) its knowledge intensity reflecting past innovation experiences. These regressions are designed to reflect a process of Poisson arrival of ideas, and provide evidence of state dependence of the arrival rate.

The empirical analyses also give support to the hypothesis about the distribution of firm categories with regard to numbers of varieties, destinations, and destination varieties. Several of the stylized facts in Klette and Kortum (2004) get additional support in the paper's context of export innovations. These stylized facts comprise observations such that a small number of firms supply many varieties and survive over long periods (like MNEs) and many firms start and disappear at a high frequency.

The model depicts for a sequence of dates the market solution each date, including every firm's introduction of new destination varieties and the exit of such varieties. In such a dynamic sequence the arrival of ideas to a firm is influenced by the past history of the firm, which has the form of state-dependent Poisson processes, and these can in turn be viewed

upon as a Markov process. The Poisson process of a particular firm *k* is such that the firm's probability of receiving (or developing) *n* innovation ideas is given by

$$\text{Prob}(N_k = n) = \exp\{-\lambda_k\}(\lambda_k)^n / n! \qquad (2.1)$$

where $\lambda_k > 0$ denotes the rate at which ideas arrive during the given time interval between two dates, N_k is the random variable and *n* is the dummy variable of the process. The results with this model are summarized in Table 2.2, which reveal that also when individual attributes of each firm have been taken into consideration, there remains a regional milieu factor.

Innovation activities of a firm can be fuelled by knowledge transfers. A rather extensive literature have studied how innovation is affected by domestic and international transmission of technology by examining different channels such as FDI, trade, licensing, cross-patenting activities, input-output relations, labour mobility, strategic alliances, and regional and international R&D collaboration.

Table 2.2: Firm attributes which stimulate the product-variety innovation rate

Export-based knowledge	• Innovation experience as a function of the firm's total number of presently active innovations • The firm's experiences of foreign-market sales • The firm's export intensity
Import-based knowledge	• The firm's exposure to knowledge flows from abroad via own import activities • Intensity of knowledge flows from abroad
Scale economies	• The size of the firm reflecting effects of scope economies • The productivity of the firm reflecting its exploitation of scale economies
Innovation and absorption capacity	• Knowledge intensity of the firm's labour force • Knowledge flows in internal networks of MNEs
Regional milieu	• (10)Export experiences among firms in each region

2.2 Innovativeness and Corporate Structure

Multinational enterprises, MNEs, are in a special position to handle knowledge transfer. Surveying the literature based on micro-data, Carkovic and Levine (2002) conclude that firm level studies often do not find positive knowledge flows, including spillovers running from foreign-owned to domestic firms. Investing a sample of MNEs with subunits in Sweden, Persson (2006) shows that only 43 percent of potential receivers of knowledge for innovation within MNE organizations are using this knowledge Veugelers and Cassiman (2004) suggest

that foreign subsidiaries are not necessarily interesting R&D partners for knowledge exchange. Having an international network of collaborators that provides access to international technology seems to be more important for local firms.

Several authors exploit patent citation data in order to trace possible links between geographical proximity and innovation (Jaffe *et at* 1993, Almeida 1996, Eaton and Kortum 1999, Bottazzi and Peri, 2002, Verspagen ands Schoenmakers 2004). This research typically shows that proximity in the creation of economically useful knowledge is important, and some authors also suggest that investors increasingly use domestic knowledge more than foreign knowledge (Sonn and Storper 2003).

Following work by Dunning and Narula (1995), Archibugi and Iammarino (2002), Le Bas and Sierra (2002), and others have compiled two useful sets of taxonomies of R&D by foreign affiliates. The first set is based on the nature of technological activity in foreign affiliates and reflects four different technological functions assigned to foreign affiliates. The second set of R&D-taxonomies groups R&D activities in host countries by the technological objectivities of the parent company. Fischer and Frölich (2001), and Karlsson and Johansson (2004) offer a third useful category of taxonomy. These contributions separate knowledge for innovation into three distinct forms: (i) scientific knowledge in the form of basic principles, (ii) technological knowledge in the form of "technical solutions", and (iii) entrepreneurial knowledge about products, attributes, customer preferences and markets conditions, business concepts etc.

Table 2.3 displays possible relationship between R&D-collaboration and innovation output on the basis of demand or supply based motives. Column (1) illustrates that we assume that adaptive R&D, technology-seeking motives and entrepreneurial knowledge can be grouped together under the header "demand driven" (or market driven) R&D-collaboration. Under the header "supply driven (or scientific driven) R&D-collaboration, column (3) shows innovative R&D for the global market, home-based augmenting motives and scientific knowledge of basic principles. Column (2) is a mix between the two pure motives for foreign and regional arrangements on collaboration, which include innovative R&D for regional markets, home-base exploiting motives and knowledge about technical solutions.

Since the typical Foreign I and Domestic I firms sell about 90 percent of their production to regional markets in Sweden it can be assumed that most of their R&D-collaboration is in conjunction with, or in response to, specific locational conditions in Sweden. It means that their motives for R&D collaboration mainly are demand driven or a combination of demand and supply driven. Moreover, we expect that Foreign II firms have a closer link to foreign collaborators than Domestic II firms.

Table 2.3: Hypotheses on motives for MNEs R&D collaboration

Hypothesis	**Demand driven**		**Demand and supply driven**		**Supply driven**	
Technological activities	Adaptive R&D		Innovative R&D for regional markets		Innovative R&D for global markets	
Father-comp. motives	Technology-seeking		Home-base exploiting		Home-base augmenting	
Required knowledge	On Products, consumers, markets, concepts etc.		Technical solutions		Scientific knowledge on basic principles	
Collaboration	Foreign	Regional	Foreign	Regional	Foreign	Regional
Foreign I	+	+ +	+ +	+	+ + +	+ + +
Domestic I	+	+ +	+	+ +	+ + +	+ + +
Foreign II	+ +	+ + +	+++	+ + +	+	+
Domestic II	+	+ + +	+	+ + +	+	+

Remark: The " + " indicates a ranking of importance. Foreign I and II refer to foreign-owned firms with global and regional sales, respectively. Domestic I and II refer to domestically owned firms with global and domestic sales, respectively.

In section 2.1 the role of the internal global network of an MNE firm provides it with a knowledge flow advantage. We can identify several reasons for locating R&D activities in economic environments outside the home country. First, in line with Dunning and Neural (1995), MNEs may locate in the proximity of places with specialized excellence, from which novelties can be developed and transferred through the internal networks of the multinational organization. Second, a firm that relies on the technology embedded in its internal network may still need to carry out R&D that requires proximity to customers in a foreign country. See for example Pearce, 1999; Zed with and Gassman, 2002 and ITPS (2003).

2.3 Market Extension and Distance Discount

The product cycle model provides a stylized framework for understanding the changes in the demand for different types of inputs over the life cycle of a product. The trajectory of a life cycle can be described with regard to an entire product group, but here the focus is on the development of a firm's supply of one or several varieties. This is one aspect, for which large

multi-product firms differ from firms with one or a few varieties. The multiproduct firm can control a whole spectrum of product varieties, comprising young, non-standardised varieties which are still in an R&D stage, together which varieties with strong expansion and varieties in a post-mature stage, with harsh cost savings and price competition. As a consequence the life cycle of the enterprise becomes decoupled from the life cycles of the set of varieties of different vintages. For a smaller, few-variety firms the development path of the firm and its output tends to be congruent.

The literature recognizes that in the early stages of a product-variety cycle, the R&D work benefits from taking place in a creative milieu, with a rich supply of knowledge resources accessible to the design activities (Vernon, 1966; Norton & Rees, 1979; Malecki, 1981; Nijkamp, 1986). Given that the design and market penetration process is successful, the pertinent variety enters a phase when the output and sales s expand at a fast rate. In this phase, the associated firms have better opportunities to routinise the production, distribution and marketing activities, and this can further stimulate the expansion. The routinisation of firm operations is facilitated when the design of product varieties are standardised. Then, the unit cost of each variety can be reduced, which will stimulate market expansion. In this stage, the location may shift to places that are less knowledge intensive, generating outsourcing and offshoring.

An MNE firm has at least three advantages over a non-MNE firm in the perspective of product cycles. The first is associated with choice of location for the juvenile and R&D intensive phase of product variety. The second is its wider options to decompose production and organize global supply chains when the scale of output increases. The third is related to the opportunities to extend the market and spread sales over a wider set of countries (Andersson, Johansson and Lööf (2008). For smaller firms, there is strong evidence that the distance discount effect is markedly stronger than for larger, multi-market and multinational firms.

The first advantage that relates to R&D capacity has already been emphasized and related to Swedish observation that as much as 9 out of 10 R&D efforts are associated with MNE firms. We have also pointed at these firms find locations in R&D intensive large urban milieus. The advantages that obtain from design of supply-chain networks play a key role when varieties are given standard attributes and the firm’s operations are routinised (Johansson and

Andersson, 1998). Along a product cycle path the knowledge intensity is high when a product is non-standardised and the production process is non-routinised. Standardisation and routinisation imply reduced knowledge intensity, favouring alternative locations, and in this way options for relocation and distributed production networks increase (Johansson & Karlsson, 1986). The extent of this phenomenon is reflected by the fact that about 1/3 of flows between countries represent deliveries that are internal in the sense that the exporter and importer belong to the same MNE.

The distant-discount effect refers to the phenomenon of reduced probability of export flows as the distance to a market increases. This principle applies to all categories of firms, and reflects that geographic transaction costs expand with increasing distance and hence friction. The response of firms to this friction phenomenon is the following:

- The average value per weight unit (export price) is higher the more distant a market is. In this way the high friction costs of distant markets are not allowed to become a prohibitively high share of the export value per exported unit.
- The described pattern is much stronger for small firms and non-MNE firms, which in general have thinner export flows than large MNE firms.

For the small firms, low-value varieties are almost exclusively exported to the neighboring export markets, whereas large MNE firms manage to find logistically cost efficient solutions for low-value products going to more distant markets. Thus, for products with a low value per weight unit, the distance discount factor is much smaller for MNE firms (Andersson, 2009). In this context, we observe that product varieties with high values per weight unit are extremely likely to be R&D intensive, whereas low value varieties are not.

The observations we have made imply that that MNE firms can have a market access advantage both in the initial phases and the later post-maturity phases of their individual product cycles. Furthermore, non-MNEs have to base their long-distance exports on successful variety innovations, whereas MNEs have less constrained opportunities. However, the major advantage of an MNE is the option to continuously renew the mix of product varieties of different vintages.

3. Characteristics of MNEs and Non-MNEs – Empirical Evidence

3.1 Multinationals – Global and Local

Globalization makes itself visible in the form of an increasing volume and variety of international trade and capital flows, a widespread diffusion of knowledge and technology, and an expanding role of multinational companies, which have a special capacity in building new networks and choosing both production and R&D sites across the world. The associated technological regime comprises just-in-time systems, flexible manufacturing systems and economies-of-scope within a framework of increasingly fine-tuned network relations between different production and R&D units with multi-country locations. This orchestration is the work of more than 70 000 multinational companies, with more than ten times as many foreign affiliates according to UNCTAD calculations (McCann, 2008).

The capacity of MNEs to subdivide and decompose operations has made it possible to offshore both production and R&D activities, while retaining control in the headquarter country (Fujita & Thisse, 2006). In spite of this, empirical evidence suggest that the proximity dependence of R&D remains equally strong as before (Andersson, et.al. 2008). In view of this we can observe two things:

- A major share of the world's R&D is carried out by multinationals
- R&D activities are concentrated in large urban (often cosmopolitan) agglomerations.

How do small, non-MNE firms survive in this development process, and which roles do they play? Small firms can interact with large (multi-location) firms, having them as customers. Moreover, the share of services in the economy is growing. This provides opportunities for small innovative entrepreneurs to offer a local variety of distance-sensitive, customized deliveries. Hence, small, non-MNE firms also benefit from urban agglomerations, where they can find MNE customers, a broader variety of customers in general, and institutions that bring down transaction costs – reducing search costs and transaction costs (Quigley, 1998), offering communication externalities (Fujita and Thisse, 2002), reducing business risks (Mills and Hamilton (1984), offering knowledge spillovers (Acs, Audretsch and Feldman, 1992) , a diverse supply of specialised labour (Marshall, 1920), a variety of non-traded inputs (Krugman, 1991a, 1999b).

Furthermore, the larger and the richer the functional region, the larger the number of potential entrepreneurs, because economic agents in such regions have better education on average, have more varied work experiences, etc. Actually, large and rich functional regions offer increasing returns in the acquisition of entrepreneurial skills due to more effective and numerous interactions in denser areas (Glaeser, 1999; Desmet, 2000). The implications of the above discussion are far reaching in terms of local entrepreneurial processes in the current era of globalisation.

In the sequel we will report findings that seem to question the assumption that firms in large urban agglomerations take advantage of greater opportunities from R&D collaboration and knowledge exchange. However, there is one particular form of knowledge spillovers that increases with the size of an urban region. When an employee changes employer, that shift makes knowledge move between the two firms involved, and labour mobility grows in a marked way as the size of a functional urban region increases in size. This is illustrated in Figure 3.1, which records the sized of Swedish urban regions along the x-axis and the corresponding labour mobility along the y-axis. The diagram shows that only the three metropolitan regions Stockholm, Göteborg and Malmö display a mobility rate above the weighed average for the country.

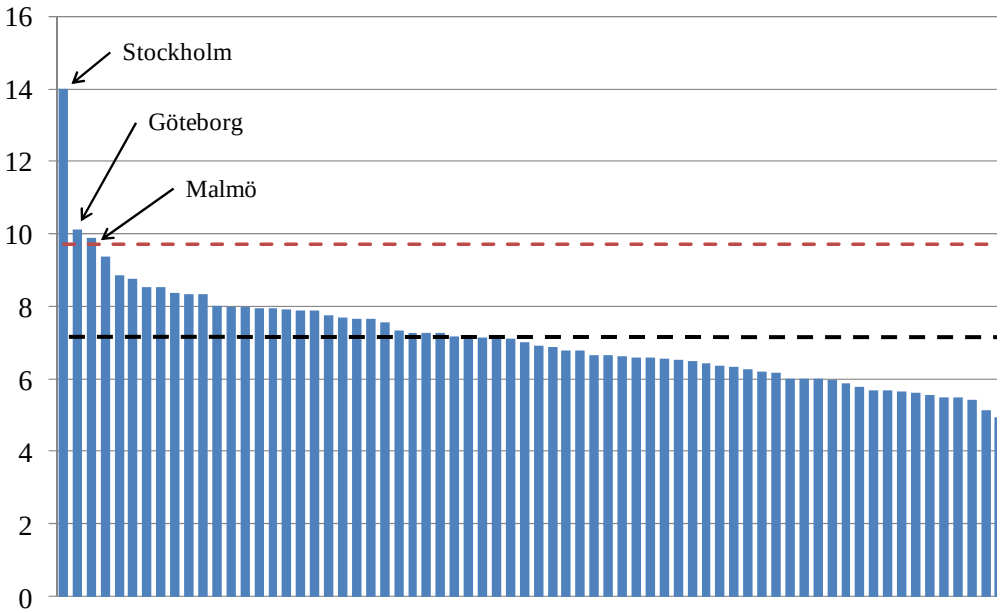

FIG 3.1. Labour mobility within 72 Swedish labour market regions 1987-2005, fraction of total employment. Along the x-axis the regions are ranked after labour mobility. The y-axis records the mobility as a fraction of total employment. The upper broken line displays weighted average for Sweden as a whole and the lower broken the unweighted average.

The described phenomenon adds to the basic conjecture that the interaction intensity is higher in large and dense urban areas (Glaeser, 1999; Desmet, 2000). Knowledge-intensive activities are favoured by proximity externalities in large urban (metropolitan) regions, with their supply of knowledge-rich producer services, R&D, etc. Advanced business services prefer accessibility to customers across all sectors. Other knowledge-handling activities are attracted by mutual accessibility. The associated location dynamics unfolds in both OECD and newly industrialised countries as a consequence of global decisions.

3.2 Attributes of Multinational Firms in Sweden

Foreign direct investments have expanded rapidly during the past decade, primarily taking the form of acquisitions. In Sweden the globalization of MNE networks is reflected by a change from 3300 foreign-owned firms in the middle of the 1990s to 7800 in the beginning of the 2000s. Johansson and Lööf (2006) demonstrate important differences between domestic MNEs (DMNE) and foreign-owned MNEs (FMNE). Hence, the delineation of corporate structures considers the following subdivision:

- MNE firms divided into DMNE and FMNE
- Non-MNE firms decomposed into (i) non-affiliated firms (single-establishment firms), (ii) uninational firms (with more than one establishment, but all inside the country)

With these distinctions the presentation in Section 3.2 reports findings in Johansson and Lööf (2009) and Lööf (2007). The papers examine to what extent the location of FMNEs in a region affect the innovation intensity and performance of firms in that region. Moreover, the papers ask the question: how do knowledge flows differ between MNEs and other firms, and are there signs of technology transfers?

Corporate Structure and Regional Characteristics

To present an overview, Sweden is divided into three areas: (i) Stockholm region which is a functional (metropolitan) region proper, (ii) West Sweden which contains several functional regions including the metropolitan region Göteborg, and (iii) Rest of Sweden. Table 3.1 makes use of CIS data (Community Innovation Survey III) to show that the Stockholm region has a disproportionally large fraction of multinational firms, whereas the Rest of Sweden has a likewise disproportionally small fraction.

Table 3.1: Distribution of corporate structures in the sample of the study. Number of firms.

Corporate structure	Stockholm	West Sweden	Rest of Sweden	Total
Non affiliate	21.8	22.2	56.0	100.0
Uninational	23.8	18.4	57.8	100.0
DMNE	33.9*	21.0	45.2*	100.0
FMNE	21.8	22.2	56.0	100.0
All firms	**25.0**	**19.9**	**55.1**	**100.0**

Remark : * Disproportional. Source: Johansson and Lööf (2009)

One may conjecture that DMNEs favour locations in the Stockholm region because of its strong concentration of service supply and clustering of High-tech manufacturing activities. This phenomenon is illustrated in Table 3.2.

Table 3.2: Share of firms in different sectors and firm entry across regions in the sample

Sector groups and entry	Stockholm	West Sweden	Rest of Sweden	Total
Knowl. intense services	51.7**	14.7	33.6	100
Newly established firms	43.5**	18.4	38.1	100
High-tech manufacturing	32.5*	15.9	51.6	100
Other services	29.2*	22.1*	48.7	100
Low-tech manufacturing	14.9	23.9*	61.2*	100
High-medium-tech man.	11.8	22.7*	65.5*	100
Low-medium-tech man	9.4	16.9	73.7 **	100
All firms	**25.0**	**19.9**	**55.1**	**100**

Remark: ** Highly disproportional, * Disproportional. Source: Johansson and Lööf (2009)

Attributes of Innovative Firms

A major result from the study by Johansson and Lööf (2009) is that FMNEs in an unambiguous way renew the local economy when acquiring or replacing domestic multi-unit firms (uninationals). Compared to other types of corporate structure, FMNE firms do not seem to improve innovation characteristics of the local economy. The analyses control for location, and compares FMNE and DMNE firms with non affiliate and uninational firms, and it combines results from both parametric and non-parametric estimations. Moreover, the analysis uses the selection variable “innovative firms”, which refers to firms that report one or several of the following events during the most recent 3-years period: (i) product innovation, (ii) process innovation and (iii) innovation efforts.

A clear conclusion is that the attributes of innovative and non-innovative firms differ in a marked way. However, firms that are classified as innovative have a similar share of knowledge-intensive labour as well as share of innovation sales – irrespective of their

corporate structure. At the same time, DMNEs have in a distinct way larger R&D intensity and a much higher share of R&D staff (Table 3.3).

Table 3.3: Knowledge and R&D intensity and innovation sales across innovative firms.

	Non-affiliate	Uninational	DMNEs	FMNEs
Human capital[a]	21.2	19.1	21.1	18.0
R&D staff[a]	6.5	6.1	18.1	6.5
R&D intensity[b]	9.8	8.4	15.0	6.2
Share of innovative sales[b]	17.4	15.2	23.9	18.7

Remark: [a] Fraction of employment, [b] Fraction of sales. Source: Johansson and Lööf (2005)

Descriptive statistics indicate that FMNE firms collaborate more intensively than non-affiliate and uninational firms, but less than domestic multinationals. Swedish multinationals are characterized by having much higher collaboration shares than all other categories. This conclusion is especially clear with regard to vertical and global innovation interaction (Table 3.4).

Table 3.4: Collaboration within the innovation systems, across types of innovative firms. [a]

	Non-affiliate	Uninational	DMNEs	FMNEs
Scientific (Universities)	17.5	17.9	63.3	29.8
Vertical (Suppliers & customers)	25.4	23.4	82.2	34.6
Horizontal (Competitors)	17.7	18.4	54.8	24.5
Global (Outside Sweden)	16.1	16.1	82.2	35.9

Remark: [a] Fraction of innovative firms. Source: Johansson and Lööf (2009)

The results from two-step regression analysis are reported in Table 3.5, where the first step estimates the likelihood of being innovative, and where the second step estimates the character of the firms' innovation efforts.

All other things equal Swedish multinationals (DMNE) have a statistically significant higher R&D intensity than uninationals and FMNE firms have not. Another way that FMNE firms can fuel the innovation processes in the local economy is by participating actively in the various innovation systems. The reference is the innovation-system participation of uninational firms. Everything else equal, DMNE firms interact with higher frequency with actors in all three innovation systems (IS). The overall picture is clear: Among innovative firms, the DMNEs have a higher R&D intensity and collaborate more frequently in their R&D projects than all other corporate structures.

Table 3.5**: Type of inputs to the innovation process. Regression results**

Equation	(1) R&D intensity	(2) Collaboration within scientific IS	(3) Collaboration within vertical IS	(4) Collaboration in horizontal IS
Corp Struct				
DMNE	A+	A+	A+	A+
FMNE	+	+	B+	+
Non Affiliate	-	B+	B+	+
Uninational	Ref	Ref	-	Ref
Region				
Stockholm	+	B-	B-	-
West Sweden	-	-	-	+
Rest of Sweden	Ref	Ref	Ref	Ref

Remark: Significant at the <1% (A), <5% (B) and (C) <10% level of significance. Six sector dummies are included, where low technology manufacturing is used as reference. Number of observations is 2086, with 1015 censored observations. Source: Johansson and Lööf (2009)

With regard to the possible effects of location in the metropolitan region Stockholm there are two aspects to report. First, firms located in the Stockholm region are more likely to be innovative. Second, once the innovative firms have been identified, there is no positive Stockholm-specific effect on the R&D-intensity or on collaboration frequency when controlling for size, sector, human capital, and physical capital.

Regression result in Johansson and Lööf (2009) indicate clearly that FMNEs have a greater probability than uninationals to carry out product innovations and have a larger share of innovation sales than uninationals. But there is no such superiority in comparisons with DMNEs and non-affiliated firms.

In order to investigate the robustness of the results, Johansson and Lööf apply a semi-parametric matching approach on the innovative firms in the sample. For each FMNE firm, their matching estimators find a similar (i) uninational, (ii) non-affiliate and (iii) Swedish MNE firm, respectively. In this way three sets of pairs are formed, where each FMNE firm has a comparison "partner". When this is obtained we interpret the difference in their outcomes (attributes) as the effect of foreign ownership.

The results from the matching analyses are presented in Table 3.6, which shows that FMNEs tend to be inferior to non-affiliated firms except for global R&D collaboration. When the

comparison is maid with uninational firms, the FMNEs display more favourable results. The third column in the table compares FMNEs and DMNEs. The comparisons are never in favour of FMNEs

Table 3.6: Two sample t-test results based on Nearest neighbour matching

	FMNEs versus non-affiliated	FMNEs versus uninationals	FMNEs versus DMNEs
R&D and innovation			
Product innovation	B-	A+	C-
Process innovation	C-	-	-
Non-imitation innovation	A-	+	-
R&D intensity	+	C+	B-
Innovation sales	A-	A+	-
Collaboration on innovation			
Scientific in Sweden	+	A+	A-
Vertical in Sweden	+	A+	A-
Horizontal in Sweden	-	B+	-
Global	B+	A+	A-

Remark: Significance is marked as A for the 1 percent level, B for the 5 percent level and C for the 10 percent level, while + and – indicate the sign of the difference between pairs. Source: Johansson and Lööf (2009)

3.3 R&D and Knowledge Flows – Domestic and Global Sources

For MNEs with headquarters in OECD countries we can for some time observe an increasing share of the R&D efforts that take place abroad. The same trend applies to Swedish MNEs (ITPS, 2005). For many companies the globalization of R&D starts with a move of R&D operations that are related to developing products for the local market, and may then later move higher end research to selected centres as their home company grows and can take advantage of the economies of scale.

Since the major part of global R&D is invested within the giant MNE:s, the increased geographical dispersion of their technological knowledge (and production capacity as well) has brought about a surge in interest for R&D-spillovers within different branches of the literature with focus on issues such as (i) the geographical scope of technological progress, (ii) transmission of technology through trade, (iii) spillovers from foreign direct investment (FDI), (iv) R&D-collaboration and technology diffusion, (v) strategic alliances and inter-firm knowledge transfer and (vi) the importance of national, regional and local innovation systems. The main findings on spillovers from these and similar studies reveal three distinct features. There is robust evidence for strong influence of global sources at the aggregate level.

The global influence becomes weaker at the industry level and the findings on spillover using firm-level data are mixed.

With a sample of approximately two-thirds of Swedish MNEs as well as non-MNEs with at least 10 employees, Lööf (2009) finds that innovation output is an increasing function of the import value. The presence of FDI, however, expressed as foreign-owned firms is neutral with respect to innovation output. Among a subsample consisting of only multinational firms there is support for knowledge transfer to the local multinational firms from international collaboration networks that include foreign scientific partners and foreign subunits. Only some weak association is found between geographical proximity to local partners and innovation.

In order to remove ambiguities in the discussion of technology spillovers, we shall introduce and define the following three concepts: (i) technology, (ii) knowledge flows and spillovers, and (iii) diffusion and transmission. Technology is knowledge about "a complex system of machines, skills and workers all characterized by distinctive elements of complementarity, interoperability and necessary compatibility" (Antonelli, 2007). This type of knowledge is characterized by strong elements of non-excludability and limited appropriability. Knowledge flows include (a) voluntary knowledge transactions and (b) externalities in the form of unintentional technology spillovers (Grossman and Helpman, 1992). Transfer of technology (technological knowledge) can take the form of (a) intentional transmission on commercial conditions, and (ii) diffusion which may be involuntary just like spillovers. Thus, transmission comprises buying licenses, buying advanced intermediate technologies and flows within multination corporations. Strategic decisions as R&D-alliances, mergers and acquisitions, and R&D-collaborations are measures in order to reduce the cost or increase the efficiency of transmission. Finally, the absorptive capacity of firms decides the ability to access and convert transmitted and diffused knowledge into product and process innovations.

Technology flows are characterised by friction. Knowledge that is difficult to codify has been termed complex by Beckmann (1994), tacit by Polanyi (1966) and sticky by von Hippel (1994). While "complex" in a direct way refers to non-codified knowledge, "sticky" refers to knowledge that is strongly attached to given persons or groups of individuals. As argued by Antonelli, Marchionatti and Usai (2003), this may imply that knowledge can be shared by firms in a local environment with little risk that the knowledge is spread outside the local

context. A general assumption is that face-to-face contacts facilitate communication and transfer of complex knowledge.

A number of stylized facts on spillovers can be crystallized based on the empirical literature. First, variation in cross-country productivity is at least as much due to foreign as to domestic technology (Keller and Yeaple, 2003, Eaton and Kortum 1999, Keller 2002). Second, there is a broad agreement that trade as well as FDI is affected by spatial factors (Leamer and Levinsohn 1995, Caves 1996). Third, geographical proximity afforded by locating in large urban regions creates an advantage for firms by facilitating information and knowledge flows for innovation activities (Antonelli et. al. 2003). Fourth, there is robust evidence for strong influence of global sources at the aggregate level. The global influence becomes weaker at the industry level and the findings on spillover using firm-level data are inconsistent.

The distinction between generic versus tacit (or complex/sticky) separates knowledge in an economically important dimension. Our second distinction is between knowledge flows that are embodied in the delivery of advanced intermediate goods and disembodied knowledge flows that appear in the form of direct communication. This second consideration provides a complementary dimension which is useful for empirical analysis. Embodied spillovers are generally measured through international trade or input-output tables based on national statistics, while the stock or flow of FDI, patent, patent citations, R&D-alliances, and R&D collaboration are used in order to capture disembodied spillover. Below we summarize the main findings from some recent estimates on the measures of embodied and disembodied spillover that are of primary interest in this paper. The overview is organized into (i) embodied and (ii) disembodied knowledge flows (spillovers).

Embodied Spillovers via Import Flows

Several studies suggest that knowledge about product attributes as well as techniques and routines diffuses to firms in each separate country, embodied in import flows. There is also clear evidence that the origin of the import flow matters:

- Acharya and Keller (2007) find significant signs of international technology transfer, where technology embodied in import flows contribute to total factor productivity and

that this contribution often far exceeds the effect of domestic R&D on productivity. The study refers to the period 1973-2002 covering 22 industries and 17 countries.

- Eaton and Kortum (1995) study aggregate productivity growth since World War II in five leading research economies and find that growth is primarily the result of research performed abroad, channeled across borders through imports. In the U.S. foreign sources are estimated to account for 40 percent of the growth
- Studying technology in the form of product design that is transmitted to other industries through trade in differentiated intermediate goods, Keller (2001a) estimates that domestic R&D in the industry contribute to 50 percent of an industry's productivity growth, while 30 percent of the growth is due to R&D. The examined period is 1970-1991, using industry level data for about 65 percent of the world's manufacturing output and most of the world's R&D expenditures

Disembodied Spillovers due to FDI Flows, R&D Collaboration and Proximity

Do FDI investments generate knowledge flows and technology spillovers in the host country or in the country from which the FDI flow originates? To this question the literature offers contradictory answers:

- Potterie and Lichtenberg (2001) find that inward FDI does not have an impact on the productivity of the host country, whereas outward FDI into R&D intensive countries is a significant source of technology spillovers. Bitzer and Kerekes (2005) come to the opposite conclusion, partly with new data.
- Keller and Yeaple (2003) as well as Branstetter (2006) find that a country benefits positively both from inward and outward FDI flows.
- Aitken and Harrison (1999) and Ebersberger and Lööf (2005) cannot find any positive impacts.

Obviously, R&D collaboration is an activity that potentially could bring about disembodied knowledge flows. However, a small set of studies report insignificant effects, e.g. Brouwer and Kleinknecht (1996), Paananen and Kleinknecht (2007), Fristch and Franke (2004), and Lechevalier, Ikeda and Nishimura (2006). The remaining source of technology spillovers is spatial proximity. In this case there are several studies which report proximity effects, e.g. Jaffe and Trajtenberg (1998), Sonn and Stolper (2003), and Keller (2001b), among others.

The basic problem with these and other studies is that proximity is defined and measured in ad hoc fashions, without a theoretical underpinning (Andersson and Gråsjö, 2009).

Knowledge Flows for Swedish MNEs and Non-MNEs

A detailed analysis of knowledge flows can be found in a study by Lööf (2009) is based on data from the Community Innovation Survey (CIS) IV for Sweden. The survey was conducted in 2005 and covers the period 2002-2004. The rate of response was close to 70 percent. It covers both manufacturing and business service sectors. The original sample contains 3,094 firms. The information on innovation activities from the survey has been supplemented with register data on sales, value added, wages, physical capital, human capital, employment, export, import and corporate structure from Statistics Sweden for the firms in question.

Table 3.7 presents descriptive statistics referring to MNE and non-MNE firms in Sweden for the period 2002-2004. The two groups of firms are characterised with regard to (i) knowledge transfer via collaboration, (ii) knowledge transfer via FDI and trade, and (iii) other characteristics. The groups are fairly similar with regard to other characteristics, whereas the frequency of knowledge flows are much higher for MNE firms. Bold types are applied to mark cases where the MNE variable is more than 50 percent higher than for other firms.

The regression results in Lööf (2009) show that the presence of inward FDI *per se* is neutral with respect to innovation output, that is, no difference can be found between foreign and domestic MNEs with respect to innovation sales. When considering the coefficients for imports, a pattern emerges in these coefficients, showing that spillovers from imports contribute significantly to innovation productivity. Note also that the estimated impact is highly significant for MNEs as well as for non-MNEs.

The typical innovative non-MNE is considerably less oriented towards the global market than its MNE counterpart. More interesting is a positive and significant correlation for non-MNE firms between innovation sales and customers and suppliers. These firms are smaller and less knowledge intensive in terms of human capital and R&D than the MNEs, and they are hence more dependent on external knowledge received through market transactions.

Table 3.7: Descriptive statistics of knowledge flows for Swedish MNE and non-MNE firms

	MNE n = 611	Non-MNE n = 408
	Mean	Mean
Performance variable		
Log innovation sales per employee	12.44	12.05
Knowledge transfer via collaboration		
Global		
Within the group	36 %	–
Scientific	16 %	4 %
Vertical	41 %	23 %
Horizontal	23 %	8 %
Domestic		
Within the group	23 %	8 %
Scientific	39 %	22 %
Vertical	49 %	39 %
Horizontal	38 %	24 %
Knowledge transfer via FDI and trade		
FDI	0.45	0.00
Log import/emp	17.13	10.91
Log export value/emp	17.41	10.88
Other characteristics		
Log R&D/ emp	10.59	10.31
Wages	5.79	5.67
Human capital	0.33	0.30

Log firms size	4.78	3.22
Log mach. inv/emp	9.63	9.07
Market [2]	0.27	0.08
Log export value/emp	17.41	10.88
Debt/(debt+equity)	0.66	0.70

Remark: Market is a dummy variable indicating if Export/sales > 0.5.

Lööf considers the effect of R&D collaboration in some detail and investigate 50 possible network arrangements between the local firm and various innovation partners. The main result is that when the network is restricted to local (domestic) partners, no spillover effect can be established. In contrast, when the network includes a foreign subunit and a scientific partner, the likelihood of successful technology transfer increases considerably. In fact, all six networks, that include the local multinational firms, a foreign subsidiary and a foreign scientific partner, correlate positively with innovation performance. It is also shown that the benefit of collaborating with local scientific, vertical and horizontal partners increases considerably when a foreign subunit and a foreign university are included in the arrangement. Finally, the possibility of spillover from foreign customers, suppliers, competitors and consultants is entirely dependent on assistance of a foreign firm within the group.

Together with the literature assessments, the study by Lööf suggests the following conclusions:

(1) There is robust evidence that FDI, observed as foreign-owned firms, is neutral with respect to innovation output. No difference can be found in innovation output between foreign-owned MNEs and domestically owned MNEs.
(2) Technology transfer through imports correlates highly significantly with innovation product sales among MNEs as well as non-MNEs.
(3) The evidence for spillover from R&D collaboration with *domestic* innovation partners is weak when bilateral arrangements are considered. Only non-MNEs collaborating with local, regional or national suppliers and customers benefit from the collaboration.
(4) When multilateral R&D arrangements are taken into account it is shown that R&D-collaborators have higher innovation inputs than non-collaborators.
(5) When the collaboration network includes a foreign subunit and a scientific partner, the likelihood of successful technology transfer increases considerably.

3.4 Innovativeness of MNEs and Agglomeration Impacts

The preceding subsection addresses proximity as one cause of knowledge flows that can influence the innovativeness and innovation outcome of individual firms. This issue can be approached from a different angle, recognizing that in a large urban region any individual firm has close (time) distances to many other economic actors. Based on this observation, we will consider two basic aspects of proximity: (i) low communication friction inside the network of an MNE, and (ii) large accessibility to R&D activities of other firms and research organizations inside an urban agglomeration.

Johansson, Lööf and Olsson (2009) examine how corporate ownership and structure and location influence innovation activities among firms in Swedish regions. They attempt 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. With this background, the study asks the following question: how does (i) *corporate structure* and (ii) *location* affect innovation efforts and innovation results. Among innovation efforts it focuses on innovativeness, R&D intensity and interaction in innovation systems. The innovation results that are highlighted comprise innovation sales, total sales per employee and value added per employee.

The location effect is examined by considering location in the Stockholm metropolitan region versus other locations. The Stockholm region is Sweden's largest metropolitan region, and is integrated in such a way that diverse and frequent face-to-face contacts are possible, which facilitates knowledge flows that can stimulate innovation activities and knowledge interaction.

Table 3.8: Probability of being innovative. Regression results from five different models

	(1)	(2)	(3)	(4)	(5)
	Propensity to be an innovative firm	**R&D and other innovation input per employee**	**Collaboration on innovation within different systems of innovation**		
			Scientific	**Vertical**	**Global**
Regions					
Stockholm	**A+**		**A-**	**B-**	
Regions II-IV					
Other Sweden	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**
Corp Structure					
Multinational	**A+**				
- Domestic		**A+**	**A+**	**A+**	**A+**
- Foreign				**B+**	**A+**
Non Affiliate			**B+**	**B+**	**A+**
Uninational	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**

Remark: Significant at the 1% level (A) and 5% level (B). (+) Positive correlation, (-) Negative correlation. Ns=non-significant. II = East central, III= South and IV = West. Source: Johansson, Lööf and Olsson (2005)

The analysis starts with a probit model to examine innovativeness. The regression results (Table 3.8) show that the likelihood of being an innovative firm is higher when the firm is located in the Stockholm region, when controlling for Schumpeterian variables such as corporate structure, human capital, firm size, and high-technology classification. From the same regression the study also concludes that multinational firms have larger probability of being innovative, when controlling for location and the other Schumpeterian variables. Thus, the results are in concordance with previous findings, while adding the influence from location and corporate structure.

The table reveals the firms in the metropolitan region are more likely to be innovative, but the R&D intensity of innovative firms is not significantly different in any of the regions. However, DMNEs are different in a distinct way by having both a particularly high R&D intensity and a higher frequency of innovation collaborations.

Table 3.9: Regressions of innovation outcome on firm attributes and location

	(1)	(2)	(3)	(4)
	Non-Imitation **innovations**	**Innovation sales/ per employee**	Total sales per **employee**	Value added per **employee**
Regions				
Stockholm		**A+**	**A+**	**B+**
Region II-IV				
Other Sweden	**Ref**	**Ref**	**Ref**	**Ref**
Corp Structure				
DMNE	**A+**	**B+**		
FMNE				
Non Affiliate	**A+**		**B-**	**B-**
Uninational	**Ref**	**Ref**	**Ref**	**Ref**

Remark: Significant at the 1% level (A) and 5% level (B), (+) Positive correlation, (-) Negative correlation. Ns=non-significant. II = East central, III= South and IV = West. DMNE = Domestically owned multinational, FMNE = Foreign owned multinational. Source: Johansson, Lööf and Olsson (2005)

There are two metropolitan effects in the study of Swedish MNEs and non-MNEs. The first is a higher propensity of firms to be innovative in the Stockholm region. The second effect is that the economic consequences of innovation activities are more favorable for firms located in the Stockholm region as described in Table 3.9. These results have been obtained with the help of a generalized Tobit model with two steps, where the first is a selection equation and the second a performance equation. The table reports on the estimated coefficients in the second equation and suggest that we can associate a metropolitan effect with the Stockholm region, such that (i) innovation sales (sales of new products as a share of total sales), (ii) total sales per employee, and (iii) value added per employee are all significantly higher in the metropolitan region.

Besides the metropolitan effect, Table 3.9 also shows that domestic MNEs differ from FMNEs. The dummy variable for DMNE firms has a positive and significant parameter with regard to both non-imitation sales and innovation sales per employee. A reasonable

interpretation is that sales of FMNE firms comprise products developed outside Sweden. Nevertheless, R&D efforts in FMNEs in Sweden generate less revenue than does R&D in DMNE firms.

With regard to the metropolitan effect on the likelihood of being innovative, are there any additional observations which can illuminate this effect? To see this, we consult a study by Gråsjö (2006), which reveals that the Stockholm region is a host for about 25 percent of the country's labor force, more than 40 percent its company as well as university R&D in man years and almost 40 percent its knowledge labor (with at least 3 years of university education). With this as a background, we emphasise the following conclusion: For a firm with given firm attributes, the likelihood of being innovative is greater when the firm has Stockholm as the host region, whereas the same location does not increase the probability of interacting in local innovation systems.

4. Innovation Strategy, Corporate Structure and Agglomeration

4.1 Innovation strategy of firms

The pre-conditions for a firm's innovation behavior and outcome include (i) attributes of the firm and (ii) the regional milieu of which the firm is a part. Given such conditions, one may compare the innovation strategy of individual firms and examine how strategic choices influence the innovation outcome.

In response to the above recognition, Johansson and Lööf (2008) suggest that firms can be distinguished by the innovation strategy they chose. First, a firm can decide to carry out R&D investments on a persistent basis, and thereby cumulate R&D results as well as routines for R&D efforts. A second alternative is to initiate R&D projects occasionally and a third option is to completely abstain from systematically organised R&D efforts A persistent innovation strategy may reveal itself in accumulated R&D results, often referred to as R&D stock. However, it also implies a learning process, in which the firm develops routines for performing R&D as well as experience in how to commercialise R&D results. The assumption is that the size of R&D investments is one dimension of an innovation strategy, while the persistence in the efforts is a second dimension.

A second consideration in Johansson and Lööf (2008) is that the regional milieu may influence the impact of a firm's R&D strategy. In this context, region refers to a functional urban region, which signifies an area in which the likelihood for face-to-face contacts is much higher than inter-regional contacts (Johansson and Lööf, 2008). Functional regions are frequently proxies by labour market regions (Johansson and Kasson, 2007).

The literature (e.g. Etzkowitz and Leyersdorf, 2000; Antonelli et al, 2003), recognises positive effects from firms' local interaction with private and public research institutions. However, the regional milieu has also consequences for the development of entrepreneurial knowledge and experience in commercialisation of R&D results. In view of this, the consequences of a firm's innovation efforts may be influenced by urban agglomeration characteristics. When this is the case, R&D impacts on firms' productivity and profits will vary in response to location characteristics.

Table 4.1 provides a map showing how the attributes and location of firms differ for the three categories of firm strategies (i) no R&D, (ii) occasional R&D and (iii) persistent R&D. The data are collected from a set of manufacturing firms in Sweden, with 10 or more employees in a representative sample from Community Innovation Survey (CIS) IV. The survey took place in 2005, and it covers the period 2002-2004. The rate of response was close to 70 percent. To obtain the full data set the authors have merged the survey data with information from a Swedish database, which contains information about all firms in Sweden including sales, profitability, value added, capital structure, intermediates, gross investment, educational data, corporate ownership structure information, trade statistics, patent data, as well as location characteristics. As can be seen from the table the total number of manufacturing firms in the data set is 1767.

The table shows that firms with persistent R&D have larger R&D investments, value added and gross profit per employee than other firms. The same group of firms is dominated by MNE firms (68 percent). Moreover, the firms in the group have on average 10 times as many persons classified as knowledge labor.

Table 4.1: Firm attributes and location for firms arranged in strategy groups

	Non R&D firms	R&D Occasionally	R&D Continuously
	N=762	N=535	N=470
	Mean	Mean	Mean
R&D investments [a]	0	70	111
Dependent variables			
Value added [a]	514	525	664
Gross profit [a]	239	250	353
Regions			
Stockholm	0.157	0.108	0.148
Goteborg	0.106	0.069	0.117
Malmo	0.061	0.063	0.061
Rest of Sweden	0.674	0.758	0.672
Corp Structure			
Non Affiliate [c]	0.378	0.287	0.143
Uninational [c]	0.329	0.305	0.170
Domestic MNE [c]	0.147	0.185	0.364
Foreign MNE	0.144	0.287	0.321
Controls			
Physical investments [a]	1,171	1,113	1,624
Ordinary labour	87	80	385
Knowledge labour	7	6	84
High technology [c]	0.066	0.076	0.145
High medium tech. [c]	0.228	0.249	0.357
Low medium tech [c]	0.260	0.271	0.221
Low technology [c]	0.444	0.402	0.275

Remark: (a) Per employee, in 1000 Swedish Crowns. (c) As a fraction of all firms. Source: Johansson and Lööf (2008)

To further characterize the firms with a persistent and non-persistent innovation strategy, we shall present two regressions, using the data set presented in Table 4.1. The first regression considers location and the second corporate structure. Results from the first regression are presented in Table 4.2, which shows two basic things. First, productivity and profitability measures are both significantly higher for firms with persistent R&D investments. Second, the location of a firm in the Stockholm metropolitan region has a positive and significant impact on both productivity and profitability. Hence, it is more rewarding to employ a strategy with persistent R&D efforts in the metropolitan milieu.

Table 4.2: Influence from R&D-strategy and metropolitan milieu on productivity And profitability

	Productivity	**Profitability**
Non –R&D	Ref	Ref
R&D Occasionally		
R&D Persistent	A+	A+
Regions		
Rest of Sweden	Ref	Ref
Stockholm	A+	B+
Goteborg	B+	
Malmo		
Observations	1767	1712

Remark: Significant at the 1% level (A) and 5% level (B), (+) Positive correlation, (-) Negative correlation. Source: Johansson and Lööf (2008)

Table 4.3 presents regression results from specifications using corporate structure as an explanatory factor. The results are straightforward. Firms that belong to an MNE group have significantly better outcome both in terms of productivity and profitability.

Table 4.3: Influence from R&D-strategy and corporate structure on productivity and profitability

	Productivity	**Profitability**
Non –R&D	Ref	Ref
R&D Occasionally		
R&D Persistent	A+	A+
Corp Structure		
Uninational	Ref	Ref
Non affiliate		
Domestic multinational	A+	A+
Foreign multinational	A+	A+
Observations	1767	1712

Remark: Significant at the 1% level (A), (+) Positive correlation, (-) Negative correlation. Source: Johansson and Lööf (2008)

4.2 Patenting, Trade and Corporate Structure

Despite broad agreement on the strategic role of SMEs (Small and Medium Sized Enterprises) in industrial renewal processes, the lack of systematized and comprehensive information on the nature and level of small innovative firms is striking. This bias is partly explained by an empirical shadow created by the limited availability of good, detailed data for comparable firm-level analyses. Based on extensive, matched databases, Andersson and Lööf (2009) provide new insights into the roles of micro and small innovative firms in research-based as well as tradition-based manufacture, while contrasting SMEs and MNEs. The data consists of

close to 160 000 observations of manufacturing firms in Sweden over the period 2000-2006, including information on innovation activities captured by patent applications, firm characteristics, international trade and the regional milieu.

The standard decomposition of corporate structure is applied with a focus on the following three categories: (i) uninationals, (ii) DMNEs) and (iii) FMNEs. Following the previous analysis, the ambition is to detect differences between non-MNEs and MNEs as well as between DMNEs and FMNEs with regard to technological diffusion and innovation. Swedish MNEs can also be expected to have a distinct role in the Swedish "innovation system", since they tend to concentrate their R&D-investments domestically.

The data source used in Andersson and Lööf (2009) covers the period 2000-2006, and the data set is unbalanced. In total 34,742 firms have been observed, of which 40 % are in the sample for all seven years. About 80 % of the firms are observed for three years or longer. Five sources of data have been matched, based on a unique identification number of each firm. The basic data set contains compulsory and audited register information on firm characteristics based on annual reports for all firms in Sweden. This data has been merged with data on (i) educational statistics, (ii) trade statistics, (iii) regional characteristics and (iv) patent applications. All the data originates from Statistics Sweden, the Swedish Customs Office and the Swedish Patent Office (PRV).

Table 4.4 presents the summary statistics of key firm attributes over the period 2000-2006, and most of these variables have been discussed in preceding sections. Two elements are novel. The first novelty is that the patenting activity of firms is recorded, including information about the number of patents associated with each firm. The second novelty is the inclusion of information about the export and import activities of firms, and this information is assumed to reflect knowledge flows. Special attention is paid to each firm's trade with the G7 countries.

Table 4.4: Attributes of patenting firms over the period 2000-2006

	1-10 Emp		11-25 Emp		26- Emp	
	All	Pat	All	Pat	All	Pat
Observations	112,684	374	22,812	261	22,298	1,315
Patent applicants[1]	0.3 %	100 %	1.1%	100 %	5.9%	100 %
Patent applications[1]	<0.1	1.3	0.2	1.3	0.3	5.1
Regions						
Stockholm[1]	19.8	21.0	14.4	17.6	11.0	14.9
Gothenborg[1]	9.8	10.8	8.8	5.7	8.4	9.4
Malmo[1]	6.1	5.4	5.8	4.6	6.2	7.3
Emp-share in LA region[1]	11.2	10.9	12.5	11.4	13.8	13.5
Corp Structure						
Non-affiliate[1]	82.5%	67.2%	49.2%	36.4%	14.9%	6.0%
Uninational[1]	14.1%	18.5%	35.7%	31.4%	28.8%	7.7%
Swedish MNE[1]	1.9%	10.0%	9.3%	23.8%	31.8%	49.5%
Foreign MNE[1]	1.5%	4.3%	5.8%	8.4%	25.5%	36.8%
Employment	3.7	4.3	16.2	17.3	170.3	617.2
Ordinary labour	3.5	3.3	15.4	15.1	148.4	488.7
Knowledge labour	0.2	1.0	0.8	2.2	21.9	128.5
Profit margin	4.6 %	5.1 %	2.5%	3.1%	2.7%	6.5%
Short term debt per emp[2]	25.1	45.5	28.8	44.1	39.5	65.5
High technology[1]	6.8%	22.6%	5.4%	16.4%	6.1%	16.9%
High med. Technology[1]	16.7%	32.0%	21.1%	38.3%	29.2%	46.8%
Low med. Technology[1]	33.5%	29.0%	35,6%	31.0%	30.5%	24.7%
Low technology[1]	43.0%	16.4%	37.8%	14.1%	34.2%	11.6%
Share ofG7-export[1]	3.3	19.9	10.6	27.5	24.5	39.8
Number of export countries	0.7	3.0	3.4	12.6	14.7	36.5
Share of G7-imports[1]	5.7	21.9	14.6	31.0	30.7	46.0
Number of import countries[1]	0.5	1.5	1.9	4.3	7.9	17.4
Exports and imports[1]	12.4	45.4	41.5	74.3	78.7	96.5

Remark: (1) Fraction, (2) 1000 Euros

The sample is separated into three size-classes: 1-10 employees, 11-25 employees and more than 25 employees. Several things stand out. First, the fraction of patent applicants differs considerably across the size-classes. While only 0.3 % of the micro firms applied for one or more patents during the period, the corresponding fraction for the group of the largest firms (more than 25 employees) is 6 %. Second, within the three size-classes, patenting firms have 3-5 times more skilled labour than non-patenting firms. Third, innovative firms (all size classes) are more profitable and have better access to bank loans. Fourth, a considerably

larger fraction of patent applicants is associated with a Swedish MNE compared to non-patenting firms. Finally, the table also reports descriptive statistics for regional characteristics over the period 2000-2006. Surprisingly, it is shown that patenting firms are not overrepresented in the three metropolitan regions of Sweden. Moreover, the statistics associated with the variable 'Emp-share in LA region', which measures the size of the sector in the region where the firms are located, also suggest that patenting firms are not overrepresented in regions where the sector to which the firms belong is large.

With regard to patenting firms in the largest size class we observe the following pattern:

- More than 85 percent of these firms are MNEs
- These firms are much larger than other firms
- These firms have a much larger share of their trade with the G7 countries, which indicates more frequent interaction with those countries that represent the most important knowledge sources in the world economy.
- These firms have a much larger number of knowledge labour (with at least 3 years of university education) than other firms.

A major observation by Andersson and Lööf (2009) is a feature of persistency or temporal invariance. The study demonstrates the following persistency in the sample from year to year: More than 99% of small and large firms that *did* not apply for a patent one year did not apply the next. Looking then at *the applicants*, 50% of the firms with more than 25 employees that applied one year also applied the next year. The corresponding figure for micro firms is 17%. In brief, the patenting and the non-patenting firms form two distinct groups – and these groups remain intact over time.

Table 4.5 reports on two alternative estimations of firm attributes that affect the probability of a firm applying for a patent. For smaller firms, with less than 6 employees, the share of knowledge labor has a significant impact on patenting. For firms in the largest size class, the size of the profit margin is correlated with patenting efforts. The table also confirms findings reported in previous sections, namely the augmented likelihood for DMNE firms to carry out R&D. The same relation applies to patenting, which means that small firms that belong to a DMNE group are more likely to apply for patents. With regard to FMNE firms, the propensity to patent is present only for large firms. This suggests an international technological diffusion.

Table 4.5 Estimation of probability of patent application, basic model

Model	Logit			Negative binominal		
Dependent variable	Application dummy			Number of applications		
Firm size	1-10	11-25	26-	1-10	11-25	26-
Profit margin			A+			A+
Short Debt						
Phys cap						
Knowledge labour	A+	A+	C+	A+	A+	
Ordinary labour		C+	A+		C+	A+
UninationalI[1]			C-			B-
DMNE[1]	A+	A+	A+	A+	A+	A+
FMNE[1]			A+			A+
Observations	112 684	22 812	22 298	112 684	22 812	22 298

Remarks: Significant at the 1% level (A), 5% level (B) and 10% level (C) , (+) Positive correlation, (-) Negative correlation, (1) Reference is domestic non-affiliated firms. Year dummies and industry dummies included

The results for the smaller firms are interesting. Affiliation to a DMNE increases the innovation capacity. MNEs tend to concentrate their R&D activities in the home country partly because of strong complementarities between the knowledge base of the MNE and the technological competencies of the "innovation system" in the home country (Patel and Pavitt 1991). Naturally, this system of innovation includes small innovative firms. Given that MNEs often buy small innovative firms in order to acquire knowledge and technology, we interpret the results as a confirmation that domestic MNEs are better equipped than foreign MNEs to scan the Swedish market and accumulate information about small innovative firms as potential members of their corporate group. Notably, membership in a uninational group is negatively associated with national patent application.

5. Summary and Conclusions

In this paper we draw attention to the issue on globalization, localization, innovation and growth by a systematic analysis of how attributes of MNEs and non-MNEs differ, and how these differences affect innovativeness, productivity and export intensity. We report results from a series of studies based on extensive Swedish firm-level data.

The presentation has a two-pronged approach by recognizing both agglomeration and corporate structure, emphasizing how they facilitate knowledge flows and generation of innovation ideas. Thus we ask: how do agglomeration economies influence innovation, productivity and export performance. At the same time we investigate whether non-multinational firms can harvest benefits from local tacit knowledge, non-traded local specialized inputs and skills, and the presence of multinationals by locating in large urban agglomerations. The answer on both questions are Yes, but in the case of small firms, close relationship to multinational forms (MNEs) are of large importance.

There are two metropolitan effects in the study. The first is a higher propensity of firms to be innovative in the Stockholm region which is the only metropolitan region proper in Sweden. The second effect is that the economic consequences of innovation activities are more favorable for firms located in the Stockholm region in term of innovation sales (sales of new products as a share of total sales), total sales per employee, value added per employee and exports as well are all significantly higher in the metropolitan region.

Many small firms in large urban regions perform excellent in terms of R&D intensity, innovativeness and sales. These small firms are characterized by belonging to an MNE company group. Importantly, a difference can be distinguished between domestically and foreign owned multinational firms. The Stockholm region has a disproportionally high presence of MNEs because of its strong concentration of service supply and clustering of high-tech manufacturing activities. The results for the smaller firms show that affiliation to domestically owned MNEs increases the innovation capacity. Among innovative firms, the domestically owned MNEs have a higher R&D intensity and collaborate more frequently in their R&D projects than all other corporate structures. Moreover, domestically owned MNEs tend to concentrate their R&D activities in the home country partly because of strong complementarities between the knowledge base of the MNE and the technological competencies of the “innovation system” in the home country. Naturally, this system of innovation includes small innovative firms.

The paper also reports the returns to innovation efforts and other investments are positively influenced by firms’ capability to exploit extended markets. All these phenomena can be

theoretically explained by MNE's capacity to coordinate global supply chains and orchestrate localized R&D activities and knowledge flows.

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