CESIS
Electronic Working Paper Series

Paper No. 22

Multinational Enterprises, Spillovers, Innovation and Productivity[1]

Bernd Ebersberger and Hans Lööf

(ISI, KTH)

November 2004

The Royal Institute of technology
Centre of Excellence for Science and Innovation Studies
http://www.infra.kth.se/cesis/research/publications/working papers
Corresponding author: hans.loof@infra.kth.se

[1] Status of the paper: The paper has been submitted for publication.

Multinational Enterprises, Spillovers, Innovation and Productivity[2]

Bernd Ebersberger[♣] and Hans Lööf [♠]

November 22, 2004

Abstract[3]

Recent debate has focused on the importance of corporate governance, localization of headquarters, foreign direct investments, externalities and key actors in national innovation systems and productivity. This study explores whether foreign-owned multinational firms differ systematically from domestic firms in terms of R&D-investments, transmission of technological knowledge and economic performance. The econometric analysis is based on a sample of 1 197 firm-level observations in Sweden, of which approximately a third from firms with foreign owners. The main finding is that domestic multinational firms are distinct from Nordic, Anglo-Saxon and European and other groups of corporate owners in terms of R&D investments and embeddedness in scientific, vertical and horizontal innovation systems. However, the advantage of higher R&D intensity and possible knowledge technological knowledge spillover does not manifest itself in superior innovation output or productivity performance. Our tentative explanation is that domestic multinationals are using the home country for developing technological capacity that is subsequently exploited in affiliates abroad. Correspondingly, the innovation and productivity performance in foreign multinationals are partly returns on activities created in their home countries.

Keywords: Multinational Enterprises, Spillovers, R&D, Innovation, Productivity

JEL Classification: C31; D21, F23; G34; O31

---

[2] The authors wish to express their gratitude to Åke E. Andersson and Börje Johansson, Jönköping International Business School, Sweden and Amy Rader Olsson, Royal Institute of Technology Centre for Banking and Finance, for their input and comments.

[♣] Technology Analysis & Innovation Strategies, Fraunhofer Institute for Systems and Innovation, Research, Breslauer Str. 48, D-76139 Karlsruhe, Germany, Phone: +49 721 6809 134
Fax: +49 721 6809 260, E-mail: b.ebersberger@isi.fraunhofer.de, Internet: www.isi.fhg.de

[♠] Royal Institute of Technology, Centre of Excellence for Science in Innovation and Studies, Department of Infrastructure, Drottning Kristinas väg 30B, SE-10044 Stockholm, Sweden, Phone: +46 8 7908012
Tele-mail: hans.loof@infra.kth.se

1. INTRODUCTION

This paper seeks to assess whether foreign owned firms systematically differ from host country firms in terms of R&D-investments, transmission of technological knowledge and economic performance. Together, domestic and foreign owned multinationals play a significant role in the Swedish economy though their share of total number of firms in the business sector is only 3 percent. ITPS (2003) report that the multinational enterprises in Sweden accounted for 46 percent of overall business sector employment and tangible investment in 2000, and 53 percent of value added, and 92 of export and almost all (96 percent) of Sweden's industrial R&D.[4]

The main justification for the study is the growing importance of multinational firms and foreign direct investments (FDI) as well as recent debate on the importance of corporate governance, the localization of headquarters, cross-border moves of jobs, externalities and the roles of various key actors in national innovation systems.

Between 1990 and 2001, production in enterprises located outside the owners' country of residence increased from 6 to 11 percent of world output. Export from foreign affiliates of multinational corporations represents more than a third of world trade. The literature suggests that the rising trend of foreign direct investments to a large extent reflects increasing and acquisition and mergers in general, rather than a more internationalized economy. The United Nations (2000) reports that the cross-boarder share of total acquisition and mergers has been relatively constant since the late 1980s.

The theoretical literature suggests some alternative and complementary hypotheses as to why firms invest in R&D activities abroad. One has to do with opportunities to exploit technological activities created within the home country. A second hypothesis concerns the exploitation of technological advantages of the host country. A third hypothesis emphasizes the increasing complexity and specialization of technology.

Recent empirical findings on the importance of foreign firms indicate that they generally have higher productivity and pay higher wages than local firms, but no robust evidence has been found on knowledge spillover from foreign firms to domestic firms or whether foreign takeovers imply a net contribution for the general growth rate or level of employment in the host country.

Proposed explanations for observed differences in productivity between domestic and foreign firms include the possibility that foreign companies tend to purchase firms with superior

[4] Fors and Svensson (2002) report corresponding figures for the Swedish economy in beginning of the 1990s. These figures are somewhat lower, which indicates that the importance of multinational has increased during the recent decade.

technology or productivity or that they focus on sectors with high productivity. Foreign firms that establish a presence in a country through the purchase of an existing firm may also benefit from the positive effects of mergers and acquisitions per se or efficiencies due to scale production, specialization or global coordination.

The present study is based on a sample of 1 197 firm level observations in Sweden, of which approximately a third have foreign owners. The data is obtained from the third wave of the Community Innovation survey, launched in 2001 for the years 1998, 1999 and 2000. In line with the business literature we assume that corporate governance styles affect firms' innovation strategies. In order to explore differences and similarities we have grouped the firms into five different categories. The first category is a reference group of Swedish uninational firms, i.e., firms belonging to a group but with no foreign affiliates. The second category is Swedish multinational firms. The third category consists of Nordic firms excluding the domestic firms. Category four is Anglo-Saxon-owned corporate groups, including UK-owned, US-owned, Irish, Canadian and South African corporate groups. Finally, all other home countries in the sample are grouped into the category "European and others," where European countries clearly dominate.

The empirical analysis explores 12 hypotheses on differences between domestic and foreign firms The first part considers the likelihood of engagement in innovation activities, the amount of R&D investment, government R&D subsidies, embeddedness in national innovations systems and the importance of internal knowledge flow between different firms and establishments of the group. The second part concerns innovation output and economic performance.

The research methodology used can be separated into three sequential steps. Initially a descriptive analysis is carried out on the basis of the data. Then, a selection model and appropriate control variables are introduced. The objective is to control for sample section bias and firm heterogeneity. That is, we study control for the likelihood that R&D firms constitute a particular group of companies and firms with specific characteristics such as firm size, export, human capital, physical capital, establishment and merger. Finally we consider a four-equation production function model that relates various determinants to research, research to innovation output and innovation output to labor productivity.

The main finding is that domestic multinational firms are distinct from Nordic, Anglo-Saxon and "European and other" groups of corporate owners when R&D investments and embeddedness in scientific, vertical and horizontal innovation systems are considered. However, the advantage of higher R&D intensity and possible technological knowledge

spillover does not manifest itself in superior innovation output or productivity performance. Our tentative explanation 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.

The remaining part of this paper is organised as follows. Section 2 briefly reviews some important theoretical and empirical papers on knowledge diffusion and the university/industry link. Section 3 delineates the data. Section 4 introduces the methodological approach. Section 5 states the empirical results, and Section 6 offers some conclusions.

2.A BRIEF REVIEW OF THE LITERATURE

Foreign-owned firms are by definition multinational firms whose holdings in another country are a result of foreign direct investments, FDI. Over the last decades FDI flows have increased dramatically (see, for example, Barrios et al 2004). Lipsey (2002) gives quantitative data for this development: between 1990 and 2000 production from foreign direct investment (production in enterprises located outside the country of residence of the owners) increased from 6 percent to a little over 10 percent of total world output. Statistics from UNCTAD (2002) indicate that this process, which Antràs and Helpman (2003) identify as a growing specialization of production, is continuing and reached 11 percent of world GDP in 2001. Export from foreign affiliates of multinational corporations represent more than a third of total word trade (Grossman et al 2003).

FDI, which is distinguished from portfolio investment in that FDI implies a greater degree of foreign control, can include acquisitions and investment in new establishments. There are indications in the literature that the rising trend of FDI to a large extent reflects increasing trends in acquisition and mergers in general, rather than a more internationalized economy. Citing a United Nations study, (2000), Lipsey (2002) reports that the cross-border share of total acquisition and mergers in the world economy has been relatively constant since the late 1980s. Moreover, the literature suggests that foreign acquisitions far exceed new establishments. U.S. data (Feliciano and Lipsey 2002) show that between 1988 and 1998, outlays for acquisitions accounted for 83% of outlays for acquisitions and new establishments. The Swedish Institute for Growth and Policy Studies (ITPS) presents more or less identical figures. During 1996 and 2000 acquisition accounted for 77% of the establishment of foreign ownership in Sweden and additional 6% was the result of mergers.

Investigating determinants of foreign direct investments, Helpman et al (2003) and Melitz (2003) suggest that low-productivity firms serve only the domestic market while high-productivity firms also serve foreign markets; less productive firms export while more productive firms engage in foreign direct investment.

Multinational firms have pursued a multitude of strategies for international expansion, as described in the Word Investment Report (UNCTAD, 1998) and cited by Yaeple (2003). Firms have opened foreign affiliates to perform activities ranging from R&D to after-sales service, and including production of parts and components, assembly, and wholesale and retail distribution, among others. In particular foreign direct investments in R&D activities have been a subject of increased interest in academic literature as well as in policymaking circles. One hypothesis is that foreign-owned firms possess superior technology and that some technological knowledge spills over to the host country firms (Lipsey, 2002). Spills over to host country firms with ensuing economic benefits?

Serapio and Dalton (1999) report that growing FDI investments are closely associated with growing multinational involvement in R&D by foreign affiliates. In recent literature large multinationals are characterized as being the main drivers for the globalization of R&D and innovation activities. (See for example Garybadze and Reger, 1999). However, Patel (1995) has shown that one of the main mechanisms for this globalization of R&D is merger and acquisitions.

Archibugi and Immarino (1999) suggest that the most evident changes implied by the increasing globalization of innovation and technology due to FDI are tougher and increased competition and greater collaboration among actors, both across and within national boundaries.

2.1 Theoretical discussions on foreign ownership

Lipsey (2002) notes that much of the earlier economic literature on foreign direct investment, explains variations in FDI levels using the general theory of international capital movements, based on the differences among countries in the abundance and cost of capital. In more recent literature, however, the transmission of technology and knowledge dominates, and partly following Dosi (1988), Porter (1990), Lundvall (1992) and Nelson (1992) several authors discuss the relationship between multinational firms, national innovation systems, geographical proximity, industrial clusters and global networks. See for example Jaffe et al (1993), Feldman and Audretch (1995), Pavitt and Patel (1999) and Cantwell and Janne (1999).

In his survey of literature on home and host country of FDI, Lipsey (2002) suggest that theoretically there are two more or less competing explanations for the sources and directions of

the direct investment inflow. One is that foreign firms wish to gain access to the locational advantages of the host country, based on the host country endowments or the host country's technological skills that are specific to the host country rather than the firms of the host country. In that case, we would expect to find that investment would be attracted to industries in which the host country had some comparative advantage in trade.

The second explanation is that foreign firms have built up firm-specific advantages in their countries, based on their home countries' current or past comparative advantages, and wish to exploit these in the host country, where firms have lost, or never acquired, these skills. In that case, we would expect to find that investment would flow to industries with comparative disadvantages in the host country, and would come from firms in industries with home country comparative trade advantages.

2.2 Empirical findings

Many empirical studies on the role of FDI and foreign ownership focus on the effect of possible superior technology. If a technology gap exists between domestic and foreign-owned firms we would also expect to find some differences in productivity or innovativeness. However, even if foreign-owned firms are shown to be superior in terms of efficiency or innovativeness, this doesn't necessarily confirm the gap-hypothesis. Foreign-owned firms can outperform domestic firms simply because foreigners have taken over more efficient domestic firms. This possibility points to the importance of using panel data and following firms before and after acquisition.

Other empirical studies attempt to explain observed differences between foreign and domestic firms or analyze spillover effects from multinational firms to the host country. Others, taking the dynamics into account, examine not only firms that can be observed over an extended period but also firms that enter and exit.

The literature on business internationalization suggests a number of different reasons for firms to undertake technological activities outside their home countries. For example Vernon (1966) suggested that the main reason for foreign R&D activities is to exploit technological activities created within the home country. More recent analyses (for example Cantwell 1995, Dunning and Narula 1995) suggest that two other factors have become increasingly important: the need to monitor new technological developments, and the ability to generate entirely new technologies and products from foreign locations. Both of these have been attributed to increasing technological complexity and the resulting rise in R&D cost.

Pavitt and Patel (1999) find that most multinationals tend to locate their R&D activities at home and that therefore the national systems of innovation of the home country affect their pattern of

innovation. Moreover, in a large majority of cases (75%), firms tend to locate their technology activities abroad in the same core areas in which they are strong at home. In a small minority of cases (10%), firm activities abroad are in areas in which they are weak at home to exploit the technological advantage of the host country. Comparing the technology advantage of the company at home and the advantage of the location abroad, Patel and Vega (1999) find that firms are active outside their home countries in technology areas that have experienced strong growth in the host country and with firms with whom they have formed strategic alliances.

Based on an investigation of 345 multinational companies Le Bas and Sierra (2001) confirm the Patel and Vega results. They find that nearly 70% of multinationals locate their activities abroad in technological areas or fields in which they are strong at home. Le Bas and Sierra suggest that the national system of innovation, and in particular the system of academic research, should strengthen the technological advantages of local firms and enable them to successfully locate a part of their R&D activities abroad.

Barrios et al (2004) is an interesting attempt to account for the dynamic aspects of foreign ownership. The authors focus on two likely effects of FDI: a competition effect, which deters entry of domestic firms, and positive markets externalities such as knowledge spillovers, which foster the development of local industry. Using plant-level data for the manufacturing sector in the Republic of Ireland over the period 1972-2000, the authors find that an increasing presence of foreign owned firms may initially harm the development of domestic firms due to increasing competitive pressure. However, after reaching a certain threshold value, the positive benefits of foreign owned firms due to technological spillover outweigh the negative factors and contributed to the development of domestic firms.

There are still a small but growing literature on foreign ownership and innovation relying on CIS-data. (See for example Tether 2000, Tether 2001, Baclet and Evangelista 2003 and Sadowski and Van Beers, 2003). A common research topic is the innovativeness of foreign-owned firms versus domestic-owned firms. Using a dataset of 1 115 observations from CIS 2, Balcet and Evangelista (2004) show that foreign-owned firms were more innovative than domestic firms in Italy during the period 1994-1996. The authors argue that the greater degree of innovativeness among foreign-owned firms than domestic firms is due to their larger size and larger concentration in science-based sectors. However, there are important exceptions: in the majority of technologically intensive sectors, for instance, domestic firms outperform foreign-owned firms, especially in terms of R&D intensity, while an opposite pattern characterizes industries with industries with low and medium R&D intensity. Balcet and Evangelista suggest that the innovation strategies of foreign-owned firms are strongly affected by the strengths and

weakness of the innovation systems in the Italian host country. For most science-based and scale-intensive sectors, the attractiveness of Italy to foreign-owned firms is low. However, the competencies and know-how accumulated in traditional and mechanical engineering industries, where Italy holds a clear competitive advantage, attract foreign-owned firms.

Frenz and Ietto-Gillies (2004) use a U.K. data set containing 679 observations from CIS 2 and CIS 3 to test the hypothesis that multinationality per se affects a firm's propensity to innovate. Comparing uninational (domestic) and multinational (domestic or foreign-owned) firms, they find that those CIS enterprises that belong to a multinational corporation are more likely to engage in innovation activities and that this engagement is on continuous basis rather than only occasionally.

The largest branch of comparison studies concerning the ownership of firms addresses efficiency in terms of productivity. The underlying assumption is mainly that productivity differences indicate a technological gap. Doms and Jensen (1998) concluded that foreign-owned plants were superior to US-owned uninational plants, even large facilities, in both labor productivity and total factor productivity, but that they were inferior to plants owned by US multinationals. Girma et al (2001) found that among firms with no change in ownership, foreign-owned firms in the United Kingdom had labor productivity about 10 percent above that of domestically-owned firms and total factor productivity about 5 percent higher. Conyon et al (1999) fond that the acquisition of UK firms by foreigners led to increases in their productivity.

Concerning whether the suspicion that foreign firms select relatively high productivity plans to acquire conflicted evidences are provided in the literature. A study by Harris and Robinson (2002) of the selection of establishments for foreign acquisition suggests that foreign firms selected relatively high productivity plants to acquire. Each group of plants was compared to a reference group of plants belonging to UK multiplant firms that did not sell any plants to foreign firms during the period 1982-1992. Investigating foreign ownership in the Swedish manufacturing sector between 1990 and 2000, Lundberg and Karpaty (2004) reject the hypothesis that foreign firms specifically targeted high-productivity firms for Swedish direct investment.

The evidence on innovation and productivity in the literature gives strong support to the notion that foreign-owned firms are both more innovative and more productive. However, studies that attempts to explain differences between domestic and foreign firms are less unanimous in their conclusions. Some recent studies have analyzed the importance of the innovation systems in the host country for the performance of subsidiary business. Furu (1999) suggests that the general competitiveness of a foreign-owned firms requires two things: first, that the subsidiary has an

established business relationship with local counterparts as well as suppliers, competitors, customers, and government agencies, in order to be able to absorb meaningful knowledge from the local competitive environment, and second, that investment in R&D is sufficient to support the development of new competence and learning. The results presented by Furu confirm previous findings by Andersson (1997) that the performance of foreign owned firms is largely dependent on their embeddedness in the network of local firms, e.g., local customers, suppliers, research institutes, and competitors.

3. METHODOLOGICAL ISSUES

3.1 Research questions

Table 1:

Gap-hypotheses

	Engagement in Innovation **The gap hypothesis is that foreign ownership is associated with:**
1.	The likelihood of carrying out innovation projects.
2.	The probability of receiving public R&D support
3.	The amount of R&D and other innovation investments
4.	The embeddedness in domestic innovation systems
5.	The utilization of knowledge from up and down the value chain
6.	The utilization of knowledge from within the same industry or related industries
7.	The utilization of the domestic science base
8.	The utilization of sources of knowledge for innovation from other enterprises within the group
B	**Results of Innovation Activities** **The gap hypothesis is that foreign ownership is associated with:**
9.	The probability of patenting
10.	The occurrence of radical innovations
11.	The return on innovation investments (innovation sales)
12.	Economic performance (Labour productivity)

Table 1 introduces the 12 hypotheses on possible gaps between foreign and domestically controlled firms that are explored in the empirical analysis. The first part considers the likelihood of engagement in innovation activities, the scope of R&D investments, public R&D grants, and "the company as an innovation system," based on internal knowledge flow between various firms and establishments of the group, and embeddedness in scientific, vertical and horizontal innovation systems. The second part attempts to capture differences in innovation output (patent, radical innovation and innovation sales) and labour productivity. The second part is attempts to capture differences in innovation output (patent, radical innovation and innovation sales) and labor productivity.

Table 1 introduces the 12 hypotheses on possible gaps between foreign and domestically controlled firms that are explored in the empirical analysis. The first part considers the likelihood of engagement in innovation activities, the scope of R&D investments, public R&D grants, and "the company as an innovation system," based on internal knowledge flow between various firms and establishments of the group, and embeddedness in scientific, vertical and horizontal innovation systems. The second part attempts to capture differences in innovation output (patent, radical innovation and innovation sales) and labour productivity. The second part is attempts to capture differences in innovation output (patent, radical innovation and innovation sales) and labor productivity.

3.2 Data

We address the gap hypotheses from the Swedish Community Innovation Survey (CIS) III for the period 1998-2000, which provides information about R&D, innovation, economic performance, whether or not the firm belongs to a group, and in which country the firm has its headquarters. CIS surveys follow the "subject-oriented" approach; they ask individual firms directly whether they were able to produce an innovation. The CIS has been widely piloted and tested before implementation and since its first use in the early 1990s the questionnaire has been continuously revised. The CIS is based on previous innovation surveys, including the Yale survey and the SPRU innovation database (Klevorick et al, 1995; Pavitt, Robson and Townsend, 1987). It provides an opportunity to investigate patterns of innovation across a large number of industrial firms.

Although far from perfect, CIS data does provide a useful complement to traditional measures of innovation such as patent statistics, as it covers a firm's innovative efforts, strategies and successes. To a certain degree, it also allows researchers to assess innovation-induced performance changes in firms. Unlike R&D and patent data, innovation output indicators in the CIS can measure innovation directly (Kleinknecht et al 2002).

3.3 Estimation methodology

The research methodology uses three sequential steps. Initially a descriptive analysis is carried out on the basis of the data. Then, a selection model and appropriate control variables are introduced. The objective is to control for sample section bias; we control for the likelihood that R&D firms constitute a particular group of companies. We also control for firm heterogeneity; we seek firms with similar characteristics such as firm size, export orientation, human capital intensity, physical capital intensity, and recent history of establishment and merger. Finally we

consider a four-equation production function model that relates various determinants to research, research to innovation output and innovation output to labour productivity.

4. DATA AND MODELS

4.1 Community Innovation Survey and corporate ownership

Although the entire CIS data set includes sampling weights we chose not to use the weights for two reasons. First, the sampling weights stratify the sample according to size, industry and innovativeness. They do not denote foreign ownership. Therefore, using the sampling weights could result in a larger distortion of the sample. So when we refer to firms in Sweden we mean both domestic and foreign-owned firms in the data set. Regrettably, being restricted by the available data we cannot know whether or not our findings are representative of the whole economy. However, we argue that by using the economic weight of firms in our models, rather than their sampling weight (as Tether (2001) suggests), the findings of this analysis do represent the differences between foreign-owned and domestically owned firms.

As this analysis endeavours to establish the differences between foreign-owned and domestically owned firms, we restrict the firms in our sample to those firms belonging to a corporate group. Had we not done so, all foreign-owned firms would by definition be part of a foreign-owned corporate group. However, only a fraction of the domestically owned firms are part of a corporate group. Therefore, observed differences between foreign-owned firms and domestically owned firms would also reflect any effect of group membership. To eliminate this effect, we only analyze firms that are part of a corporate group. In referring to firms we implicitly mean firms belonging to a corporate group.

4.2 Data and descriptive statistics

This section reports the basic characteristics of the data and the main findings from a descriptive statistical analysis. The Swedish Community Innovation Survey is conducted by Statistics Sweden. The third wave of the CIS, on which this analysis based, was launched in 2001 and refers to the years 1998 to 2000. The survey was sent to 4 266 firms, and yielded a response rate of 48% (Statistics Sweden 2002). The data used in this study consists of a subsample of the observations from the third Community Innovation Survey. This subsample is comprised only of firms belonging to a group. The total number of observed firms is 1 197 of which 814 (68%) are domestically owned firms. See Table 2.

Table 2

Sample distribution

Notation	Representing	Observations Total	Innovative firms[1]	Percent
DU	Domestic uninationals	752	384	51.1
DM	Domestic multinationals	62	62	100.0
NM	Nordic multinationals	138	85	61.6
ASM	Anglo-Saxon multinationals	105	70	66.7
EOM	European multinationals and others	140	93	66.4
DOM	Domestically-owned firms	814	446	54.8
FOR	Foreign-owned firms	383	248	64.8
TOTAL		1 197	694	58.0

Note: This table describes only firms that are a part of a corporate group. Innovative firms are firms reporting a product and/or process innovation and/or report ongoing innovation activities. The 100% innovators share of the domestic multinationals is due to the construction of the domestic multinational indicator.

Firms are grouped into five different categories: domestic uninational firms (752 observations), domestic multinationals (62), Nordic multinationals (138 firms with headquarters in Denmark, Finland, Norway or Iceland), Anglo-Saxon (105) and European and other multinationals (140). [5]

Taken as a group, the domestic and foreign-owned multinationals play a significant role in the Swedish economy.

A majority of the firms (55% of domestic firms and 65% of foreign-owned firms) are classified as “innovative firms”; they launched at least one process innovation or product innovation during the period 1998-2000, or they were reporting ongoing innovation activities in 2000. Note the large variation in the share of innovative firms among domestic firms; while six in ten of the observed non-multinationals are innovative, the corresponding share for multinationals is ten in ten.

[5] Among foreign firms, 34% are Nordic, 25% Anglo-Saxon and 41% are controlled by owners in (other) European countries or other countries. These shares are in agreement with the official statistics on multinational firms in Sweden (ITPS, 2002). According to the ITPS statistics the shares are 36% for Nordic firms, 27% for Anglo-Saxon firms and 37% for European and other firms.

Table 3

Summary statistics of firm characteristics and innovation activities

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
	N=752	N=62	N=138	N=414	N=140	N=814	N=383
Size	276	1 277	304	414	340	352	348
Sales	11.364	13.183	12.098	12.312	12.140	11.502	12.172
Labour prod.	5.006	5.171	5.319	5.364	5.250	5.019	5.306
Exports	1.870	3.617	3.059	3.762	2.964	2.003	3.217
Investment	3.497	3.782	3.461	3.751	3.608	3.519	3.594
Innov. input	0.582	2.253	0.660	1.112	1.029	0.709	0.919
Innov. output	0.914	2.996	1.566	1.822	1.625	1.073	1.658

Note: The table reports the averages of the innovation activities. All categories except the size are in logs and in per capita terms

Table 3 reports summary statistics of key economic and innovation variables. The table shows that the average number of employees is about 350 in domestic as well as in foreign-owned firms. However, Table 3 reveals a large size difference between non-multinational and multinational domestic firms. While the average firm in the first category has 276 employees the average multinational firm is nearly five times larger.

Expressed in intensity terms (per capita) the right part of the table shows that sales, labour productivity, export, physical investments, R&D and other innovation input and innovation sales are larger among foreign-owned firms than in domestic firms. However, this may be due to differences between uninational firms and multinational firms rather than between domestic and foreign-owned firms, since a majority domestic firms in this sample are uninational. Note that labour productivity is an exception; both the uninational and multinational firms have a lower labour productivity compared to foreign-owned firms. Swedish multinational firms outperform all other category of owners when sales, tangible and intangible investments and innovation output are considered. Note that both categories of domestic firms have, on average, lower labor productivity compared to foreign-owned firms.

Comparing the three categories of foreign-owned firms, we find that the average Anglo-Saxon firm is the largest in terms of number of employees. It has also the largest values in all the economic and innovation performance variables. Swedish, Anglo-Saxon and European and other multinational firms are more intensive in human capital (21-22 %) than uninational firms (18%) and Nordic multinational companies (14%)

Table 4 shows the distribution of manufacturing and service firms of different technology intensities. The table shows a large similarity in distribution of technology intensities among domestic and foreign-owned firms, with the exception of high medium manufacturing technology which is more prevalent among foreign-owned firms) and knowledge intensive service which is most prevalent among domestic firms. Considering the two classes of domestic firms, we find that multinationals are especially concentrated in high medium and low medium manufacturing technology categories, while 44% of the uninational belong to the service sector. Among foreign-owned firms, Nordic multinational are relatively more concentrated in service sectors than other foreign owned firms.

Across all five categories of firm ownership and location, domestic multinationals have the largest concentration in high and high medium technology sectors (52%). The corresponding share for the other categories of firms are: European and other multinationals (38%), Anglo-Saxon (34 %), Nordic (25 %) and Swedish non multinationals (26%)

Table 4

Sectoral distribution with ownership categories in percent

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
	N=752	N=62	N=138	N=414	N=140	N=814	N=383
HI M	5.7	14.5	4.4	9.5	7.1	6.4	6.8
HM M	16.0	37.1	21.0	24.8	30.7	17.6	25.6
LM M	19.0	21.0	13.0	24.8	20.7	19.2	19.0
LO M	14.6	12.9	15.2	12.4	15.0	14.5	14.4
KIS	22.7	9.7	26.1	12.4	5.7	21.7	14.9
OS	21.9	4.8	20.3	16.2	20.7	20.6	19.3

Note: The sectors are defined along the lines of the OECD classification of knowledge intensity: 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 (KIS) and other services (OS). See Hatzichronoglou (1997).

Table 5 below indicates that the most significant market for domestic-owned firms is the domestic market, while the global market dominates the focus of foreign-owned firms. The domestic market (Sweden) is the most significant market for domestic non-multinationals as well as for Nordic multinationals. Swedish multinationals and Anglo-Saxon firms are concentrated on the global market. (Other) European and other multinationals report that they are equally focused on the Swedish and the global markets.

Table 5

Firms' most significant market

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
	N=752	N=62	N=138	N=414	N=140	N=814	N=383
Local	27.4	6.5	9.4	8.6	8.6	25.8	8.9
National	42.3	24.2	48.6	26.7	45.7	40.9	41.5
Global	30.3	69.4	42.0	64.8	45.7	33.3	49.6

Note: The table reports the share of firms in percentages.

In Tables 6 through 10 we display summary statistics for innovative firms only. Table 6 describes the percentage of firms in which innovation activity can be observed. As can be expected, nearly all firms defined as innovative in this study reported innovation expenditures in 2000. But when innovation sales are considered, an extensive difference is found between the two groups of domestic firms. Only six of ten uninational firms report innovation sales, compared to nearly nine of ten multinational firms. On average, 70 percent of foreign firms report innovation sales compared to 60 percent of domestic firms. The corresponding proportions are approximately the same for firms reporting continuous R&D expenditures, i.e., the average foreign firm is somewhat more innovative than the average domestic firm. About one half of the firms surveyed report that they introduced a new or significantly improved process to the market during the period 1998-2000. This share was somewhat higher among domestic multinational firms. The propensity to receive governmental R&D support is about the same for foreign-owned firms and uninational firms, however this propensity is three times higher for Swedish multinational firms.

Table 6

Innovation activities

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
	N=384	N=62	N=47	N=40	N=32	N=396	N=119
Innovation expenditure	95.3	96.7	92.9	94.2	98.9	95.5	95.5
Innovation sales	57.6	85.4	72.9	71.4	69.8	61.4	71.3
Product innovation	60.1	91.9	74.1	74.2	73.1	64.5	73.7
Process innovation	48.4	61.2	47.0	51.4	53.7	50.2	50.8
Continuous R&D	48.4	85.4	55.2	64.2	64.5	53.5	61.2
Public Funding for R&D	12.2	35.4	11.7	15.7	10.7	15.4	12.5

Note: Table gives the share of firms in percent where the respective innovation activities can be observed.

Table 7 gives descriptive statistics on methods used by firms to protect intellectual property. For every single method, ranging from patent to lead-time advantage, we find considerably larger values among domestic multinational firms and a considerably smaller protection propensity among domestic non-multinational firms compared to Nordic, Anglo-Saxon and European and other multinational firms.

Table 7

Methods of protection

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
	N=384	N=62	N=47	N=40	N=32	N=396	N=119
Patent (Valid)	32.6	74.2	49.4	64.2	67.7	38.3	60.4
Patent (Application)	27.6	74.2	35.2	54.2	53.7	34.0	47.5
Design patterns	17.2	38.7	28.2	37.1	34.4	20.2	33.0
Trademarks	40.3	72.5	58.8	65.7	61.2	44.8	61.7
Copyright	19.0	46.8	29.4	34.2	30.1	22.8	31.0
Secrecy	26.8	67.7	40.0	32.8	41.9	32.5	38.7
Complexity of design	16.1	40.3	32.9	22.8	26.8	19.5	27.8
Lead-time advantage	39.6	74.2	55.2	40.0	54.8	44.3	50.8

Note: The table gives the share of firms indicating the use of the respective methods of protection.

Table 8 summarizes the innovation input and the innovation output of innovating firms. The average uninational firm and the average Anglo-Saxon, European and other multinational firm invests about 7-8 percent of sales income in innovation activities (R&D and other innovation

activities). The innovation input is considerably larger in the average domestic multinational firm (15%). The innovation input in Nordic-owned firms corresponds only to 3 percent of sales. In total we find an average input ratio of 9.4 percent among Swedish firms compared to 6.2 percent for foreign-owned firms.

The lower part of Table 8 gives the mean values for innovation output. We find the largest average share of sales income from innovative products among domestic multinationals (24%), Anglo-Saxon owned firms (20%) and European and other multinationals (19%). The mean share of innovation output is 17 percent for Nordic multinationals; Swedish uninational firms have the lowest output share, 15 percent. In aggregate figures innovation output is 16 percent for domestic firms and 19 percent among domestically owned firms. Hence, foreign-owned firms are less innovative with respect to innovation input but more innovative in terms of innovation output.

Table 8

Innovation Input and Innovation Output

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
	N=384	N=62	N=47	N=40	N=32	N=396	N=119
Input							
Mean	8.4	15.0	3.0	7.2	8.3	9.4	6.2
Standard dev.	19.4	25.7	4.6	20.3	18.2	20.5	14.1
Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Max	100	100	22.6	100	100	100	100
Output							
Mean	15.2	23.9	17.2	20.4	18.9	16.4	18.8
Standard dev.	24.2	28.8	22.7	26.2	24.7	24.9	24.4
Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Max	100	100	100	100	100	100	100

Note: This table reports the summary statistics for the innovation expenditure (input) as a fraction of sales and the fraction of turnover generated by new or significantly modified products (output). All values are percentages.

Recent literature emphasizes the importance of innovation systems for the performance of individual firms (see for example Pavitt and Patel (1999)). Table 9 reports indicator values describing domestic and global collaboration on innovation with eight different categories of partners. The evidence on networking clearly indicates that Swedish multinationals cooperate more intensely at both domestic and global levels for all types of partners. Swedish uninational firms have a lower degree of domestic as well as global collaboration on innovation compared

to foreign-owned firms. Note that foreign-owned firms cooperate more closely with the Swedish scientific network (universities and public R&D organisations) than uninational Swedish firms.

Table 9

Cooperation on innovation

		DOMESTIC		FOREIGN			TOTAL	
		DU	DM	NM	ASM	EOM	DOM	FOR
		N=384	N=62	N=47	N=40	N=32	N=396	N=119
Within the group	D	18.2	64.5	15.2	11.4	21.5	24.7	16.5
	G	0.0	-[1]	24.9	42.8	44.0	13.9	38.7
Suppliers	D	17.7	69.3	23.5	20.0	21.5	24.9	21.7
	G	9.3	69.3	21.1	27.1	24.7	17.7	24.1
Customers	D	12.5	62.9	22.3	28.5	30.1	19.5	27.0
	G	7.5	56.4	17.6	21.4	23.7	14.3	20.9
Competitors	D	6.0	20.9	3.5	5.7	5.4	8,0	4.8
	G	2.3	17.7	4.7	8.5	5.4	4.4	6.0
Consultancies	D	14.8	48.3	20.0	24.2	24.7	19.5	22.9
	G	2.8	29.0	7.0	12.8	10.7	6.5	10.0
Priv. R&D Labs	D	6.5	27.4	10.5	18.5	13.9	9.4	14.1
	G	3.3	30.6	5.9	14.2	6.4	7.1	8.4
Universities	D	14.8	64.5	21.1	31.4	32.2	21.7	28.2
	G	3.6	32.2	9.4	15.7	9.6	7.6	11.2
Public R&D Org.	D	8.8	33.8	9.4	18.5	14.0	12.3	13.7
	G	3.1	9.7	4.7	5.7	7.5	4.0	6.0
Domestic								
- collaboration		32.8	93.5	40.0	50.0	47.3	41.2	45.5
- vertical coll.		23.4	82.2	30.5	37.1	36.5	31.6	34.6
- horizontal coll		5.9	20.9	3.5	5.7	5.3	8.0	4.8
- scientific coll.		17.9	69.3	23.5	34.2	32.2	25.1	29.8

Note: This table gives the fraction of companies reporting collaborative innovation efforts with the respective partners. D denotes domestic partners and G denotes international partners. The diversity index is the number of partners currently used relative to the number of potential partners. For the diversity index the table reports the means.

Table 10 shows that all categories of innovative firms are largely dependent on external sources of information used in innovation activities. Swedish multinationals, which are more likely to collaborate on innovation activities (Table 9), also rely more on external sources of knowledge for innovation compared to other firms. Swedish multinationals also seem to exploit somewhat

more internal knowledge than other types of firms, which may be due to their larger size compared to other firm types defined in this sample. The aggregate figures in the right part of the table reveal only minor differences in the pattern of knowledge sources between domestic and foreign-owned firms.

Table 10
Sources of information for innovation

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
	N=384	N=62	N=47	N=40	N=32	N=396	N=119
Within the firm	83.3	95.1	87.0	84.2	82.7	84.9	84.6
Within the group	44.2	75.8	60.0	62.8	70.9	48.6	64.9
Suppliers	56.5	62.9	63.5	45.7	54.8	57.3	55.2
Customers	73.9	90.3	83.5	80.0	75.2	76.2	79.4
Competitors	48.9	59.6	44.7	37.1	44.0	50.4	42.3
Universities	25.2	53.2	22.3	31.4	26.9	29.1	26.6
Government	15.1	35.4	14.1	18.6	19.3	17.9	17.3
Prof conferences	37.7	53.2	37.6	32.8	34.4	39.9	35.0
Fairs, exhibitions	42.1	54.8	37.6	37.1	32.2	43.9	35.4

Note: The table report the fraction of companies reporting a high or medium importance of the information sources for their innovation activities.

4.4 Models

To provide a comprehensive picture of the effects of foreign ownership on firms' innovation activities and productivity, we analyse the CIS data sets using both sample selection models and a complete production model. The basic theoretical model can be simplified by the following relationship:

$$\log Y = \alpha + \beta \log X + \gamma \log K + \lambda \log C + \varepsilon \qquad (1)$$

where Y is productivity or innovation output at the firm level, X is a vector of standard inputs, and K is R&D (investment?), C is corporate ownership, and α and ε represent systematic and random fluctuations, respectively.

Empirically the model is estimated as a selection model and a multistep model. More specifically, we have the following equations:

$$g^* = \beta_0^0 + \sum_n \beta_n^0 x_n^0 + \varepsilon^0 \quad (2)$$

$$k = \beta_0^1 + \sum_m \beta_m^1 x_m^1 + \varepsilon^1 \quad (3)$$

$$t = \beta_0^2 + \beta_k \hat{k} + \beta_q \hat{q} + \beta_{MR} MR + \sum_l \beta_l^2 x_l^2 + \varepsilon^2 \quad (4)$$

$$q = \beta_0^3 + \beta_t \hat{t} + \sum_j \beta_j^3 x_j^3 + \varepsilon^3 \quad (5)$$

where g^* is a latent innovation decision variable, k represents innovation input, t is innovation output, q is productivity, MR is the inverted Mill's ratio introduced to correct for possible selection bias, x^0, x^1, x^2 and x^3 are N, M, L and J vectors of variables explaining investment decision, innovation input, innovation output and productivity including corporate ownership, employment, human capital and various innovation indicators. The coefficients β^0 and β^1 are vectors of unknown parameters reflecting the impact of certain factors on the firm's probability of being engaged in R&D and other innovation investments and on the actual level on these investments; the β^2 is a composite of several parameters associated with the level of innovation output while β^3 is associated with the level of productivity.

In the selection equations we only estimate the two first equations as a Heckman two-step model. In the multi-step model all four equations are estimated together as a recursive system. $\varepsilon^0, \varepsilon^1, \varepsilon^2$ and ε^3 are random error terms. We assume that the two error terms in the selection model are correlated and that the two error terms in the simultaneous equation system are correlated. In addition, there is also a partial correlation between the error terms in the selection equation and the simultaneous equation due to the predicted Mills' ratio and the predicted innovation input estimate in equation (4), both generated from the selection model. The two last equations can be estimated by two stage least square or three stage least square methods. In this study we use the 2SLS estimator.

These econometric models assume that any given dependent variable, say, innovation effort, is only observed for "innovative firms," that is, firms that have decided to engage in innovation activities. A firm's decision to be innovative, however, is not independent of its characteristics such as size, investment activities, foreign ownership, etc. Both the decision about what efforts are expended to achieve innovation and the decision of which innovation activities will be pursued must be modelled simultaneously. Hence in equation (2) information from all observed firms is included while equations (3) – equation (5) include only information from innovative firms.

While the two first equations are designed to solve or reduce the selectivity bias problem, the two latter equations attempt to account for simultaneity bias problems. When several links in the process of transforming innovation investment to productivity are considered in a simultaneous framework, one possible problem is that some explanatory variables are often determined jointly with the dependent variable, i.e. they are not exogenously given; there will be simultaneity bias in the estimates.

To our knowledge, the idea of modelling a system accounting for both selectivity bias and simultaneity bias in productivity studies was first? introduced by Crepon, Duguet and Mairesse (1998). Recent years have seen the publication of a number of works using CIS databases and alternative versions of the Crepon, Duguet and Mairesse 1998-model (CDM). Kleinknecht and Mohnen (2003) survey this literature. The results presented in this study add to the CDM-literature by including ownership of the firms in the model.

The endogenous and exogenous used in the study are presented in the Appendix-section.

5. RESULTS

This section presents the results of the regression analysis. We report the main findings and then comment on some details of the selection and the multistep equations.

5.1 Main findings

Table 11 presents the results of the model estimating propensity to carry out innovations. With domestic firms used as the reference group we cannot find that foreign-owned firms on average differ from Swedish owned firm in their likelihood of investing in R&D when we control for firm size, sector, human capital, physical, the firm's history (establishment and merging), and market orientation.

Table 11

Corporate ownership and gap in engagement in innovation activities.

Gap-Hypotheses	Corporate ownership						
	UN	DM	NM	ASM	EOM	DOM	FOR
1. The likelihood of carrying out innovation projects.	-	-	-	-	-	Ref	
2. Investment in R&D and other innovation activities per employee	Ref	0.6***			0.2*	-	-
3. The probability of receiving public R&D support	Ref	0.5***				-	-
4. The transmission of knowledge for innovation within the company	Ref	0.6***	0.3**	0.3**	0.5**		
5. The embeddedness in the domestic innovation system.	Ref	1.3***				-	-
6. The embeddedness in vertical innovation system.	Ref	1.3***			0.3**	-	-
7. The embeddedness in the horizontal innovation system	Ref	0.6***				-	-
8. The embeddedness in the scientific innovation system	Ref	0.6***		0.4**	0.4**	-	-

Notes: Control group is domestic firms in equation 1 and uninational firms in equations 2 through 8.

*, **, ** and * indicates significant association at the 1%, 5% or 10% level of significance

Uninational firms are the reference group. DM is domestic multinationals, NM Nordic multinationals, ASM, Anglo-Saxon multinationals and EOM is European and other multinational.

In gap-equations 2 through 8 uninational firms are used as a reference group. The evidence is compelling that domestic multinationals outperform foreign firms and uninational firms in R&D investments per capita. See equation 2. Weak evidence (at the 10% level) is provided that European and other multinational firms on the average invest more in R&D than Anglo-Saxon and Nordic firms.

The main finding from equation 3 is that given that among firms that can be classified as innovative, domestic multinationals have a significantly larger likelihood of receiving public R&D subsidies than other groups of firms.

Estimations from equation 4 indicate that knowledge flow from affiliates within the group is an important source of information for innovation for all multinational firms. This characteristic distinguishes multinational firms significantly from uninational firms.

All estimates of the aggregate indicator on embeddedness in the national innovation system indicate that domestic multinationals are more integrated in the national innovation system (NIS) than any other of the investigated firms. De-composing the embeddedness in vertical, horizontal and scientific innovation systems yields the following: first, both Swedish multinationals and European and other foreign controlled firms collaborate more closely with

suppliers and customers on innovation than other groups of firms. Second, domestic multinationals have are significantly more involved in cooperation on innovation with competitors and suppliers than are uninational firms and foreign firms. Third, the scientific innovation system (universities, private and governmental R&D laboratories) seems to be the most attractive innovation system in Sweden for foreign firms. Together with domestic multinationals, both Anglo-Saxon and Nordic controlled firms are significantly more integrated in the scientific innovation system than uninational firms. Notably no difference can be established between the reference group and Nordic multinationals. Presumably the latter group is more integrated in the scientific innovation system in Denmark, Finland, Norway and Iceland respectively.

Table 12

Corporate ownership and gap in innovation output and productivity performance

Gap-Hypotheses	Corporate ownership				
	UN	DM	NM	ASM	EOM
9. The probability to patent.	Ref	0.6 ***		0.4 *	0.5 ***
10. Radical innovations	Ref	0.7 ***		0.3 *	0.3 **
11a. Return on innovation investments - Selection equation	Ref	0.9 ***	0.6 ***	0.6 **	0.5 **
11b. Return on innovation investments - Selection and simultaneity equations	Ref	0.5 *	0.6 ***	0.5 *	
12a. Labor productivity - Selection equation	Ref			0.3 **	
12b. Labor productivity - Selection and simultaneity equations	Ref				

Notes: Control group is domestic firms in equation 1 and uninational firms in equations 2 through 8.
*, **, ** and * indicates significant association at the 1%, 5% or 10% level of significance
Uninational firms are the reference group. DM is domestic multinationals, NM Nordic multinationals, ASM, Anglo-Saxon multinationals and EOM is European and other multinational.

Table 12 reports the summary finding from the performance equations. Estimations from equations 9 and 10 indicate that Swedish multinationals and European and other multinational have a significantly larger probability of patenting and introducing radical innovations than other firms. The point estimate for Anglo-Saxon is only significantly different from the reference group at the 10% level of significance.

For equations 11 and 12 estimates from both the selection model and the multistep model are presented. Assuming that the combined finding of both equations can be interpreted as a robust result, we conclude from equations 11a and 11b that, somewhat surprisingly, Nordic-owned firms have higher innovation productivity than other firms. Although they have a lower

likelihood than other firms of patenting and introducing radical innovations, they are more effective than other firms in reaping returns on their innovation activities. The highly significant estimates for Swedish multinationals, provided from the selection estimate is reduced to a weakly significant estimate (10%) when we also control for simultaneity bias.

Somewhat surprisingly, we do not find any significant difference in productivity between foreign and domestically owned firms in the Swedish economy. See equation 12. The selection equation (12a) indicates that Anglo-Saxon firms are more productive than other firms (at the 5% level of significance). However the multistep model (12b) does not produce any difference at all among the firm groups. The finding is not only inconsistent with what Modén (1998) Karpati and Lundberg (2004) have shown for firms in Sweden, but also with the conclusions of a majority of previous empirical studies. Possible explanations for our divergent results are: (i) the extensive set of firm characteristics and the exploitation of econometric methods appropriate for the peculiarities in the data set is better able to help us select comparable firms (ii) our research methodology with a production function model captures the relations between the decision to invest and R&D-investments, between R&D investments and innovation output, and between innovation output and productivity, (iii) our method highlights differences between uninational domestic firms and multinational domestic firms, and between different categories of foreign owned firms (iv) our inclusion of small firms in the analysis (the lower limit is 10 employees) adds a dimension that better reflects the economy as a whole, and (v) the cross-sectional nature of our data may mask variations in firm behaviour over time.

In sum, the main finding is that domestic multinational firms are distinct from Nordic, Anglo-Saxon and European and other groups of corporate owners when R&D investments and embeddedness in scientific, vertical and horizontal innovation systems are considered. However, the advantage of higher R&D intensity and possible technological knowledge spillover does not translate into superior innovation output or productivity performance. Our tentative explanation 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. This explanation is supported by Ebersberger and Lööf (2004) who find that the main findings reported in this paper can be generalized to the entire Nordic economic area including Denmark, Finland, Norway, Iceland and Sweden.

5.2 Some additional interesting findings

The regression results for the selection equations and the multistep equations are described as Tables 13 through 18. As could be expected and consistent with the innovation literature (See

Cohen and Klepper 1996 and Klette and Kortum 2002) the probability of being innovative increases with firm size. These results are given as Table 13 (selection equation) and Table 17(multistep equation). In addition, a firm's market orientation is an important determinant of its product innovations. A firm with a global or national market orientation has a significantly higher probability of introducing new innovations than firms acting mainly on the local market. Not surprisingly, the likelihood of being innovative is an increasing function of the intensity of human capital. Investment in R&D and other intangible capital is also closely associated with investment in tangible capital. Weak evidence is provided indicating that firms with a recent history of mergers or acquisitions have a larger probability of being innovative. However the point estimate is only significant at the 10% level of significance.

When controlling for firm size, market orientation, productivity (as a proxy for internal financial resources for R&D investments), new and newly merged establishments, gross investments and human capital (approximated by the share of employees with a university education), we find no evidence that foreign ownership influences the decision to engage in innovative activities. The main determinants of the decision to be innovative are presence on global or national markets and the human capital indicator.

Whereas the occurrence of product innovations is higher the larger the firm, innovation input, defined as innovation expenditures per employee, decreases with firm size. See Table 14, column 1 (selection equation), and Table 17 (multistep model). This is also consistent with the results presented by Janz et al (2004) and Lööf and Heshmati (2004). It is should be noted that the two equations are not identically specified. However, common to both specifications is that R&D per employee is a decreasing function of firm size, while it is positively associated with continuous R&D, governmental subsidies and non-local market focus.

Both international knowledge flow within the group and collaboration on innovation with external partners is an increasing function of the firms' history of conducting R&D on a regular basis. Notable is the reported significant and negative point estimate for global market focus when these four equations are considered. See Table 14, column 3 and Table 15.

Confirming previous studies, we find that innovation output increases significantly with innovation input. See Table 16 (Selection equation) and Table 18. The coefficient of the estimate indicates that a 10% increase in innovation expenditure per employee increases innovation output by 3%. Furthermore, as indicated by Table 18, collaboration diversity has a positive impact on innovation output whereas R&D funding somewhat unexpectedly has the opposite effect. The latter is contrary to the finding by Czarnitzki and Ebersberger (2004) and Lööf and Heshmati (2004) but can be explained by the formulation of the model. The subsidy

effect is already incorporated in the predicted innovation variable. Human capital has a positive but only weakly significant effect on innovation output.

These results indicate that all multinational firms, irrespective of ownership, have a higher capacity to effectively utilise innovation input to produce innovation output than uninational firms. In other words multinationals enjoy a higher return on their innovation investments than uninational firms. This may be due to their superior ability to transfer knowledge among the varied facilities and subsidiaries within the corporation.

The results of the productivity equation presented in Table 16, column 4 (Selection equation) and Table 18 (multistep equation) show that innovation input (selection) as well as output (multistep) are important contributors to productivity after controlling for sector, size, capital investment, human capital, and process innovation. The effect is highly significant. The size of the estimate is within the range of what has previously been found in the literature. A 10% increase in innovation input increases the level of productivity by about 2 percent and a 10% increase in innovation output increases the level of productivity by about 2 percent. Interestingly we find no impact of the ownership variables in the multistep model. The conclusion here is that foreign firms are not more or less productive than uninational firms or domestic multinational firms at the margin when using the control variables commonly used in the Schumpeterian literature. In the selection model, the estimate for Anglo-Saxon firms is significantly larger than for uninational firms at the 5% level of significance. For other groups of firms no difference from uninational Swedish firms can be found.

6. SUMMARY CONCLUSIONS

This paper explore 12 gap-hypotheses on systematic differences in R&D, spillover, innovation and productivity between 1 197 foreign and domestically owned firms in the Swedish economy. Based on the literature we would *a priori* expect that the foreign firms would outperform Swedish firms in terms of productivity and that no robust evidence could be found on knowledge spillover from foreign firms to domestic firms.

The main finding is that domestic multinational firms are distinct from Nordic, Anglo-Saxon and European and other groups of corporate owners when R&D investments and embeddedness in scientific, vertical and horizontal innovation systems are considered. However, the advantage of higher R&D intensity and possible technological knowledge spillover does not translate into superior innovation output or productivity performance. we do not find any significant difference in productivity between foreign and domestically owned firms in the Swedish economy. The finding is not only inconsistent with what Modén (1998) Karpati and Lundberg

(2004) have shown for firms in Sweden, but also with the conclusions of a majority of previous empirical studies. Possible explanations for our divergent results are: (i) the extensive set of firm characteristics and the exploitation of econometric methods appropriate for the peculiarities in the data set is better able to help us select comparable firms (ii) our research methodology with a production function model captures the relations between the decision to invest and R&D-investments, between R&D investments and innovation output, and between innovation output and productivity, (iii) our method highlights differences between uninational domestic firms and multinational domestic firms, and between different categories of foreign owned firms (iv) our inclusion of small firms in the analysis (the lower limit is 10 employees) adds a dimension that better reflects the economy as a whole, and (v) the cross-sectional nature of our data may mask variations in firm behaviour over time.

Our results support the findings by Pavitt and Patel (1999), Patel and Vega 1999 and Le Bas and Sierra(2001) suggesting 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.

REFERENCES

Andersson, U. (1997) "*Subsidiary network embeddedness: Integration, control and influence in the multinational corporation*," Doctoral thesis, Department of Business Studies, Uppsala University, Sweden.

Archibugi, D., and S. Iammaarino (1999) "The policy implication of the globalization of innovation," *Research Policy* **28** 2-3, 317-336.

Balcet, G. and R. Evangelista (2004) "Global Technology: Innovative Strategies of Multinational Affiliates in Italy," Paper presented at the 10th International Schumpeter Society Conference, Milan.

Barrios. S., H. Görg and E. Strobl (2004), "Foreign direct investment, competition and industrial development in host country," German Institute for Economic Research, DIW, Discussion Papers 426.

Cantwell, J., and O. Janne (1999) "Technological globalisation and innovative centres: the role of corporate technological leadership and location hierarchy," *Research Policy* **28** 2-3, 119-144.

Caves, R. E. (1982) "*Multinational Enterprise and Economic Analysis*," Cambridge, U.K.: Cambridge University Press.

Crepon B., E. Duguet and J. Mairesse (1998) "Research, innovation and productivity: an econometric analysis at the firm level," *Economics of Innovation and New Technology*, **7**, 115-158.

Czarnitzki, D., B. Ebersberger and A. Fier (2004) "*The Relationship between R&D Collaboration, Subsidies and Patenting Activity: Empirical Evidence from Finland and Germany*," ZEW Discussion Paper No. 04-, ZEW Mannheim.

Doms, M., E and J. Brandford Jensen (1998) "Comparing Wages, Skills, and Productivity between Domestically and Foreign- Owned Manufacturing Establishments in the United States," In R., E. Baldwin, R., E. Lipsey and J., David Richardson (Eds) *Geography and Ownership as Bases for Economic Accounting*, Studies in Income and Wealth, **59**, Chicago, University of Chicago Press, 235-258.

Dosi, G. (1988) "The nature of the innovation process," In Dosi, G., et al (Eds.), *Technical Change and Economic Theory*. Frances Piter Publishers, London.

Dunning, J. H. (1993) " *Multinational Enterprises and the Global Economy*," Workingham U.K.: Adison Wesley Publishing Co.

Feldman, M.P. and D.B. Audretch (1995) "Science-Based Diversity, Specialization, Localized Competion and Innovation," Discussion Paper. Wissenschaftscebtrum Berlin Fur Socialforschung, FS IV 95-123.

Feliciano, Z., and R.E. Lipsey (2002) "Foreign entry into U:S. manufacturing by takeovers and the creation of new firms," NBER Working Paper no 9122.

Fors, G., and R. Svensson (2002) "R&D and foreign sales in Swedish multinationals: a simultaneous relationship?," *Research Policy* 31, 95-107.

Frenz, M., and G.Ietto-Gillies (2004) "The impact of multinationality on the propensity to innovate: An analysis of the UK Community Innovation Survey 3", paper presented at the 2004 Schumpeter conference in Milano.

Furu, P. (2001) "Drivers of competence development in different types of multinational subsidiaries," *Scandinavian Journal of Management* 17, 133-149.

Girma, S. and K. Wakelin (2000) "Are There regional Spillovers from FDI in the UK?," Research Paper 2000/16, Centre for Research on Globalisation and Labor Markets, School of Economics, Nottingham.

Girma, S., D. Greenway and K. Wakelin (2001) "Who Benefits from Foreign Direct Investment in the UK?," *Scottish Journal of Political Economy* **48** 2, 119-133.

Griffith, R and H. Simpson (2003) "Characteristics of foreign-owned firms in British Manufacturing," NBER Working Paper Series 9573.

Görg, H. and E. Strobl (2003) "Multinational Companies, Technology Spillovers and Plant Survival," *Scandinavian Journal of Economics* 105, 581-595.

Grossman, Gene M, Helpman Elhanan and. Szeidl, Adam (2003) "Optimal Integration Strategies for the Multinational Firm," NBER Working Paper No. 10189.

Harris, R. and C. Robinson (2002) "The Effect of Foreign Acquisitions on Total Factor Productivity: Plant Level Evidence from UK Manufacturing, 1987-1992," *Review of Economic Statistics* **48** 3, 562-568.

Haskel, J. E., S. C. Pereira and M. J Slaughter (2002) "Does Inward Foreign Direct Investment Boost the Productivity of Domestic Firms?," NBER Working Paper No 8724.

Hatzichronoglou, T. (1997) "*Revision of the High-Technology Sector and Product Classification*," Vol. 2 of STI Working Papers, OECD, Paris.

Helpman, E., M.J. Melitz and S.R. Yeape (2003) "Export versus FDI with Heterogenous Firms," *American Economic Review*

Swedish Institute for Growth Policy Studies, ITPS (2003) "Flytt av huvudkontor – tänkbara orsaker," ITPS Publication series.

Jaffe, A., M. Trajtenberg and R. Hendersson (1993) "*Geographical localisation of knowledge spillovers as evidence by patent citations*," Quartely Journal of Economics **108**, 577-599.

Janz, N., H. Lööf and B. Peters, B (2003) "Firm Level Innovation and Productivity - Is there a Common Story Across Countries*?," Problems and Perspectives in Management* **2**, 184-204.

Kleinknecht, A., K van Montfort and E. Brouwer (2002) "The non-trivial choice between innovation indicators," *Economics of Innovation and New Technology* **11**, 109-121.

Klevorick, A. K., R. C. Levin, R.R. Nelson and S.Winter (1995) "On the sources and significance of interindustry differences in technological opportunities," *Research Policy* **24**, 185-205.

Kummerle, W (1999) “Foreign direct ibvestment in industrial research in the pharmaceutical and electronic industries – results from a survey of multinational firms,” *Research Policy* **28** 2-3, 179-193.

Lundberg , L and P. Karpaty, P (2004) “Foreign Direct Investment and Productivity Spillovers in Swedish Manufacturing,” FIEF Working Paper Series No. 194.

Le Bas, C. and C. Sierra (2002) “Location versus home country advantages in R&D activities: some further results on multinationals’ location strategies,” *Research Policy* 31, 589-609.

Lipsey, R.E. (2002) “ Home and Host Country Effects of FDI,” NBER Working Paper 9293.

Lööf H and A Heshmati (2004) “On the Relationship Between Innovation and Performance: A Sensitivity Analysis” *Economics of Innovation and New Technology*. Forthcoming

Lundvall, B-Å. (Ed.) (1992) ”*National System of Innovation: Towards a Theory of Innovation and Interactive Learning*,” Printer, London.

Modén, K. (1998) “Foreign Acquisitions of Swedish Companies – effects son R&D and Productivity. ISA 1998/2. Stockholm.

Nelson, R. (Ed.), (1992) ”*National Innovation Systems: a Comparative Analysis*,” Oxford Univ. Press, New York.

Norbäck, P-J. (2001), ”Multinational firms, technology and location,” *Journal of International Economics* 54, 449-469.

OECD (2001) “*Science, Technology and Industry Scoreboard*,” OECD, Paris.URL: http://www1.oecd.org/publications/e-book/92-2001-04-1-2987/D.5.htm

Patel, P. (1995) “Localised production of technology for global markets”, Cambridge Journal of Economics **19** 1, 141-154.

Patel, P. and M. Vega (1999) “Patterns of internationalization of corporate technology: location vs. home country advantages”, *Research Policy* **28** 2-3, 145-155.

Patel, P. (2004) “Internationalisation of Corporate Technology: What we know and don’t know?” Presentation at the 6CP Network Workshop, June 18 , Helsinki.

Pavitt, K. and P. Patel (1999) “Global corporations and national systems of innovation who dominates whom?. In: D. Archiburgi, J. Howells and J. Michie (eds.), *Innovation Policy in a Global Economy*, Cambridge: Cambridge University Press, pp 94-119.

Pavitt, K., M. Robson and J. Townsend (1987) “The Size Distribution of Innovating Firms in the UK: 1945-1883.” *The Journal of Industrial Economics* **35**, 297-316.

Pol, A., and E. Helpman (2003) “Global Sourcing,” NBER Working Paper No. 10082.

Porter, M (1990) “*The Competitive Advantage of Nations*”, London, Mcmillan.

Sadowski, B.M and C. van Beers (2003) “On the Innovativeness of Foreign Affilities: Some Evidence from Dutch Manufacturing Firms,” (Momeo)

Serapiro Jr. M. G. and D.H. Dalton (1999), "Globalization of industrial R&D: an examination of foreign direct investment in R&D in United States", *Research Policy* **28** 2-3, 303-316.

Tether, B. S. (2001) Identifying Innovation, Innovators and Innovative Behaviours: A Critical Assessment of the Community Innovation Survey (CIS), CRIC Discussion Paper 48, Manchester.

United Nations (2000) "*World Investment Report, 2000: Cross-Border Mergers and Acquisitions and Development*," United Nations Conference of Trade and Development, New York and Geneva, United Nations.

Vernon, R. (1966) "International investment and international trade in the product cycle," *Quarterly Journal of Economics* **80** 2, 190-207.

Table 13

Innovation activities, selection equations

	Dependent variable: The propensity to invest in innovatio0n activities		
	Coeff	Sign	Std err
Foreign ownership	0.053		0.086
Size	0.198	***	0.029
Local markets		Reference	
National markets	0.307	***	0.108
Global markets	0.585	***	0.118
Labor productivity	0.078		0.051
Recently established	0.003		0.142
Recently merged	0.216	*	0.120
Human capital	0.579	***	0.204
Physical investment	0.049		0.149
High technology manufacturing	0.833	***	0.216
Medium high technology manufacturing	0.190		0.126
Medium low technology manufacturing	0.066		0.132
Low technology manufacturing		Reference	
Knowledge intensive services	0.047		0.149
Other services	-0.437	***	0.130
Constant	-1.733	***	0.271

Table 14

Innovation activities, two equation selection models

	Innovation input per worker			Public funding			Knowledge flow within the company		
	Coeff	Sign	Std err	Coeff	Sign	Std err	Coeff	Sign	Std err
Corporate ownership									
DU		Reference			Reference			Reference	
DM	0.687	***	0.229	0.488	***	0.170	0.613	***	0.179
NM	0.009		0.193	-0.102		0.186	0.279	**	0.136
ASM	0.103		0.213	0.047		0.197	0.309	**	0.155
EOM	0.150	*	0.188	-0.187		0.190	0.525	***	0.147
Other determinants									
Innovation input	-	-	-	-	-	-	0.024		0.023
Physical capital investments	0.190	***	0.043	0.112	***	0.038	-0.043		0.026
Size (emp)	-0.310	***	0.062	0.114	***	0.036	-0.023		0.033
Local markets		Reference			Reference			Reference	
National markets	0.336		0.232	0.310		0.192	-0.229	*	0.133
Global markets	0.730	**	0.285	0.349	*	0.204	-0.453	***	0.146
Product orientation	0.343	*	0.208	-0.152		0.194	0.369	***	0.145
Process orientation	0.131		0.243	-0.168		0.229	0.264		0.163
Continual R&D	0.143	***	0.137	0.306	**	0.126	0.188	**	0.093
Public funding	0.425	**	0.176	-		-	-0.061		0.116
Sector dummies		Included			Included			Included	
Constant	0.040		0.854	-2.763	***	0.298	0.806	***	0.296
Wald test	260.71	***		72.96	***		63.99	***	
LR test	0.09			1.27			8.11	***	

Note*:* *** (**, *) Indicates significance at the 1% (5%, 10%) level.

DU= Domestic firms, non-multinational; DM= domestic multinational; NM= Nordic multinational, ASM= Anglo-Saxon multinational; EOM= European and other multinationals.

The results of the selection equation are not reported here.

The Wald statistic tests joint significance and the LR tests the correlation of the two equations. If this correlation is not significantly different from 0, Heckman's model is equivalent to the combination of a regression for the outcome and a probit model for selection variable.

Table 15

Innovation activities, two equation selection models (continued)

	Domestic collaboration			Domestic vertical collaboration			Domestic horizontal collaboration			Utilization of domestic science system		
	Coeff	Sign	St err	Coeff	Sign	St err	Coeff	Sign	St err	Coeff	Sign	St err
Corpor.ownership												
DU	Reference			Reference			Reference			Reference		
DM	1.318	***	0.247	1.253	***	0.213	0.584	***	0.195	0.832	***	0.214
NM	0.150		0.147	0.236		0.173	0.102		0.178	0.224		0.179
ASM	0.205		0.171	0.297		0.189	0.094		0.193	0.392	**	0.190
EOM	0.232		0.149	0.334	**	0.167	0.187		0.171	0.400	**	0.170
Other determinants												
Innovation input	0.093	***	0.033	0.107	***	0.037	0.119	***	0.042	0.125	***	0.040
Physical cap invest	-0.027		0.032	0.001		0.035	-0.045		0.038	0.037		0.041
Size	0.065		0.049	0.104	***	0.034	0.104		0.086	0.271	***	0.041
Local markets	Reference			Reference			Reference			Reference		
National markets	-0.707	***	0.154	-0.613	***	0.169	-0.726	***	0.172	-0.507	**	0.240
Global markets	-0.786	***	0.164	-0.664	***	0.186	-0.825	***	0.197	-0.449		0.280
Product orientation	0.159		0.162	0.324	*	0.185	0.117		0.184	0.186		0.186
Process orientation	-0.003		0.179	0.032		0.215	-0.019		0.209	-0.083		0.215
Continual R&D	0.667	***	0.135	0.757	***	0.135	0.635	***	0.210	0.753	***	0.154
Public funding	0.722	***	0.147	0.545	***	0.150	0.332	**	0.141	0.743	***	0.169
Sector dummies	Included			Included			Included			Included		
Constant	0.054		0.470	-1.275		-	-0.626		1.067	-2.88	***	
Wald test	103.26	***		260.20	***		69.65	***		188.95	***	
LR test	2.18			0.01			0.64			0.82		

Notes: *** (**, *) Indicates significance at the 1% (5%, 10%) level.

DU= Domestic firms, non-multinational; DM= domestic multinational; NM= Nordic multinational, ASM= Anglo-Saxon multinational; EOM= European and other multinationals.

The results of the selection equation are not reported here.

The Wald statistic tests joint significance and the LR tests the correlation of the two equations. If this correlation is not significantly different from 0, Heckman's model is equivalent to the combination of a regression for the outcome and a probit model for selection variable.

Table 16

Innovation activities, two equation selection models (continued)

	Patent application			Products new to the market			Returns to innovation per worker			Labor productivity		
	Coeff	Sign	St err	Coeff	Sign	St err	Coeff	Sign	St err	Coeff	Sign	St err
Corpor.ownership												
DU	Reference			Reference			Reference			Reference		
DM	0.635	***	0.219	0.674	***	0.246	0.923	***	0.261	0.031		0.131
NM	0.073		0.174	0.219		0.146	0.612	***	0.222	0.143		0.110
ASM	0.370	*	0.186	0.275	*	0.157	0.587	**	0.246	0.270	**	0.121
EOM	0.513	***	0.169	0.317	**	0.149	0.476	**	0.217	-0.007		0.107
Other determinants												
Innovation input	0.109	***	0.039	0.036		0.029	0.145	***	0.041	0.105	***	0.021
Physical cap invest	0.059		0.044	0.056		0.034	0.067		0.047	0.209	***	0.023
Size	0.126	**	0.061	0.021		0.068	-0.210	***	0.058	0.021		0.028
Local markets	Reference			Reference			Reference			Reference		
National markets	0.325		0.245	0.136		0.187	0.339		0.235	0.363	***	0.118
Global markets	0.750	***	0.290	0.157		0.258	0.244		0.257	0.382	***	0.135
Product orientation	0.418	**	0.191	0.864	***	0.335	1.677	***	0.234	-0.261	**	0.119
Process orientation	-0.108		0.216	-0.099		0.173	0.217		0.269	-0.036		0.138
Continual R&D	0.575	***	0.131	0.366	***	0.140	0.137		0.159	-0.037		0.081
Public funding	0.471	***	0.162	0.075		0.139	-0.278		0.196	-0.124		0.100
Sector dummies	Reference			Reference			Reference			Reference		
Constant	-2.621	***	0.234	-1.908	***	0.531	2.581	***	0.559	3.960	***	0.312
Wald test	105.34	***		129.70	***		165.34	***		292.42	***	
LR test	0.01			0.61			12.38	***		0.06		

Note: *** (**, *) Indicates significance at the 1% (5%, 10%) level.

DU= Domestic firms, non-multinational; DM= domestic multinational; NM= Nordic multinational, ASM= Anglo-Saxon multinational; EOM= European and other multinationals.

The results of the selection equation are not reported here.

The Wald statistic tests joint significance and the LR tests the correlation of the two equations. If this correlation is not significantly different from 0, Heckman's model is equivalent to the combination of a regression for the outcome and a probit model for selection variable.

Table 17

Multi step production function model

Step 1: Selection equation Dependent variable: The probability to be an innovative firm			
	Coefficient		Std.err.
Foreign ownership	0.068		0.085
Size	0.198	***	0.029
Local markets		Reference	
National markets	0.337	***	0.106
Global markets	0.627	***	0.113
Recently established	-0.039		0.141
Recently merged	0.228	*	0.119
Human capital	0.539	**	0.215
Investment per employee (log)	0.065	***	0.022
Constant	-1.424	***	0.183
Step 2: Innovation input equation Dependent variable Log innovation expenditures per employee			
DU		Reference	
DM	0.651	***	0.230
NM	0.041		0.193
ASM	0.125		0.213
EOM	0.141		0.188
Size	-0.293	***	0.054
Local markets		Reference	
Regional markets	0.468	**	0.216
Global markets	0.936	***	0.254
Public funding for R&D	0.426	**	0.176
Process innovation	0.272	**	0.121
Continuous R&D	1.183	***	0.136
Constant	-0.604		0.678

Note: *** (**, *) indicates significance at the 1% (5%, 10%) level. DU= Domestic firms, non-multinational; DM= domestic multinational; NM= Nordic multinational, ASM= Anglo-Saxon multinational; EOM= European and other multinationals. 6 sector dummies included in the regression, not reported here.

Table 18

Multi step production function model (continued)

Step 3: Innovation Output equation Dependent variable: The log of innovation sales per capita			
	Coefficient		Std. error
DU	Reference		
DM	0.519	*	0.268
NM	0.638	***	0.212
ASM	0.455	*	0.228
EOM	0.308		0.226
Predicted innovation input	0.393	***	0.136
Predicted labour productivity	0.242		0.286
Size	-0.077		0.111
Inverted Mills' ratio from the selection equation.	-0.618		0.756
Public funding for R&D	-0.566	***	0.202
Collaboration diversity	0.992	**	0.398
Human capital	0.880	*	0.466
Constant	0.926		1.989
Step 4: Productivity equation Dependent variable: Log sales per employee			
DU	Reference		
DM	-0.103		0.156
NM	0.013		0.113
ASM	0.160		0.131
EOM	-0.051		0.112
Predicted innovation output	0.221	***	0.086
Physical Investment per employee (log)	0.183	***	0.050
Process innovation	-0.021		0.075
Size	0.006		0.026
Human capital	-0.357		0.243
Constant	4.095	***	0.224

Note: *** (**, *) indicates significance at the 1% (5%, 10%) level. DU= Domestic firms, non-multinational; DM= domestic multinational; NM= Nordic multinational, ASM= Anglo-Saxon multinational; EOM= European and other multinationals. 6 sector dummies included in the regression, not reported here.

APPENDIX

The endogenous variables

- Innovation engagement (the firm has introduced a product innovation, a process innovation or ongoing innovation projects, dummy)
- R&D and other investments per employee (log)
- R&D subsidies (dummy)
- The utilization of sources of knowledge for innovation from other enterprises or establishments within the group.
- Embeddedness in domestic innovation system (an aggregate of collaboration within the enterprise group, suppliers, clients, competitors, consultancies, competitors, private non profit research laboratories, universities, governmental R&D facilities, dummy)
- The utilization of knowledge from up and down the value chain (vertical) (customers and suppliers)
- The utilization of the domestic science base (scientific innovation system; universities, governmental R&D facilities and private R&D laboratories)
- The utilization of sources of knowledge for innovation from other enterprises or establishments within the group.
- Patents (dummy)
- Radical innovation (products new or significantly improved for the market, dummy)
- The return on innovation investments. Innovation sales per employee. (log)
- Labor productivity. Sales per employee. (log)

The exogenous variables, used in the selection equation (2):

- Foreign ownership (firms with headquarter in foreign country is used a proxy)
- Size (log employment)
- Productivity (log labor productivity)
- Significant market area – local, national or global (dummies)
- Newly established firm
- Recently merged firm
- Human capital (university educated/total employment)
- Tangible investment (log)
- High technology manufacturing sector, medium high technology manufacturing sectors, medium low technology manufacturing sectors, low technology manufacturing sectors, knowledge intensive services and other services (dummies)

The exogenous variables, used in the probit model (3):

- Classification of corporate governance: uninational Swedish firms, Swedish multinational firms, Nordic multinational, Anglo-Saxon multinational and European and Other multinationals (dummies)
- Size (log employment)
- Productivity (log labour productivity). This variable is not included in the multistep model.
- Significant market area – local, national or global (dummies))
- Newly established firm
- Recently merged firm
- Human capital (university educated/total employment)
- Tangible investment per employee (log)
- High technology manufacturing sector, medium high technology manufacturing sectors, medium low technology manufacturing sectors, low technology manufacturing sectors, knowledge intensive services and other services (dummies)

Determinant variables, the regressions of equation (4) and (5):

- Classification of corporate governance: uninational Swedish firms, Swedish multinational firms, Nordic multinational, Anglo-Saxon multinational and European and Other multinationals (dummies)
- Size (log employment)
- Human capital (university educated/total employment)
- Tangible investment per employee (log)
- Diversity (domestically and globally cooperation on innovation, dummy)
- Innovation input per worker (log)
- Significant market area – local, national or global (dummies)
- Product oriented innovation strategy (dummy)
- Process oriented innovation strategy (dummy)
- Continuous R&D (dummy)
- Public funding (dummy)
- High technology manufacturing sector, medium high technology manufacturing sectors, medium low technology manufacturing sectors, low technology manufacturing sectors, knowledge intensive services and other services (dummies)