FOTON

Foreign Takeovers in the Nordic Countries

3. Corporate innovation activities, does ownership matter?

The CIS Study Report

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Corporate Innovation Activities, Does Ownership Matter?

Evidence from the Innovation Surveys of the Nordic Countries

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The main objectives of FOTON are to study how foreign takeovers of firms in the Nordic countries affect local innovation capabilities and how this issue is approached by policy makers. FOTON is made up of three modules:

The first module is a statistical exercise providing an overall picture of foreign industrial ownership in the Nordic countries. A quantitative analysis of the effects of foreign ownership on firms' innovation performance is presented in FOTON report No. 3: *Corporate Innovation Activities - Does Ownership Matter?* Report No. 1 has a short overview of available statistics.

The second module consists of case studies of Nordic firms that have been taken over by foreign companies. To allow for inter-Nordic comparisons, takeovers within two specific industries have been selected: Pharmaceuticals and ICT. The main focus of the case studies is on how the takeovers have affected innovation capabilities, not only in the acquired firms but also – through these firms' linkages to local actors – in the surrounding innovation systems. Module 2 is presented in FOTON report No. 2: *Impacts of Foreign Takeovers in the Nordic Countries - what do the company case studies tell us?*

Module 3 studies policy developments of importance for foreign direct investments in general. The policy analysis is included in FOTON report No. 1: *Summary and Policy Recommendations.*

The reports can be downloaded for free from www.step.no/foton.

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1. Summary

Objectives

This study highlights the differences between domestic and foreign owned firms with respect to innovation, technology and productivity. The main question investigated is whether foreign takeovers imply benefits for the host country. The primary issue to be explored is if it is better for companies not to be taken over at all.

The study also seeks to assess the importance of different corporate governance styles: is it better for a domestically owned Nordic firm to be taken over by a company from some of the neighbouring Nordic countries, or is it more preferable if the takeover is an Anglo-Saxon company or a continental European company?

The fundamental research question is whether foreign-owned firms perform better than domestic firms *ceteris paribus* – every thing else being equal? If the ceteris paribus assumption is fulfilled, a reasonable conclusion is that a superior performance indicates possible welfare gains while inferior results in terms of innovation and productivity indicate the opposite.

Methodological issues

There are several methodological difficulties in assessing the importance of foreign-owned firms in the context of gain or drain of productive resources. One is that we don't know what would have happened with the acquired firms had they not been takeover.

For comparison analysis domestic firms are commonly used as a control group. However, such a comparison requires that the control group firms really are representative of what would have happened to the acquired firms had they not been taken over. Otherwise we need to use different statistical

The fundamental research question

The fundamental research question is whether foreign-owned firms perform better than domestic firms *ceteris paribus,* or every thing else equal? If the ceteris paribus assumption is fulfilled, a reasonable conclusion is that a superior performance indicates possible welfare gains while inferior results in terms of innovation and productivity signals welfare drain.

techniques in order to increase the comparability between domestically owned and foreign-owned firms.

Furthermore, the difficulties to properly capture and measure knowledge spillovers is perhaps even more challenging than the issue of reliable control groups.

This study attempts to solve the problem of comparing comparable firms by a combination of statistical and econometric analysis. The possible differences between domestic and foreign-owned firms are studied with respect to gaps regarding innovativeness, R&D and other innovation expenditures, embeddeddness in national innovation systems, R&D output and labor productivity.

The study is based on a large sample of 5 293 firm level observations in a cross-country comparison over the five Nordic countries Denmark, Finland, Iceland, Norway and Sweden. The five countries are all small economies with a large dependence on the international economy in terms of import and export and an extensive presence of foreign owned enterprises.

The present study explores the issue of corporate ownership in three dimensions.

First, domestic and foreign-owned firms are compared.

Second, we investigate differences between three groups of foreign owned firms (i) firms owned by other Nordic companies, (ii) firms with Anglo-Saxon owners, (iii) other firms which mostly have owners from other European countries.

Third, we are comparing domestic multinationals (firms with foreign affiliates) and domestic uninational (firms belonging to a group with only domestic affiliates). In addition to the large number of observations the study is characterised by an extensive set of firm characteristics on internal and external aspects of innovation.

Table 1.1

Number of observed firms in the study

	Domestic	**Foreign**	**Total**	**Foreign/Total**
Denmark	621	223	844	26,4
Finland	634	184	818	22,5
Iceland	80	27	107	25,2
Norway	1,642	685	2,327	29,4
Sweden	814	383	1,197	32,0
Total	**3,791**	**1,502**	**5,293**	**28,4**

The data used in the study is obtained from the internationally harmonised Community Innovation Survey III conducted by statistical agencies in the Finland, Iceland, Norway and Sweden, and a research institute in Denmark.

The focus is on both manufacturing and service firms. In total the data consists of 3,501 uninational firms, 259 domestic multinationals, 540 not domestically owned Nordic multinationals, 339 Anglo-Saxon multinationals and 654 European and other multinationals.

In Norway the survey is compulsory which explains the large number of observations. In the four other countries the rate of response was about 50 percent. The proportion of foreign-owned firms has a range from 22,5% in Finland to 32.0% in Sweden. The average for the Nordic counties is 28,4%. See Table 1.1

Table 1.2

Average firm size in employees

	Domestic uninationals		**Domestic multinationals**		**Foreign multinationals**	
	Mean	Median	Mean	Median	Mean	Median
Denmark	292	62	1 975	600	210	83
Finland	316	85	1 835	407	180	89
Iceland	75	36	181	181	81	29
Norway	150	61	406	133	222	82
Sweden	276	50	1 277	355	348	105
Average	**222**	**59**	**1 135**	**335**	**208**	**78**

A prominent feature in all Nordic countries, shown in Table 1.2, is that the domestic multinational firms are significantly larger than the domestic uninational firms and foreign owned firms. Domestic multinational firms are 4-5 times larger than the two other groups of firms regardless of the size being measured by the mean value or median value of the employment.

Hypotheses and suggestions

The main justification for the study is the growing importance of multinational firms and foreign direct investments (FDI) during recent decades. Between 1990 and 2001 production in enterprises located outside the country of residence of the owners 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 United Nations (2000) reports that the cross-boarder share of total acquisition and mergers have been relatively constant since the late 1980s.

Why are the firms investing in R&D abroad? Three different hypotheses can be distinguished in recent studies.

- The first hypothesis is that firms invest in foreign countries in order to exploit technological activities created within home countries.

- The second is that due to weakness in the home country, multinational enterprises conduct R&D in foreign affiliates in order to exploit the technological advantage of the host country.
- The third hypothesis is that due to increasing complexity of technology, firms need to monitor new technological developments worldwide to sustain the home-based competitive advantage.

The different explanations might have varying impact on transmission of technology and knowledge in the host countries and by those means also on innovativeness and economic growth.

Empirical regularities or stylized facts, which have emerged from a large number of comparison studies on domestic and foreign-owned firms, give some suggestions to the "gain or drain" discussion.

- First, there is robust evidence that within countries, foreign owned firms almost always pay higher wages than domestically owned firms.
- Second, foreign-owned firms generally have higher productivity then local firms.
- Third, the evidence for knowledge spillovers from foreign-owned firms to domestic firms is mixed.
- Fourth, the evidence for a general growth impact from foreign-owned multinationals on the host-country is mixed.

The literature suggests some alternative explanations for the differences in performance between domestic and foreign-owned firms.

- Some studies suggest that only firms with superior technology or superior productivity are candidates for acquisitions or mergers.
- Other studies find that FDI investment is oriented toward high productivity sectors.

Stylized facts

Empirical regularities or stylized facts, which have emerged from a large number of comparison studies on domestic and foreign-owned firms, give some suggestions to the "gain or drain" discussion. First, there is robust evidence that within countries, foreign owned firms almost always pay higher wages than domestically owned firms. Second, foreign-owned firms generally have higher productivity then local firms. Third, the evidence for knowledge spillovers from foreign-owned firms to domestic firms is mixed. Forth, the evidence for a general growth impact from foreign multinationals on the host-country is mixed.

- A third finding is that acquisitions and mergers have a positive impact on efficiency of firms *per se*.
- Finally, if the hypothesis on FDI as a strategy to exploit technological activities created within home countries is correct, a higher productivity due to scale economics or other competitive advantages should be expected.

Relevant indicators

This present study attempts to explain differences in different categories of innovation and growth measures. The differences are referred to as 'gaps'. In particular we investigate the following indicators:

- R&D and other innovation expenditures,
- product and process innovation that are ongoing or carried out,
- embeddedness in the innovation system horizontal and vertical innovation networks, scientific innovation network,
- possession of patents and patent application,
- radical innovations,
- innovation sales,
- labor productivity and
- public R&D funding.

Among the determinants of firms' innovation and productivity performance we have different categories of ownership, capital intensity, export and market orientation, focus of the firms innovation activities, R&D history, human capital and sector classification.

Research methodology

The research methodology used can be separated into three sequential steps.

- Initially a descriptive analysis is carried out on the basis of the extensive data.
- Then a selection model and appropriate control variables are introduced. The objective is to control for large heterogeneity and selection:
    - First, the study takes into account that extensive differences in firm performance possibly can be explained by idiosyncratic factors such as firm size, market orientation or sector.

  - Second, the study controls for the likelihood that R&D firms constitute a particular group of companies. Therefore, the comparison is focused only on innovative firms. However, information from the total sample is exploited in the analysis.

- In a final step the study considers a four-equation model that relates various determinants to research, research to innovation output and innovation output to labor productivity.

Raw data, main findings

The descriptive statistics, not controlling for any firm specific or industry specific differences, shows a robust pattern on superiority of foreign owned firms for all five Nordic countries.

The foreign owned firms in the Nordic countries are distinguished by having

(i) larger proportion of innovative firms,
(ii) higher R&D intensity,
(iii) higher level of innovation sales per employee,
(iv) larger proportion of firms applying for patents,
(v) larger proportion if firms possessing patents,
(vi) larger proportion of firms conduction R&D on regular basis,
(vii) larger export intensity,
(viii) stronger focus on global markets,
(ix) more human capital in terms of well educated people as a share of total employment,
(x) higher level of labor productivity,
(xi) stronger dependence on sources of knowledge for innovation from other enterprises within the group.

The findings on embeddedness in national innovation systems are more mixed.

In Denmark, Finland and Norway, the domestically owned firms are more integrated in the national innovation system compared to foreign-owned firms.

The integration is measured as share of the firms collaborating on innovation with domestic (host-country) innovation partners. Three innovation systems are considered: The scientific system, vertical partners in the value chain and horizontal partners in the value chain.

Within Iceland and Sweden a lager proportion of foreign-owned firms are integrated in the innovation system than domestic firms. Within Iceland and Sweden a larger percentage of the foreign owned firms is found to collaborate on innovation with domestic (host-country) partners compare to other firms.

Controlled data, main findings

In the regression part of the analysis the heterogeneity within the five observed samples is taken into account. Here, the study control for differences in innovation and productivity that can be related to factors as firm size, sector, human capital, physical capital, market orientation, innovation focus etc.

Moreover, the firms are separated into five different groups of owners, domestic uninational firms, domestic multinational firms, Nordic multinationals, Anglo-Saxon multinationals and European and other multinational firms. The main results are presented in tables 1.3 and 1.4.

Table 1.3:

Corporate ownership and gap in engagement in innovation activities.

Gap	**The importance of corporate ownership**						
	DOM	**FOR**	Den	Fin	Ice	Nor	Swe
The likelihood to carry out innovation projects.	-					-DM	
Investment in R&D and other innovation activities per employee	+++	+	-DM	+DM		+DM -NM +ASM	+DM
The probability of receiving public R&D support	+++	--		+DM -NM -EOM		+DM	+DM
The embeddedness in the domestic innovation system.	++++	+	+DM	+DM +NM		+DM	+DM
The embeddedness in vertical innovation system.	++++	+	+DM	+DM +NM		+DM	+DM
The embeddedness in the horizontal innovation system.	++			+DM			+DM
The embeddedness in the scientific innovation system.	++++	++	+DM	+DM		+DM	+DM +ASM +EOM
The utilization of knowledge for innovation from other enterprises within the group	++++	+++ +++ +++	+DM +NM +ASM	+DM +NM		+DM +NM +ASM +EOM	+DM +NM +ASM +EOM

Notes: Control group is uninational firms

+ (-) indicates significant association at the 1% or 5% 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.

Propensity to innovate:

The top part of table 1.3 depicts the results from the estimated propensity to carry out innovations. The most interesting finding is that no differences can be found between foreign owned firms and domestically owned firms among the Nordic countries.

Norway, however, deviate from the general Nordic pattern. Here domestic multinationals have a significantly lower likelihood of being innovative than other firms.

R&D and other innovation expenditures*:*

The evidence is compelling that domestic multinationals outperform foreign-owned firms in terms of R&D investments in Finland and Sweden, everything else being equal.

In Norway domestic multinationals and Anglo-Saxon multinationals have significantly higher R&D intensity than the control group of domestic uninationals, and Nordic multinationals, and European and other multinationals.

Public R&D support.

Conditional on that firms can be classified as innovative, domestic multinationals have a significantly larger likelihood of receiving public R&D subsidies than other groups of firms in Finland, Sweden and Norway. For foreign owned firms the likelihood of receiving public funding in Finland is significantly lower than for domestically owned firms.

For Denmark and Iceland no clear difference between the five groups of firms can be established.

Embeddedness in the national innovation systems

In this report we define national innovation systems (NIS) as an aggregate of vertical, horizontal and scientific innovation systems.

NIS is normally understood as the system of firms, knowledge institutions and other institutions that influence the innovative capabilities of firms. The premise is that the competences developed in one part of the system, may – directly or indirectly – influence the learning process in the firms that are part of that system, by the way of collaboration, the acquisition of goods and services, and other forms of knowledge and technology diffusion.

The evidence is very clear: Domestic multinationals in the Nordic countries are more integrated in the national innovation system than any other type of investigated firms.

The only group of firms that have the same presence in national innovations system as domestic multinationals is Nordic owned enterprises in Finland.

Embeddedness in the vertical innovation system

The result for the subset embeddedness in vertical innovation system is identical with the overall estimates for NIS. Vertical collaboration means collaboration with customers or suppliers in the same value chain.

Domestic multinationals are significantly more integrated in vertical collaboration for innovation than other firms. In Finland this conclusion is valid also for Nordic multinationals.

Embeddedness in the horizontal innovation system

In Finland and Sweden we find that domestic multinationals have a significant larger propensity to conduct horizontal cooperation on innovation with firms within the same industry than other firms.

In Denmark, Iceland and Norway no difference can be found between the five groups of firms.

Embeddedness in the scientific innovation system

The scientific innovation system is the part of the national innovation system that consists of knowledge institutions like universities, colleges and institutes.

The domestic multinationals play a dominant role in the scientific innovation system in Denmark, Finland and Norway.

This situation form a contrast to Sweden where foreign-owned firms with Anglo-Saxon or other owners show the same likelihood to participate in common research projects with universities and public R&D labs than Swedish multinationals.

In Iceland domestic and foreign-owned firms have the same propensity to be involved in the scientific innovation system

Knowledge sources from other enterprises within the group.

Not surprisingly we find that knowledge sources from other enterprises within the same corporate group play an important role for domestic as well as foreign-owned multinationals. This is most evident in the case of Finland, Norway and Sweden.

Conclusion: on possible gaps in engagement in innovation and technological activities

The most striking finding from the analysis on corporate ownership and engagement in innovation and technological activities is the dominating role of domestic multinationals in all Nordic countries. As the analysis for the Icelandic data does not allow us to discriminate domestic multinationals

from domestic uninationals the differences between domestically owned firms and foreign owned firms may be blurred.

Table 1.4:

Corporate ownership and gap in innovation and economic performance

Gap	**The importance of corporate ownership**						
The probability to patent.	**DOM** ++	**FOR** +++ +++	Den +NM +ASM	Fin +DM	Ice	Nor +NM +ASM +EOM	Swe +DM +ASM
Radical innovations	+++	++++	+DM +ASM	+DM +NM			+DM +ASM +EOM
The return on innovation investments (innovation sales)	+ +[1]	++ +++[1] ++++[1]	 +NM[1] +ASM	+DM +ASM[1]		 +NM[1] +ASM[1] +EOM[1]	+DM[1] +NM +ASM[1] +EOM[1]
The Economic performance (Labor productivity)		+ ++++[1] +[2]		 +NM[2] +ASM[1]		 +NM +ASM[1] +EOM[1]	 +ASM[1]

Notes: Uninational firms are the reference group.

+ (-) indicate significant association at the 1% or 5% level of significance

DM is domestic multinationals, NM Nordic multinationals, ASM, Anglo-Saxon multinationals and EOM is European and other multinational. [1]not significant in the multi-step analysis, [2]not significant in the selection models.

Patent application

A large variation in the propensity to patent between different groups of firms can be found in the Nordic countries. See table 1.4.

In both Denmark and Norway Nordic multinationals and Anglo-Saxon firms are significantly more likely to apply for patents than domestic uninational and multinational firms, and European and other foreign owned firms.

In Finland domestic multinationals have a higher propensity to apply for patent than other firms.

In Sweden domestic multinationals and Anglo-Saxon firms have lager patent intensity than other firms.

Radical innovations

Radical innovation captures the company's ability to launch products, processes or services that are new to the market, not only new to the company.

The most interesting finding from the estimation on radical innovation is that no systematic differences between company groups can be established in Denmark, Finland, Iceland and Sweden.

The most interesting finding from the estimation on radical innovation is that no systematic differences between foreign owned and domestically owned companies can be established in Denmark, Finland, Iceland and Sweden.

Domestic multinationals, however, exceed the domestic uninationals in their ability to launch products that are new to the markets in Denmark, Finland and Sweden. Foreign ownership matters in different countries differently. Anglo-Saxon owned companies show a higher performance in launching radical innovations in Denmark and Sweden and Nordic owned companies do so in Finland.

Norway is the odd man out as neither a domestic owned multinationals nor the foreign owned companies show a better performance in launching radical innovations**.**

Innovation sales

The ultimate goal with almost all innovation activities is to make profit. Innovation sales are a gross measure on the return on innovation investment, increasingly exploited in innovation studies based on Community Innovation Survey data.

In the present report two alternative measures are used to investigate the relationship between innovation sales and corporate ownership, a two-step selection model and a multistep production function model.

The summary results presented in Table 1.4 report the results of both models.

In the selection models domestic multinationals in Finland and in Sweden have a higher gross return on innovation investments compared to their uninational counterparts. With few exceptions foreign owned firms also show higher returns to innovation than the domestic uninational firms. Especially the Anglo-Saxon owned firms have significantly higher returns to innovation.

In Norway we observe the strongest influence of foreign ownership as foreign owned companies yield higher returns to innovation than domestic companies.

When a more sophisticated multistep knowledge production function model was exploited the superiority of the foreign owned companies was reduced in Denmark and Sweden, while it vanished totally in Finland and Norway.

Considering both models the robust results are quite mixed. Anglo-Saxon firms have the highest level of innovation productivity in Denmark. In Finland domestic multinationals reveals higher innovation sales per employee than other firms. In Sweden Nordic multinationals are superior to other firms. For Iceland and Norway no robust difference can be found.

Labour productivity

Previous research suggests that foreign-owned firms generally have higher productivity than domestic firms.

Looking at the selection models we find that Anglo-Saxon firms almost exclusively have higher labour productivity, which, however, vanishes when employing the more sophisticated multi-step models. Then Nordic owned firms are more productive in the case of Finland and Norway.

A possible explanation to these divergent results is the extensive set of firm characteristics and the exploitation of econometric methods appropriate for the peculiarities in the data set. A complementary explanation can be found in our method of distinguishing between uninational domestic firms and multinational domestic firms.

Is should, however, be noted that we find some indication (at the 5% level of significance in Norway, at the 10% level in Finland, and just outside the 10% level in Denmark) that Nordic multinationals are more productive than other firms in these three Nordic countries.

Concluding findings on possible gaps in innovation output and economic performance

Contrary to our finding on superiority of domestic multinationals in innovation engagement, no robust pattern can be established when innovation performance is considered for the Nordic area as a whole.

In Denmark and Norway foreign firm outperform domestic firms. In Iceland and Sweden no systematic differences can be found while the Finnish multinationals reveals a better innovation performance than other firms.

Regarding economic performance our study does not confirm the hypothesis that there is a gap between foreign and domestic firms among the Nordic countries.

Summary

To summarize, 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 5 293 firm-level observations in the five Nordic countries, of which approximately 30 percent from firms with foreign owners.

Our investigation whether foreign-owned firms perform better or worser than domestic firms, every thing else being equal, has yielded the following overall results:

No robust difference in the propensity to be innovative can be established. Among the group of innovative firms, foreign-owned multinationals are generally outperformed by domestic multinationals in R&D and innovation engagement.

Considering the results of innovation activities in terms of innovation output, however, the findings are somewhat mixed.

Finally, our results on labor productivity are at variance with the findings in a large number of previous comparison studies. No systematic difference can be found in productivity between foreign and domestic-owned firms.

The general pattern for the Nordic countries 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. A 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-owned multinationals are partly returns on activities created in their home countries.

Part I: Analysis for all the Nordic countries

2. Introduction

The objective of the research here is to investigate the impact of foreign takeovers on the innovation activities of the companies which have been taken over. The impact of foreign acquisition on innovative activities can be seen as the difference between the companies' innovative activities in two scenarios or "states":

1. In the case where there has been a takeover

2. In the case of no takeover.

For companies that have been taken over we can not observe their innovative activities in the counterfactual state: "What would the innovative activities have been had the companies not been taken over?" So we have to approximate the counterfactual state by companies which are not foreign owned.

The domestically owned companies serve as a proxy for the companies in the state of no takeover. We estimate the impact of foreign takeover by estimation of the difference as the difference between **foreign owned** firms and **domestically owned** firms.

Hence, the fundamental research question is whether foreign-owned firms perform or behave differently than domestic firms *ceteris paribus,* or every thing else being equal? If the ceteris paribus assumption is fulfilled, a reasonable conclusion is that a superior performance indicates possible welfare gains while inferior results in terms of innovation and productivity indicate the opposite.

This study attempts to solve the counterfactual problem when assessing the importance of foreign ownership in the Nordic countries by a combination of statistical and econometric analysis. The possible differences between domestic and foreign-owned firms are studied with respect to gaps regarding innovativeness, R&D and other innovation expenditures, embeddeddness in national innovation systems, R&D output and labor productivity.

The fundamental research question

The fundamental research question is whether foreign-owned firms perform better than domestic firms *ceteris paribus,* or every thing else being equal? If the ceteris paribus assumption is fulfilled, a reasonable conclusion is that a superior performance indicates possible welfare gains while inferior results in terms of innovation and productivity signals welfare drain.

The study is based on a large sample of 5 293 firm level observations in a cross-country comparison over the five Nordic countries Denmark, Finland, Iceland, Norway and Sweden. The five countries are all small economies with a large dependence on the international economy in terms of export and export and an extensive presence of foreign owned enterprises

The present study explores the issue of corporate ownership in three dimensions. First, domestic and foreign-owned firms are compared. Second, we investigate differences between three groups of domestic firms (i) firms owned by other Nordic companies, (ii) firms with Anglo-Saxon owners, (iii) other firms that mostly have owners from other European countries. Third, we are comparing domestic multinationals (firms with foreign affiliates) and domestic uninational (firms belonging to a group with only domestic affiliates). In addition to the large number of observations the study is characterised by an extensive set of firm characteristics on internal and external aspects of innovation.

The remaining part of this paper is organised as follows. Section 3 briefly reviews some important theoretical and empirical paper 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 concludes. In Section 7-11 the individual country studies are

3. Brief review of the literature

The objective of this study is to investigate the impact of ownership on the firms´ innovation performance and productivity. We differentiate between domestic and foreign owned firms and between multinational and uninational companies (i.e. domestic firms with no foreign subsidiaries). The study in restricted to firms belonging to a group.

Foreign owned firms are by definition multinational firms and ownership in another country is 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 per cent of world total output.

Statistics from UNCTAD (2002) indicate that this process – which Antràs and Helpman (2003) identifies as a growing specialization of the production – is continuing. It had 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 are distinguished from portfolio investment in that it implies a greater degree of foreign control, can be divided between acquisitions and investment in new companies or units (greenfield investments). 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 United Nations 2000, Lipsey (2002) reports that the cross-border shares of total acquisition and mergers in the world economy have been relatively constant since the late 1980s. Moreover, the literature suggests that foreign acquisitions by far exceed the 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. 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 to 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 the more productive ones 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 services, production of parts and components, assembly work, wholesale and retail distribution and more.

There is in particular an increased interest for foreign direct investments in R&D activities among academics and policy makers. One hypothesis is that foreign-owned firms possess superior technology and that some of that technological knowledge spills over into the economy of the host country (Lipsey, 2002). Indeed, Serapio and Dalton (1999) report that the growing FDI investments are closely associated with growing multinational involvement in R&D in foreign affiliates.

In recent literature large multinationals are characterized as 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 grater collaboration between actors, both across and within national boundaries.

3.1 Theoretical discussions on foreign ownership

Lipsey (2002) notices that much of the earlier economic literature on foreign direct investment, but not the business literature, treated it as a part of 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.[1]

In his survey of literature on home and host country 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-owned firms wish to gain access to location advantages of the host country, based on the host country endowments or the host country's technological skills – i.e. skills that are specific to the host country

[1] See for example Jaffe et al (1993), Feldman and Audretch (1995), Pavitt and Patel (1999) and Cantwell and Janne (1999).

in general. 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-owned 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 of the host country, and would come from firms in industries in which their own home country had comparative advantages in trade.

3.2 Empirical findings

Many empirical studies on role of FDI and foreign ownership are dealing with the effect of possible superior technology. If a technology gap exists between domestic and foreign owned firms we would 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 only because foreigners have taken over more efficient domestic firms. This possibility points to the importance of using panel data and follow firms before and after the acquisition.

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

The literature on internationalization of business suggests a number of different reasons for companies undertaking technological activities outside their home country.

Vernon (1966), for example, suggested that the main reason for foreign R&D activities is to exploit technological activities created within the home country.

More recent analyzes (for example Cantwell 1995, Dunning and Narula 1995) suggest that two other factors have become increasingly important. These are 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 complexity of technology and the resulting rise in the cost of R&D. In the former case a company would be active abroad in technologies where the complimentarily between (i) the strength of the host country and (ii) its own domestic strength. In the

latter case a company is simply interested in exploiting the technical advantage of the host country in order to alleviate technological weakness at home.

Pavitt and Patel (1999) find that most MNCs 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, a comparison of the technological advantage of the company at home and the advantage of the location shows that in a large majority of cases, firms tend to locate their technology abroad in their core areas where they are strong at home.

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 those areas of technology where there have been big increases and where they have formed strategic alliances. In a large majority (more than 75%) of cases, firms tend to locate their technology abroad in their core areas, i.e. areas where they are strong at home. In a small minority of cases (10%), firms go abroad in their areas of weakness at home to exploit the technological advantage of the host country.

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 MNC locate their activities abroad in technological areas or fields where they are strong at home. In terms of policy implications 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 example of a study trying to account for the dynamic aspect of foreign ownership. The focus is 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 to 2000 the authors find that 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 innovativeness of foreign owned firms versus domestically 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 explain the grater innovativeness of foreign-owned firms by a larger concentration in science-based sectors and by being in larger in size when compared to domestic firms. However, in the majority of technologically intensive sectors domestic firms outperform domestically owned firms, especially in terms of R&D intensity, while an opposite pattern characterize the medium and low innovative industries.

Based on their results Balcet and Evangelista suggest that the innovation strategies of foreign owned firms are strongly affected by strengths and weakness of the innovation systems in the Italian host country. In the case of most science-based and scale intensive sectors, the attractiveness if Italy is low while the foreign owned firms seems to be attracted by the competencies and know-how accumulated in all traditional and mechanical engineering industries, where Italy holds a clear competitive advantage.

Frenz and Ietto-Gillies (2004) are using a U.K. data set containing 679 observations from CIS 2 and CIS 3 for testing the hypothesis that multinationality per se affects the propensity to innovate. Comparing domestic and foreign owned firms being part of a multinational versus firms being part of a uninational company they find that those CIS enterprises that belongs 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 ownership of firms is dealing with 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 U.S.- owned plants of non-multinational firms, even large firms, in both labor productivity and TFP[2], but that they were behind plants owned by U.S. multinationals. Girma et al (2001) found in their data set that among firms with no change in ownership, foreign-owned firms in the United Kingdom had labor productivity about 10 per cent above that for domestically-owned firms and total factor productivity about 5 per cent higher. Conyon et al (1999) fond that the acquisition of UK firms by foreigners led to increases in their productivity.

One might suspect that foreign-owned firms choose to acquire plants with high productivity, and that this may explain the differences. A study by Harris and Robinson (2002) on what kind of companies foreign firms choose, does indeed suggests that foreign-owned firms selected plants with a relatively high productivity. Each group of plants were compared with a reference group consisting of plants belonging to UK multiplant firms that did not sell any plants to foreign-owned firms during 1982-1992.

[2] Total factor productivity

Investigating foreign ownership in the Swedish manufacturing sector between 1990 and 2000, Lundberg and Karpaty (2004) rejected the hypothesis that foreign owned companies had a relatively higher productivity before the takeover.

The evidence on innovation and productivity in the literature is quite strong on more innovative and more productive foreign owned firms, but the attempts to explain differences between domestic and foreign-owned firms are less unanimous.

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 foreign owned firms requires two things:

- first that the subsidiary has to establish business relationship with local counterparts as well as suppliers, competitors, customers, government agencies, in order to be able to absorb meaningful knowledge from the local competitive environment; and
- second, that investment in R&D is needed to support the development of new competence an learning.

The results presented by Furu confirm previous finding by Andersson (1997) that the performance of foreign owned firms is largely dependent on its embeddedness in the network of local firms, e.g., local customers, suppliers, research institutes, and competitors.

4. Research questions and methodology

Our fundamental research problem is to measure the influence of foreign ownership on firms' innovation performance among the five Nordic countries. In addition we are also interested in the economic impact in terms of productivity. A main challenge is what in the statistics literature is discussed as the lack of *counterfactual evidence*: We do not know what would have happened with the foreign owned firms' innovation and productivity performance in the absence of acquisition or mergers.

If the domestic firms are not representative of what would have happened to the foreign-owned firms in the counterfactual situation of no takeover we must try to solve the sample selection problem.

The research methodology used can be separated into three sequential steps. Initially a descriptive analysis is carried out on the basic of the extensive data. Then a selection model and appropriate control variables are introduced. The objective is to control for large heterogeneity and selection: First, the study takes into account that extensive differences in firm performance can possibly be explained by idiosyncratic factors such as firm size, market orientation or sector. Second, the study control for the likelihood that R&D firms constitute a particular group of companies.

Therefore, the comparison is focused only on innovative firms. However information from the total sample is exploited in the analysis. In a final step the study considers a four-equation model that relates various determinants to research, research to innovation output and innovation output to labor productivity.

In this section we will introduce the research questions in terms of a number of gap-hypotheses. Then the appropriateness and quality of the data is discussed. A description of the research methodology and the data concludes.

4.1 Research questions

Table 4.1 shows the 12 hypotheses that are raised in the study. The upper part of the table considers hypotheses on various aspects of engagement in innovation activities.

First we ask if foreign owned firms have a lager probability to carry out innovation activities, every thing else being equal. We are then interested in whether domestic governments systematically discriminate between domestic and foreign ownership when subsidising R&D investments. The subsidy variable is also used as a control variable when we compare the amount of investments in R&D and other innovation activities between firms with respect to the ownership issue.

Furthermore, the potential differences in embeddedness in various nation (host-country) innovation systems are analysed. We are also interested in how foreign-owned firms differ from domestic firms when the utilization of sources for knowledge for innovation from other enterprises within the group are considered.

The lower part of Table 4.1 presents the four hypotheses on possible gaps in the results of innovation activities. The first hypothesis considers the propensity to apply for patents, the second the degree of novelty characterising the innovations, and the third hypothesis has reference to innovation productivity. It measures innovation sales per employee between the five categories of firms in the study.

Finally, we are comparing levels of labor productivity between the innovative foreign and domestic firms in Denmark, Finland, Iceland, Sweden and Norway.

Table 4.1:

Gap-hypotheses

Hyp	**Engagement in Innovation. Foreign ownership influences:**
1.	The likelihood to carry 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 the domestic innovation systems (scientific. vertical, horizontal).
5.	The utilization of knowledge from up and down the value chain (vertical innovation system)
6.	The utilization of knowledge from within the same industry (horizontal innovation system)
7.	The utilization of the domestic science base (scientific innovation system)
8.	The utilization of sources of knowledge for innovation from other enterprises within the group
	Results of Innovation Activities. Foreign ownership influences:
9.	The probability to patent
10.	The ' focus of innovation (radical innovation=new for the market)
11.	The return on innovation investments (innovation sales)
12.	The Economic performance (Labor productivity)

4.2 Data

The research questions relate to innovation activities and foreign ownership, and most of the data sources relating to the internationalization of corporate R&D contain some information about the questions at stake. Table 4.2 contains a brief assessment of the available data sources, their strengths and weaknesses.

As the core of this analysis is to obtain a common view on all Nordic countries, comparability is important when selecting data sources. As the analysis also looks at innovation activities as such, the analysis heavily depends on the comprehensiveness of the items covered in the data sets. The Community Innovation Survey represent such as data sources.[3]

Community innovation survey data is increasingly being used as a key data source in the study of innovation at the firm level in Europe. Data based on the homogenized CIS questionnaire is not only available for the EU member states. Also Norway and Iceland participate in the CIS initiative. Table 4.3 summarizes the details of the CIS 3 methodology for each of the Nordic countries. Within Europe, CIS surveys are usually conducted every five years. The third and most recent wave of the CIS was carried out in 2001. It covers the years 1998 to 2000. CIS surveys follow the 'subject-oriented' approach because they ask individual firms directly whether they were able

[3] CORDIS has more information on the Community Innovation Survey: http://www.cordis.lu/innovation-smes/src/cis.htm

to produce an innovation. The CIS is widely piloted and tested before implementation and, since it was first used in the early 1990s, the questionnaire has been continuously revised. The CIS bases on previous experience with 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.

Table 4.2

Data sources for analysis of internationalization of innovation activities

Data source	Measure	Strength	Weaknesses	Sources
R&D surveys	Innovation expenditure	Regular and recognised data on main source of technology, large samples	Lacks detail, no output measure, no indicators for motives etc.	OECD R&D surveys
Patents counts	Patenting activity	Regular detailed & long-term data available by firm, location, industry, technical fields	Uneven propensity to patent amongst countries, sectors and companies; misses software	US PTO EPO
Innovation Surveys (CIS)	Innovation input, innovation output, innovation process characteristics, firm characteristics	Systematic data on innovative activities of foreign owned & domestic firms, homogenous across countries	Cross section, no panel, sample size, subjective answers	National Sources,
Other Ad Hoc Surveys		Detailed data, e.g. on motivations for conducting foreign R&D	Uneven coverage across countries	Various

Source: based on Patel (2004)

Although far from being perfect, CIS data does provide a useful supplement to the traditional measures of innovation, such as patent statistics, as it covers the innovative efforts of firms, their innovation strategies, their innovation success and to a certain degree it allows to assess the innovation induced performance changes of firms. As compared the R&D and patent data, innovation output indicators in the CIS have the advantage of measuring innovation directly (Kleinknecht et al 2002). The new indicators in CIS capture the market introduction of new products and services and their relative importance for the innovators sales.

In addition to the new set of innovation output variables the CIS data offers internationally comparable data, a feature which – with few exceptions such as Janz et al. (2003), Lööf and Heshmati (2002) or Czarnitzki et al (2004) – has not been utilized, yet.

Table 4.3

Methodology for each of the Nordic countries[4]

Country	Survey method	Participation	Sampling frame
Denmark	Postal +Telephone	Voluntary	Private Business Register 'NewBiz'.
Finland	Postal	Voluntary	Finnish Business Register
Iceland	Postal + Telephone	Voluntary	The register of Enterprises
Norway	Postal	Mandatory	Statistics Norway's Central Register of Establishments and Enterprises
Sweden	Postal	Voluntary	Swedish Business Register

Note: Taken from Götzfried (2003)

4.3 Methodology and variables used

Although the CIS data set contains sampling weights for the whole data set we choose not to use the weights for two reasons.

First, the sampling weights stratify the sample according to size, industry and innovativeness. They do not refer to foreign ownership. So using the sampling weights we may even include a larger distortion of the sample.

Second, it is argued that not weighting the observations is closer to their economic significance (cf. Tether 2001). So, fundamentally, when we speak about, say, Finland or the Finnish firms, we mean the firms in the data set. Regrettably, being restricted by the available data we have to leave it open whether or not our findings are representative for the whole economy. However, as suggested by Tether (2001) looking at the economic weight of firms, rather than looking at their sampling weight, we would argue that the findings of this analysis do represent the differences between foreign owned and domestically owned firms.

As this analysis endeavours to establish the difference between foreign owned and domestically owned firms, we restrict the firms in our sample to the 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. Only a fraction of the domestically owned firms, are part of a corporate group, though. Observing a difference between foreign owned firms and domestically owned firms would in this case also include the effect of group membership. To eliminate this effect, we only analyze firms that are part of a corporate group. Hence, talking about firms we implicitly mean firms belonging to a corporate group.

[4] The size of the Icelandic economy required and enabled Statistics Iceland to carry out a special sampling procedure. Statistics Iceland collected *all* 798 Icelandic companies above with 10 employees or above and conducted a telephone survey on whether or not they carry out innovation activities. Subsequently the CIS questionnaire was sent to the 471 innovation active companies with a response of 223 companies. 60 of the responding companies turned out to be not innovation active, although having claimed to carry out innovation activities in the telephone survey.

We try do give a most comprehensive picture of the effects foreign ownership has on the innovation activities of firms. We do so by analysing the CIS data sets by means of two econometric setups. First, we employ sample selection models; second we employ a complete production model in the vein of Crepon, Duguet and Mairesse (1998).

Selection models

To analyze the hypothesis given in section 0 above, depending on the type of the exogenous variable, we use two different, yet quite comparable econometric models. The common idea of the econometric models is that it takes account of the fact that the dependent variable, say, the innovation effort, is only observed for innovative companies, companies, that is, which have decided to engage in innovation activities. The decision to be innovative, however, is not independent of certain firm characteristics such as size, investment activities, foreign ownership, etc. Both the decision about the innovation effort and the decision about the innovation activity have to be modeled simultaneously. If the dependent variable *k* is a continuous variable we use a Heckman selection model described in equations (1) and (0). If the dependent variable is a dummy variable *k* we use a Heckman probit model.

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

$$k = \beta_0^1 + \sum_m \beta_m^1 x_m^1 + \varepsilon^1$$

…with *k* being a continuous variable (1)

…with *k* being a dichotomous variable (2)

where g^* is a latent innovation decision variable, *k* represents innovation input. *x* are the exogenous variables and ε are the error terms.

Endogenous variables

A description of the endogenous variables can be found in table 4.4 used to test the hypothesis. For the selection models each gap hypothesis will be tested in a separate regression model. Each hypothesis hence relates to an equation in the regression models.

Table 4.4:

Endogenous variables

Hyp		
1	Innovation activity	Product innovation or process innovation or ongoing R&D project (dummy)
2	Innovation input	Innovation effort per worker (log)
3	Funding	Public funding (dummy)
4.	Embeddedness in the domestic innovation system	Aggregate of 5, 6 and 7 below.
5	Utilization of domestic knowledge up and down the value chain	Domestic vertical innovation collaboration (dummy)
6	Utilization of domestic knowledge from within the same industry	Domestic horizontal innovation collaboration (dummy)[1]
7.	Embeddedness in the domestic science base	Collaboration with domestic universities or research institutes (dummy)
8.	Utilization of domestic knowledge from within the group	Dummy variable for sources of knowledge for innovation from other enterprises within the group
9	Patent behaviour	Patent application (dummy) [1]
10	Quality level of innovation	Product new to the market (dummy)
11	Innovation output	Sales from new / modified products per worker (log)
12	Productivity	Sales per worker (log)

Note: 1 not used for the analysis of the Icelandic data.

Exogenous variables

Based on the literature about corporate governance styles reviewed above, we suspect that the home country of the corporate group matters for determining the innovation activities of the firms. Hence, we include information about the home country of the corporate group in the analysis.

Ex ante we build country groups that are supposed to yield similar corporate governance styles, or that are of particular interest in this analysis. We group companies together that are part of Anglo-Saxon owned corporate

groups, including UK-owned, US-owned, Irish, Canadian and South African corporate groups.

Of particular interest in this study are the Nordic countries; so we group, Danish, Finnish, Icelandic, Norwegian and Swedish[5] owned companies into this category.

All other home countries in the sample are grouped into the category European and others, where European countries clearly prevail.[6]

In estimating the selection equation and in the descriptive statistics below we differentiate between foreign owned and domestically owned companies.

Within the domestically owned companies we differentiate the domestically owned companies and companies which are a part of a domestically owned multinational group.

All companies in the sample belong to corporate groups. Companies, which are not part of a domestically owned multinational, are supposed to be part of groups with only domestic facilities.[7]

Table 4.5 and Table 4.6 summarize the exogenous variables used in the selection models.

[5] Of course, for each analyzed country the foreign owned country group labelled 'Nordic' consists only of the four non-domestic Nordic countries.

[6] Due to the small sample size in the Icelandic data set we cannot maintain the country group differentiation for Iceland. We use the foreign owned / domestically owned dichotomy instead.

[7] Details about the generation of the grouping variables can be found in Appendix.

Table 4.5:

Exogenous variables for the selection equation (0)

Variable	DK	FI	IS	NO	SE
Foreign ownership	X	X	X	X	X
Size (log employment)	X	X	X	X	X
Productivity (log labor productivity)	X[1]	X[1]	X[1]	X[1]	X[1]
Significant market area - local (dummy)l	/	/	/	/	/
Significant market area - National (dummy)	X	X	X	X	X
Significant market area - global (dummy)	X	X	X	X	X
Established	X	X	X	X	X
Merged	X	X	X	X	X
Human capital	X	X	X	X	X
Tangible investment (log)	X	X	X	X	X
High technology manufacturing sector	X	X	X	X	X
Medium high technology manufacturing sectors	X	X	-	X	X
Medium low technology manufacturing sectors	X	X	-	X	X
Low technology manufacturing sectors	/	/	-	/	/
Knowledge intensive services	X	X	X	X	X
Other services	X	X	X	X	X
Processing and preserving of food (dummy)	-	-	X	-	-
Manufacturing (dummy)	-	-	/	-	-

Note: X variable in regression, / variable used as reference category, - variable not in regression,
[1]variable not in regression for the hypothesis 9

Table 4.6

Exogenous variables for the regressions of equation (1) and (2)

Variable	DK	FI	IS	NO	SE
Foreign ownership	-	-	X	-	-
Domestic non multinational (dummy)	/	/	-	/	/
Domestic multinational (dummy)	X	X	-	X	X
Nordic multinational (dummy)	X	X	-	X	X
Anglo-Saxon multinational (dummy)	X[2]	X	-	X	X
European multinational or other (dummy)	X	X	-	X	X
Size (log employment)	X	X	X	X	X
Innovation input per worker (log)	X[1]	X[1]	X[1]	X	X
Significant market area – local (dummy)	/	/	/	/	/
Significant market area – national (dummy)	X	X	X	X	X
Significant market area – global (dummy)	X	X	X	X	X
Product oriented innovation strategy (dummy)	X	X	X	X	X
Process oriented innovation strategy (dummy)	X	X	X	X	X
Continuous R&D (dummy)	X	X	X	X	X
Public funding (dummy)	X	X	X	X	X
High technology manufacturing sector (dummy)	X	X	-	X	X
Medium high technology manuf. Sectors (dummy)	X	X	-	X	X
Medium low technology manuf. Sectors (dummy)	X	X	-	X	X
Low technology manufacturing sectors (dummy)	X	X	-	X	X
Knowledge intensive services (dummy)	X	X	X	X	X
Other services (dummy)	X	X	X	X	X
Processing and preserving of food (dummy)	-	-	X	-	-
Manufacturing (dummy)	-	-	/	-	-

Note: X variable in regression, / variable used as reference category, - variable not in regression. [1]variable not in regression for the hypothesis 1, [2]variable not in regression for hypothesis 8 as no Anglo-Saxon owned companies had horizontal domestic collaboration,

Models a la Crepon Duguet & Mairesse

The theoretical model we consider is a modified version of the standard Cobb-Douglas production function. The approach used can be simplified by the following relationship:

$$\log Y = \alpha + \beta \log \mathrm{X} + \gamma \log K + \varepsilon \qquad (3)$$

where Y is productivity at the firm level, X is a vector of standard inputs, and K is knowledge capital capturing the transformation process from innovation input to innovation output, and α and ε represent systematic and random fluctuations, respectively, in productivity. Here, the focus is on

estimation of γ, the elasticity of productivity with respect to knowledge capital.

The empirical model in the study is a modified version of the production function model introduced by Pakes and Griliches (1984) and further developed by Crepon, Duguet and Mairesse. (1998). The model, referred to as the CDM model, includes four equations and three established relationships including the innovation input linked to its determinants, so called knowledge production function relating innovation input to innovation output, and the productivity equation relating innovation output to productivity.

The basic econometric problems that the empirical model aims to solve are selectivity and simultaneity biases. When only R&D investing firms are considered, which is most common in innovation studies, a selection bias may arise. And when several links in the process of transforming innovation investment to productivity is considered in a simultaneous framework, one possible problem emerging is that some explanatory variables often are determined jointly with the dependent variable, i.e. they are not exogenously given and there will be simultaneity bias in the estimates.

The first two equations in our version of the CDM-model are estimated separately as a generalized tobit model where observations on both innovative and non-innovative firms are included. It should be noted that the first two steps of the model are econometrically identical with the Heckman selection model presented in section above. The last two equations are estimated in a simultaneous equation system where the endogenous innovation output variable is limited only to strictly positive values in the last step. More specifically, we have the following equations:

$$g^* = \beta_0^0 + \sum_n \beta_n^0 x_n^0 + \varepsilon^0 \quad (4)$$

$$k = \beta_0^1 + \sum_m \beta_m^1 x_m^1 + \varepsilon^1 \quad (5)$$

$$t = \beta_0^2 + \beta_k k + \beta_{MR} MR + \sum_l \beta_l^2 x_l^2 + \varepsilon^2 \quad (6)$$

$$q = \beta_0^3 + \beta_t t + \sum_j \beta_j^3 x_j^3 + \varepsilon^3 \quad (7)$$

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 employment, human capital and various innovation indicators variables. The coefficients β^0 and β^1 are vectors of unknown parameters to be estimated reflecting the

impact of certain factors on the probability of being engaged in R&D and other innovation investments and on the actual level on these investments, the β^2 is parameters associated with the level of innovation output while β^3 is associated with the level of productivity.

The $\varepsilon^0, \varepsilon^1, \varepsilon^2$ and ε^3 are random error terms. We assume that the two error terms in the selection model are correlated and the two error terms in the simultaneous equation system are correlated. In addition, due to the predicted Mills' ratio and the predicted innovation input estimate in equation (6), both generated from the selection model there is also a partial correlation between the error terms in the selection equation and the simultaneous equation. The two last equation can be estimated by two stage least square or three stage least square. In this report we are utilizing the 2SLS estimator.

Tables 4.7 to 4.10 summarize the exogenous variable of the individual country analysis.

Table 4.7:

Exogenous variables for the selection equation (4)

Variable	DK	FI	IS	NO	SE
Foreign ownership	X	X	X	X	X
Size (log employment)	X	X	X	X	X
Significant market area - local (dummy)l	/	/	/	/	/
Significant market area - National (dummy)	X	X	X	X	X
Significant market area - global (dummy)	X	X	X	X	X
Established	X	X	X	X	X
Merged	X	X	X	X	X
Human capital	X	X	X	X	X
Tangible investment (log)	X	X	X	X	X
High technology manufacturing sector	X	X	X	X	X
Medium high technology manufacturing sectors	X	X	-	X	X
Medium low technology manufacturing sectors	X	X	-	X	X
Low technology manufacturing sectors	/	/	-	/	/
Knowledge intensive services	X	X	X	X	X
Other services	X	X	X	X	X
Processing and preserving of food (dummy)	-	-	X	-	-
Manufacturing (dummy)	-	-	/	-	-

Note: X variable in regression, / variable used as reference category, - variable not in regression,
[1]variable not in regression for the hypothesis 9

Table 4.8

Exogenous variables for the regressions of equation (5)

Variable	DK	FI	IS	NO	SE
Foreign ownership	-	-	X	-	-
Domestic non multinational (dummy)	/	/	-	/	/
Domestic multinational (dummy)	X	X	-	X	X
Nordic multinational (dummy)	X	X	-	X	X
Anglo-Saxon multinational (dummy)	X[2]	X	-	X	X
European multinational or other (dummy)	X	X	-	X	X
Size (log employment)	X	X	X	X	X
Innovation input per worker (log)	X[1]	X[1]	X[1]	X	X
Significant market area – local (dummy)	/	/	/	/	/
Significant market area – national (dummy)	X	X	X	X	X
Significant market area – global (dummy)	X	X	X	X	X
Continuous R&D (dummy)	X	X	X	X	X
Public funding (dummy)	X	X	X	X	X
High technology manufacturing sector (dummy)	X	X	-	X	X
Medium high technology manuf. Sectors (dummy)	X	X	-	X	X
Medium low technology manuf. Sectors (dummy)	X	X	-	X	X
Low technology manufacturing sectors (dummy)	/	/	-	/	/
Knowledge intensive services (dummy)	X	X	X	X	X
Other services (dummy)	X	X	X	X	X
Processing and preserving of food (dummy)	-	-	X	-	-
Manufacturing (dummy)	-	-	/	-	-

Note: X variable in regression, / variable used as reference category, - variable not in regression. [1]variable not in regression for the hypothesis 1, [2]variable not in regression for hypothesis 8 as no Anglo-Saxon owned companies had horizontal domestic collaboration,

Table 4.9

Exogenous variables for the regressions of equation (6)

Variable	DK	FI	IS	NO	SE
Foreign ownership	-	-	X	-	-
Domestic non multinational (dummy)	/	/	-	/	/
Domestic multinational (dummy)	X	X	-	X	X
Nordic multinational (dummy)	X	X	-	X	X
Anglo-Saxon multinational (dummy)	X[2]	X	-	X	X
European multinational or other (dummy)	X	X	-	X	X
Size (log employment)	X	X	X	X	X
Innovation input per worker (predicted)	X[1]	X[1]	X[1]	X	X
Predicted labour productivity	X	X	X	X	X
Inverted Mill's ratio for the selection equation (4)	X	X	X	X	X
Collaboration diversity	X	X	X	X	X
Human capital	X	X	X	X	X
Continuous R&D (dummy)	X	X	X	X	X
Public funding (dummy)	X	X	X	X	X
High technology manufacturing sector (dummy)	X	X	-	X	X
Medium high technology manuf. Sectors (dummy)	X	X	-	X	X
Medium low technology manuf. Sectors (dummy)	X	X	-	X	X
Low technology manufacturing sectors (dummy)	X	X	-	X	X
Knowledge intensive services (dummy)	X	X	X	X	X
Other services (dummy)	X	X	X	X	X
Processing and preserving of food (dummy)	-	-	X	-	-
Manufacturing (dummy)	-	-	/	-	-

Note: X variable in regression, / variable used as reference category, - variable not in regression. [1]variable not in regression for the hypothesis 1, [2]variable not in regression for hypothesis 8 as no Anglo-Saxon owned companies had horizontal domestic collaboration,

Table 4.9

Exogenous variables for the regressions of equation (7)

Variable	DK	FI	IS	NO	SE
Foreign ownership	-	-	X	-	-
Domestic non multinational (dummy)	/	/	-	/	/
Domestic multinational (dummy)	X	X	-	X	X
Nordic multinational (dummy)	X	X	-	X	X
Anglo-Saxon multinational (dummy)	X[2]	X	-	X	X
European multinational or other (dummy)	X	X	-	X	X
Size (log employment)	X	X	X	X	X
Innovation input per worker (predicted)	X[1]	X[1]	X[1]	X	X
Predicted labour productivity	X	X	X	X	X
Inverted Mill's ratio for the selection equation (4)	X	X	X	X	X
Process innovation	X	X	X	X	X
Investment per employee	X	X	X	X	X
Public funding (dummy)	X	X	X	X	X
High technology manufacturing sector (dummy)	X	X	-	X	X
Medium high technology manuf. Sectors (dummy)	X	X	-	X	X
Medium low technology manuf. Sectors (dummy)	X	X	-	X	X
Low technology manufacturing sectors (dummy)	X	X	-	X	X
Knowledge intensive services (dummy)	X	X	X	X	X
Other services (dummy)	X	X	X	X	X
Processing and preserving of food (dummy)	-	-	X	-	-
Manufacturing (dummy)	-	-	/	-	-

Note: X variable in regression, / variable used as reference category, - variable not in regression. [1]variable not in regression for the hypothesis 1, [2]variable not in regression for hypothesis 8 as no Anglo-Saxon owned companies had horizontal domestic collaboration,

5. Results

The following section delivers a synopsis of the country analysis of all five Nordic countries. Consequently it will lack some aspect with can be found in the more detailed country analysis, which can be found in part 2 of this study. When discussing the exploratory analysis in the sections below we confine ourselves to report only the figures for domestic firms (DOM) which we split up into domestic uninationals (DU), domestic multi-nationals (DM). We also report the results for foreign owned firms (FOR).

5.1 Preliminary findings from the descriptive statistics

In this section we describe the distribution of the total sample of 5 293 observed firms with respect to ownership, sectors firm size and market orientation.

5.11 Distribution of all companies and innovative companies

Table 5.1

Distribution of domestically owned and foreign owned firm

	Denmark		Finland		Iceland		Norway		Sweden	
	Total	Innov.	Total	Innov.	Total	Innov.	Total	Innov.	Total	Innov.
DOM	**73.6**	**73.5**	**77.5**	**76.9**	**74.8**	**71.4**	**69.2**	**71.6**	**68.0**	**64.3**
DU	92.4	86.4	85.3	76.5	97.5	95.0	96.6	93.1	92.4	86.1
DM	7.6	13.6	14.7	23.5	2.5	5.0	3.4	6.9	7.6	13.9
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
FOR	**26.4**	**26.5**	**22.5**	**23.1**	**25.2**	**28.6**	**30.8**	**28.4**	**32.0**	**35.7**
NM	37.2	36.8	39.1	39.5	29.6	25.0	33.4	34.3	36.0	34.3
ASM	22.9	24.0	29.3	33.6	37.0	43.8	16.6	22.6	27.4	28.2
EOM	39.9	39.2	31.5	26.9	33.3	31.3	50.0	43.1	36.6	37.5
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	100	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Notes: Distribution of domestic and foreign owned companies; numbers are percent. Total indicates the whole sample of companies being part of a corporate group. Innov. indicates the sub-sample of innovation active companies. DOM= Domestically owned firms; FOR= foreign owned firms; DU= Domestic uninational firms; DM= domestic multinational; NM= Nordic multinational, ASM= Anglo-Saxon multinational; EOM= European and other multi-nationals.

Table 5.1 summarize the distribution of domestically owned and foreign owned firms in the sample. We display the distribution of the total sample of companies and the sub-sample of innovative companies in terms of foreign vs. domestically owned firms. The domestically owned firms are subdivided into domestic groups and domestic multinationals. For the foreign owned companies we display the distribution across Nordic owners, Anglo-Saxon owners and European owners.

Although we use an unweighted sample of companies for each country some distributional pattern are striking here.

Across Denmark, Finland, Iceland the share of foreign owned companies seems to be quite constant around 25 % – slightly less in Finland, though. Norway and Sweden host a larger fraction of foreign owned companies.

Also among the innovation active companies the share of foreign owned companies seems to be quite constant with Norway being comparable to Denmark, Finland and Iceland. Also here, Finland hosts the lowest fraction. In Sweden we find the largest share of foreign owned companies among the innovation active companies.

Interestingly, the share of foreign owned companies is higher among the innovation active companies than it is among the whole sample of companies, roughly indicating that innovation activity is slightly less frequent among domestically owned firms than it is among foreign owned firms.

Among the foreign owned Icelandic companies the Anglos-Saxon ownership is strongest with the US representing 80% of this country group.

In Denmark the strongest group among the foreign owned firms are both the Nordic as well as the European countries, where the neighbouring countries such as the Germany, Sweden, Norway and the Netherlands clearly prevail.

The foreign owned companies in Sweden are also to a large degree controlled by firms in neighbouring countries. In the study 36 percent are Nordic multinationals. This share is about the same is reported by official statistics for enterprises with 10 or more employees.[8]

With its rather peripheral location Finland's foreign owned companies tend to be owned by Nordic firms. Anglo-Saxon and European ownership is equally likely, however, although not as likely as Nordic ownership.

The largest share of foreign owned companies in Norway is under European ownership.

This brief analysis suggests two findings: Although the institutional and local conditions in the Nordic countries vary, internationalization in the shape of foreign ownership is a ubiquitous phenomenon.

The sketchy analysis above reveals some variation in the degree of foreign ownership. The analysis also suggests that the location of the country matters in terms of attractiveness for investment. Proximity and cultural similarity seems to play a role on the companies' selection. Iceland being closest to the US shows the highest rate of US American ownership.

[8] ITPS statistics on foreign owned firms in Sweden 2001 showed at 34.1% of the enterprises were controlled by Nordic firms. In our CIS-sample the corresponding share was 36.0%. The percentage of Anglo-Saxon firms was 24.5% on the official statistics and 27.4% in the CIS sample. For the European and other ITPS reported a share of 41.3% compared with 36.6% in the Swedish CIS sample.

Finland, being furthest from the centre of Europe and being close to all the other Nordic countries shows a high Nordic ownership rate among the foreign owned companies. So does Norway. Denmark with its location between the centre of Europe and the Nordic countries reveals a fairly even distribution between Nordic and European owned companies.

Sectoral distribution

Table 5.2

Sectoral distribution with ownership categories in percent

	Denmark			Finland			Iceland			Norway			Sweden		
	DU	DM	FOR	DU	DM	FOR	DU	DM	FOR	DU	DM	FOR	DU	DM	FOR
Manuf.	**49.0**	**61.8**	**37.3**	**53.2**	**75.4**	**63.5**	**38.5**	**50.0**	**37.0**	**53.7**	**69.1**	**44.1**	**55.3**	**85.5**	**65.8**
HI M	6.9	7.0	4.8	7.9	12.9	9.4	6.8	0.0	10.0	4.8	18.4	8.3	10.3	17.0	10.3
HM M	28.8	51.6	39.7	27.4	55.7	46.9	3.4	100	30.0	13.9	42.1	32.8	28.9	43.4	38.9
LM M	27.8	20.7	31.4	37.6	18.6	15.4	20.0	0.0	30.0	29.3	7.9	28.1	34.4	24.6	28.9
LO M	36.5	20.7	24.1	27.1	12.9	28.2	69.9	0.0	30.0	52.0	31.6	30.8	26.4	15.1	21.9
	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Services	**51.0**	**38.3**	**62.8**	**46.8**	**24.7**	**36.4**	**61.5**	**50.0**	**62.9**	**46.3**	**30.9**	**55.9**	**44.6**	**14.5**	**34.2**
KIS	35.1	66.6	34.2	47.9	82.6	35.7	58.4	0.0	64.7	41.8	58.8	44.6	50.9	66.9	43.6
OS	64.9	33.4	65.8	52.1	17.4	64.3	41.6	100	35.3	58.2	41.2	55.4	49.1	33.1	56.4
	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
	100	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 5.2 displays the sectoral distribution of the companies based on their ownership and their multinationality. For all countries we observe that domestic multinationals are more concentrated in manufacturing sectors than in service sectors.

In Finland more than 75% of all domestic multinationals in the sample are in manufacturing sectors. In Sweden this share is larger than 85%.

Apart from this pattern, we also find a common pattern across the Nordic countries, if we investigate the distribution of companies within the manufacturing sectors. Domestic multinationals are more concentrated on high technology sectors (including medium high technologies) than they are in low technology sectors.

Within the service sectors multinationality seems to be a phenomenon being more concentrated among knowledge intensive services.

Although we observe a common pattern as regards the distribution of the domestically owned multinational firms, the pattern for the foreign owned firms is less clear across the Nordic countries. What stands out is, that foreign owned firms are less concentrated in manufacturing than the domestic multinationals are. A common pattern can also be found in the

distribution of foreign owned firms across the manufacturing sector. Across all Nordic countries foreign ownership in manufacturing is most concentrated in the medium high technology sectors. In the service sectors, however, with the exception of Iceland, the foreign owned companies are most concentrated in the sectors not classified as knowledge intensive.

In the manufacturing sector the domestically owned (uninational) companies are mostly concentrated in the low technology manufacturing sectors or the medium low technology manufacturing sectors.

Size of the companies

Table 5.3

Firm size

	Denmark			Finland			Iceland			Norway			Sweden		
	DU	DM	FOR	DU	DM	FOR	DU	DM	FOR	DU	DM	FOR	DU	DM	FOR
Size *Mean*	292	1975	210	316	1835	180	75	181	81	150	406	222	276	1277	348
Size *Median*	62	600	83	85	407	89	36	181	29	61	133	82	50	355	105
Sales *Log*	9.9	11.2	10.0	9.4	11.3	9.7	8.8	10.1	5.1	11.4	12.4	11.8	11.4	13.2	12.2

Note: Sales is reported in logs. Norwegian sales are in 1,000 Norwegian Kroner, all others are 1,000 euros.

As reported in Table 5.3 we observe differences in the average size and the median size[9] of the companies across the Nordic countries. The mean of the size is larger than its median. This suggests that a small number of very large companies influence the mean. Hence, the median gives a more robust picture of the sample.

Although we observe a large difference in the size of the companies across the countries, a common picture emerges for all Nordic countries, except Iceland, domestic multinational companies are larger than the foreign owned companies, which are in turn larger than the domestically owned uninational companies. In Iceland the foreign owned companies are smaller than the domestically owned uninationals.

[9] The median gives the size where 50% of the companies in the sample are larger and 50% of the companies are smaller.

Market focus

Table 5.4

Firms' most significant market

	Denmark			Finland			Iceland			Norway			Sweden		
	DU	DM	FOR	DU	DM	FOR	DU	DM	FOR	DU	DM	FOR	DU	DM	FOR
Local	21.1	10.6	12.6	25.4	1.1	3.8	55.1	50.0	40.7	39.4	5.5	28.3	27.4	6.5	8.9
Nation	43.4	31.9	52.9	47.9	21.5	53.3	24.4	00.0	18.5	40.4	23.6	47.0	42.3	24.2	41.5
Global	35.5	57.5	34.5	26.6	77.4	42.9	20.5	50.0	40.7	20.2	70.9	24.7	30.3	69.4	49.6
	100	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

When investigating what firms reported as their most important market (Table 5.4) we find expected as well as unexpected similarities. The companies, which we classified as domestic multinationals, are least focused on domestic markets. More than 50% of them – in the case of Finland, Norway and Sweden close to 70% or more – state that their most important markets are international markets.

The orientation of the foreign owned companies towards the domestic markets is surprisingly high. More than half of the foreign owned companies in all Nordic countries report that their most important market is domestic. In Norway this fraction is even larger than three quarters. In Denmark and in Norway foreign owned companies focus on domestic markets as intensively as domestic uninational firms do. In Finland, Iceland and Sweden we observe that foreign ownership goes along with a more global market focus. Compared to domestic uninational companies foreign owned ones are less focused on domestic markets.

The rather high fraction of foreign owned companies focusing on domestic markets suggests that a large fraction of foreign investment in the Nordic countries is at least partially motivated by an asset exploiting strategy.

A strategy of foreign investment is *asset exploiting*, if assets such as knowledge, brands, and business models are created elsewhere and exploited in the host country. On the contrary a strategy may be called *asset seeking* if valuable resources including knowledge are sought for in the host country. A clear distinction between both strategies is of course impossible. However, the strong focus of foreign owned companies on the domestic market suggests that the owner, at least partially, follows the asset exploiting strategy. This does not exclude, however, that simultaneously an asset seeking strategy may be present.

5.12 Innovative firms

Table 5.5

Sample distribution. Firm size and share of innovative firms.

	Denmark		Finland		Iceland		Norway		Sweden	
	Obs	Inno	Obs	Inno	Obs	Inno	Obs	Inno	Obs	Inno
DOM	621	55.7 %	634	62.5 %	80	50.0 %	1 642	49.6 %	814	54.8 %
FOR	223	56.1 %	184	64.7 %	27	59.2 %	685	44.7 %	383	64.8 %

In the previous sections we focused on all companies in the data sets. As the data sets contain some pieces of information only for companies that have carried out innovation activities, in the following we focus on companies that have carried out innovation activities in the year 1998 to 2000. In total 55 percent of the domestic firms were classified as innovative, and 65 percent of the firms with foreign owners. Se Table 5.5

Innovation activity

Table 5.6

Innovation activity

	Denmark			Finland			Iceland			Norway			Sweden		
	DU	DM	FOR	DU	DM	FOR	DU	DM	FOR	DU	DM	FOR	DU	DM	FOR
Inno. expen.	79.2	91.5	69.6	96.7	98.9	97.5	97.4	100.0	100.0	93.7	98.2	89.9	95.3	96.7	95.5
Inno. sales	87.3	97.9	91.2	73.6	94.6	83.2	100.0	100.0	100.0	82.1	90.9	80.1	57.6	85.4	71.3
Product inno.	84.9	97.9	91.2	75.2	94.6	84.9	92.1	100.0	87.5	83.7	92.7	80.1	60.1	91.9	73.7
Process inno.	69.6	85.1	60.8	49.2	77.4	49.6	68.4	100.0	68.8	68.1	72.7	63.4	48.4	61.2	50.8
Cont. R&D	21.4	59.6	27.2	61.4	95.7	71.4	52.6	100.0	68.8	33.3	70.9	42.5	48.4	85.4	61.2

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

In Table 5.6 we depict the fraction of innovation active companies that have reported certain types of innovation related characteristics. The first row gives the percentage of companies reporting positive innovation expenditure.

The definition of innovation expenditure goes beyond R&D expenditure. Amongst others, it also contains expenditure for ordered research and development, for the acquisition of innovation related machinery, for market introduction of new products and for training.

The most striking, yet not unexpected, feature is that domestic multinationals have the largest share of innovation active companies reporting positive innovation expenditure.[10]

The second row in Table 5.6 gives the percentage of firms with positive sales generated by new or significantly modified products. Except for the Icelandic firms – where the figures may be distorted due to the small number of observations – the Danish firms show the highest fraction of companies with innovative sales. Swedish firms reveal the lowest share of companies with positive sales from new or significantly modified products. This observation coincides with the fraction of product innovators reported in row three of the table. Also the fraction of process innovation follows the same pattern. In a way the high fraction of product and process innovators in Denmark is surprising as the fraction of firms continuously carrying out R&D activities is the lowest across the board as depicted in row five of Table 5.6.

Whereas we observe a higher fraction of product innovators among the foreign owned firms than among the domestic uninational firms in Denmark, Finland and Sweden, we see no difference in Iceland and Norway. Across all Nordic countries domestic uninational companies do not perform differently a compared to the foreign owned firms when process innovation is considered.

A common pattern across the Nordic countries emerges for the persistence of carrying out innovation activities. Domestic multi-national companies have the highest fraction of companies continuously carrying out innovation activities. Foreign owned firms lag behind. However, the share of foreign owned firms is larger than the share of domestic uninationals. Foreign owned companies are more involved in continuous R&D.

Cooperation on innovation

Table 5.7

Domestic external cooperation for innovation

	Denmark			Finland			Iceland			Norway			Sweden		
	DU	DM	FOR	DU	DM	FOR	DU	DM	FOR	DU	DM	FOR	DU	DM	FOR
Collab.	29.4	89.4	29.6	59.1	98.9	65.8	63.2	50.0	68.8	41.2	85.5	36.6	32.8	93.5	45.5
Vertical	24.8	70.2	24.0	46.5	91.4	53.8	42.1	50.0	43.8	27.2	65.5	28.1	23.4	82.2	34.6
Horizontal	6.4	12.8	3.2	11.9	34.4	9.2	21.1	0.0	0.0	4.7	7.3	5.6	5.9	20.9	4.8
Scientific	15.7	59.6	16.0	41.9	95.7	49.6	29.0	50.0	38.0	18.3	65.5	22.5	17.9	69.3	29.9

[10] On the average the Danish fraction of companies with positive innovation expenditure seems rather low both in absolute terms and compared to the other Nordic countries. As the Danish date revealed that Danish firms are quite reluctant to report sales figures in the innovation survey, we suspect that the low figures here are also due to the high share of missing values in the data.

Analysing the companies' propensity to collaborate with domestic partners reveals their embeddedness in the local and national innovation system.

Table 5.7summarizes the percentage of innovative companies, which collaborate with domestic partners. The first row reports the share of companies collaborating with a domestic partner disregarding the type of partner.

Domestic multi-national firms tend to collaborate more frequently with domestic partners than any other type of company. The qualification of the Icelandic results applies here due to the small number of observations. In Finland, Iceland and Sweden foreign owned companies collaborate with domestic partners more frequently than their domestic counterparts. In Denmark we do not observe a difference. In Norway, however, foreign owned firms collaborate less frequently with domestic partners than domestic uninational firms do.

Innovation collaboration with domestic vertical partners such as suppliers and customers is most frequent in the domestic multi-national firms. Only in Finland and Sweden foreign owned companies exhibit a stronger propensity to collaborate vertically than their domestic counterparts. We do not observe this in Denmark, Iceland and Norway.

Horizontal collaboration for innovation involves competitors as collaboration partners. Among the different types of collaboration summarized in Table 4-6 horizontal collaboration is the least frequent one. As in all other collaboration types the propensity of domestic multi-national companies to collaborate is the strongest, although there appears to be a strong difference across countries in the frequency of collaborative innovation activities with competitors.

Scientific innovation collaboration that involves universities and research institutes indicates the embeddedness in and the utilization of the scientific environment. Domestic multinational firms reveal a higher frequency of collaboration than all other types of firms. In Finland, Iceland, Norway and Sweden foreign owned companies tend to collaborate more frequently with domestic universities and research institutes than domestic uninational companies do.

However, it should be mentioned that the sheer size of the company could account for the finding. The larger a company the more likely it is to carry out innovation activities in collaboration with any particular partner.

Even considering the above caveat we can summarize the findings here:

Domestic multinationals do not only maintain production and/or R&D facilities abroad they are also more locally embedded than the domestic uninational firms. They show a higher propensity to collaborate for innovation with any type of domestic collaboration partner, regardless of whether the partners are from industry or from science.

Foreign owned firms in the Nordic countries do not differ significantly from domestically owned companies. When they do, they show a somewhat deeper embeddedness than domestically owned firms.

Table 5.8 shows the utilization of knowledge for innovation from other enterprises within the group. For each country we find that the domestic multinationals is the category of companies that use the network *within* the group most extensively. Companies being owned by national groups utilize this particular source of innovation the least. For each country we observe that foreign owned companies more often draw information and inspiration from companies within the group. Although we have no precise information about the nationality of the companies that are being used as an information source, we may however conjecture that it is the multinationality of the companies' network that drives the sourcing process.

Table 5.8

Utilization of knowledge for innovation from other enterprises within the group

Denmark			Finland			Iceland			Norway			Sweden		
DU	DM	FOR	DU	DM	FOR	DU	DM	FOR	DU	DM	FOR	DU	DM	FOR
26.1	54.3	40.4	19.1	49.4	28.6	18.8	0	35.7				44.2	75.8	64.9

5.2 Regression analysis

This section summarizes the findings of the regression analysis. Although we found some indication for differential innovation behaviour between domestically owned companies and foreign owned companies and their sub groups in particular, an analysis is required that controls for firm specific characteristics.

When everything else is equal – such as firm size, industrial sector, physical capital investment, human capital, R&D investment, process innovation and product innovation – we get quite different results compared to the descriptive statistics.

The detailed results of the regressions can be found in the country specific studies in part II of this report.

Due to a limited number of observations in the Icelandic survey the foreign-owned firms are not separated on five different groups of ownership. For the other four Nordic countries estimates are reported for domestic enterprises, domestic multinationals (DM), Nordic multinationals (NM), Anglo-Saxon multinationals (ASM) and European and other multinational (EOS) enterprises. Domestic uninational firms (UN) are the control group when Denmark, Finland, Norway and Sweden are considered. In the case of Iceland we have domestic multinationals and uninational firms as reference.

Ownership and innovation

The first issue we are investigating is whether foreign ownership influences the likelihood of carrying out innovation (see Table 5.8).

The simple descriptive statistics indicate that a lager share of foreign-owned firms are innovative compared to domestic firms in Denmark, Finland, Iceland and Sweden, but not in Norway.

The adjusted results show two different patterns within the Nordic area: In Denmark, Finland, Iceland and Sweden foreign ownership has no influence on the likelihood of a company to be innovation active. In Norway, however, foreign owned companies are *less* likely to be innovation active compared to domestically owned firms

Table 5.8

Hypothesis 1: *The probability of engagement in innovation activities*

	Denmark	Finland	Iceland	Norway	Sweden
DOM	Reference	Reference	Reference	Reference	Reference
FOR	-0.104	-0.115	0.066	-0.238***	0.049

Notes: *** (**, *) indicates significance at the 1% (5%, 10%)

In the following equation we only consider subsamples with innovative firms.

Starting with hypothesis 2, Table 5.9 presents the estimated association between investment in innovation activities per employee, and its determinants.

When looking at the importance of corporate ownership we find that in Finland and Sweden domestic multinationals invest significantly more in R&D and other innovation expenditures. At the 5% level of significance no differences can be established between foreign controlled firms and domestic uninational firms.

In Norway domestic and Anglo-Saxon firms are superior in terms of innovation input. The Icelandic regression reveals no difference between domestic and foreign-owned firms. Denmark is the outlier in this analysis. The table shows that domestic multinational invest significantly less than other firms, ceteris paribus. There is weak evidence (10% level of significance) that Anglo-Saxon firms invest more than the firms in the control group, and that Nordic firms invest less.

Public R&D subsidies and ownership

Equation 3 depicts the relationship between public R&D subsidies and ownership. Unambiguously it is found that governments in the Finland, Norway and Sweden have a bias in the R&D subsidy policy towards

domestic multinationals. Notable is that the estimated association is negative and significant for Nordic firms and European and other firms in Finland, and negative and significant at the highest acceptable level of significance for Nordic multinationals in Norway.

Table 5.9

Hypothesis 2: *Log innovation investment expenditures per employee*
Hypothesis 3*: The probability of receiving public R&D subsidies*

	Denmark		Finland		Iceland		Norway		Sweden	
Equat	2	3	2	3	2	3	2	3	2	3
UN	Reference		Reference		-	-	Reference		Reference	
DM	-0.08***	0.35	0.51***	0.53***	-	-	0.61***	0.38**	0.69***	0.55***
NM	-0.32*	-0.47	0.23	-0.21**	-	-	-0.31**	-0.33*	-0.02	-0.12
ASM	0.33*	-0.34	0.47	0.07	-	-	0.53***	-0.30	0.10	0.03
EOM	0.01	0.30	0.44*	-0.54***	-	-	0.25	-0.12	0.14	-0.23
DOM	-		-		Reference		-		-	
FOR	-	-	-	-	0.45	0.05	-	-	-	-

Notes: *** (**, *) indicates significance at the 1% (5%, 10%)

Collaboration within the national innovation system

Equations 4-7 in Tables 5.10 and 5.11 consider collaboration on innovation with partners within national innovation systems. Some main conclusion can be drawn.

First, equation 4, an aggregate of vertical, horizontal and scientific systems shows that domestic multinationals in the Nordic countries are more integrated in the national innovation systems than other firms. Deviating, however, is Finland where firms controlled by the Nordic neighbours are as embedded as Finnish multinationals. In Iceland no differences between domestic and foreign-owned firms can be found. In Iceland we find no difference between domestic and foreign-owned firms.

The result for the subset embeddedness in vertical innovation system is identical with the overall estimates for NIS. See equation 5. Domestic multinationals are significantly more integrated in vertical collaboration on innovation than other firms. In Finland this conclusion is valid only of we add Nordic multinationals to Finnish multinationals.

Table 5.10

Hypothesis 4: *Embeddedness in the national innovation systems*
Hypothesis 5: *Embeddedness in the vertical innovation system*

	Denmark		Finland		Iceland		Norway		Sweden	
Equat	4	5	4	5	4	5	4	5	4	5
UN	Reference		Reference		-		Reference		Reference	
DM	1.43***	0.67***	1.52***	1.02***			0.93***	0.76***	1.33***	1.24***
NM	0.28	0.03	0.56***	0.55***			-0.21*	-0.01	0.16	0.23
ASM	-0.20	-0.07	0.02	0.07			0.16	0.22	0.21	0.28
EOM	-0.22	-0.16	-0.05	0.10			-0.03	0.18*	0.24	0.32
DOM	-		-		Reference		-		-	
FOR	-	-	-	-	0.09	-0.32-	-	-	-	-

Notes: *** (**, *) indicates significance at the 1% (5%, 10%)

In Finland and Sweden we find that domestic multinationals have a significant larger propensity to conduct horizontal cooperation on innovation with firms within the same industry than with other firms. In Denmark, Iceland and Norway no difference can be found between the five groups of firms. See equation 6.

Equation 7 shows that the domestic multinationals play a dominant role in the scientific innovation system in Denmark, Finland and Norway. This in contrast to Sweden where foreign-owned firms with Anglo-Saxon or other owners show the same likelihood to participate in common research projects with universities and public R&D labs as Swedish multinationals. In Iceland domestic and foreign-owned firms have the same propensity to be involved in the scientific innovation system

Table 5.11

Hypothesis 6: *Embeddedness in the horizontal innovation systems*
Hypothesis 7: *Embeddedness in the scientific innovation system*

	Denmark		Finland		Iceland		Norway		Sweden	
Equat	6	7	6	7	6	7	6	7	6	7
UN	Reference		Reference		-		Reference		Reference	
DM	-0.22	0.53**	0.61***	1.50***			0.26	0.90***	0.53**	0.90***
NM	-0.19	0.22	-0.25	0.22			0.03	-0.01	-0.24	0.23
ASM	??	0.32	0.15	0.38			0.17	0.14	-0.04	0.38***
EOM	-0.07	-0.51	0.07	0.34			0.12	0.17	0.01*	0.42**
DOM	-		-		Reference		-		-	
FOR	-	-	-	-	-	0.09-	-	-	-	-

Notes: *** (**, *) indicates significance at the 1% (5%, 10%)

In Table 5.12 the analysis of hypothesis 8, is presented. It shows that the group the company is part of is more important as a source of information for innovation among multinationals compared to uninational firms.

In Norway and Sweden all four categories of multinational firms are relying significantly more on knowledge from the corporate group than uninational firms. In Denmark this finding is relevant for domestic, Nordic and Anglo-Saxon multinationals. In the case of Finland, however, only Finnish and Nordic multinationals exploit group knowledge more than uninational firms.

Table 5.12

Hypothesis 8: *Source of knowledge for innovation from enterprises within the group.*

	Denmark	Finland	Iceland	Norway	Sweden
Equat	8	8	8	8	8
UN	Reference	Reference	-	Reference	Reference
DM	0.78***	0.72***		0.76***	0.61***
NM	0.50**	0.38**		0.54***	0.28**
ASM	0.52***	0.33		0.81***	0.31**
EOM	0.32	0.21		0.33**	0.53***
DOM	-	-	Reference	-	-
FOR	- -	- -	0.064	- -	- -

Notes: *** (**, *) indicates significance at the 1% (5%, 10%)

Patents

A large variation in the propensity to patent between different groups of firms can be found in the Nordic countries. See the analysis of hypothesis 9 in Table 5.13.

In both Denmark and Norway Nordic multinationals and Anglo-Saxon firms have a significantly lager likelihood to apply for patents than domestic uninational and multinational firms, and European and other foreign owned firms. In Finland domestic multinationals have a higher propensity to apply for patent than other firms. In Sweden domestic multinationals and Anglo-Saxon firms have lager patent intensity than other firms.

Radical innovations

The most interesting finding from the estimation on radical innovation,[11] presented in Table 5.13 (hypothesis 10) is that no systematic differences between can be established in Denmark, Finland, Iceland and Sweden.

Only in Norway one group of foreign owned firms, namely the firms owned by Anglo-Saxon mother companies, have a significant lager propensity to

[11] Radical innovations are new to the market and not only to the firm.

launch radical innovation than other firms. In Denmark no difference in this respect can be found between Domestic multinationals and Anglo-Saxon enterprises. In Finland, domestic multinationals and Nordic multinationals have the same propensity to introduce innovations new to the market. Finally, in Sweden domestic multinationals and European and other firms are distinguished from other firms by a larger propensity to launch radical innovations.

Table 5.13

Hypothesis 9: *Patenting*

Hypothesis 10: *Radical innovations (Products new to the market).*

	Denmark		Finland		Iceland		Norway		Sweden	
Equat	9	10	9	10	9	10	9	10	9	10
UN	Reference		Reference		-		Reference		Reference	
DM	0.18	1.41***	0.90***	0.41***			0.36*	0.34*	0.62***	0.78***
NM	0.82***	0.09	0.10	0.37***			0.32**	-0.15	0.07	0.22
ASM	0.61***	0.87**	0.16	0.08			0.71***	0.16	0.36***	0.26
EOM	0.43	0.04	0.17	-0.12			0.45***	0.07	0.49***	0.34***
DOM	-		-		Reference		-		-	
FOR	-	-	-	-	-0.26	0.01	-	-	-	-

Notes: *** (**, *) indicates significance at the 1% (5%, 10%)

Innovation sales

The ultimate goal with almost all innovation activities is to make profit. Innovation sales is a gross measure on the return on innovation investment (hypothesis 11), increasingly exploited in innovation studies based on Community Innovation Survey data.

In Table 5.14 we present two alternative measures to investigate the relationship between innovation sales and corporate ownership, a two-step selection model (a) and a multistep production function model (b).

The summary results are mixed between the Nordic countries. In Finland domestic multinationals have a higher gross return on innovation investments compare to other firms. In Sweden domestic multinationals and Nordic multinationals have significantly higher innovation sales than uninational firms, Anglo-Saxon firms and European and other firm. In Denmark, however, it is found that foreign-owned firms (Anglo-Saxon) outperform domestic firms in innovation productivity. Regarding Norway and Iceland we find no difference between the five groups if firms.

Using a two-equation selection model it is found that Anglo Saxon firms have significantly higher innovation sales per employee, everything else equal, in Sweden. Anglo-Saxon firm and Nordic multinationals are superior to other firms in Denmark. Anglo-Saxon firms and domestic multinationals have the highest innovation sales in Finland. All three groups of foreign

multinational firms have higher innovation sales than domestic firm in Norway. For Iceland no difference between domestic and foreign-owned firms can be established.

When a more sophisticated multistep knowledge production function model was exploited the superiority of the Anglo-Saxon companies was reduced in Denmark and Finland, while it diminished totally in Norway and Sweden. Considering both models the robust results are quite mixed. Anglo-Saxon firms have the highest level of innovation productivity in Denmark. In Finland domestic multinationals reveals higher innovation sales per employee than other firms. In Sweden Nordic multinationals are superior to other firms. For Iceland and Norway no robust difference can be established.

Table 5.14

Hypothesis 11a: *Log innovation sales per employee (Selection equation)*

Hypothesis 11b: *Log innovation sales per employee (Multistep model)*

	Denmark		Finland		Iceland		Norway		Sweden	
Equat	11a	11b	11a	11b	11a	11b	11a	11b	11a	11b
UN	Reference		Reference		-		Reference		Reference	
DM	0.33	0.29	0.53**	0.50**			0.19	-0.47	0.92***	0.52*
NM	0.58**	0.28	0.39	0.30			0.54**	0.49	0.61***	0.59***
ASM	1.10***	0.68**	0.68**	0.55*			0.49***	-0.48	0.59**	0.36
EOM	0.38	0.19	0.54*	0.24*			0.63***	- 0.02	0.48**	0.31
DOM										
FOR	-	-	-	-	-0.01	-0.26-	-	-	-	-

Notes: *** (**, *) indicates significance at the 1% (5%, 10%)

Productivity

Previously research suggests that foreign-owned firms generally have higher productivity than domestic firms. In the case of Norway our study confirms this finding. But more interesting, when looking at the five Nordic countries as a group, the general conclusion is that no difference in productivity between foreign and domestic firms can be found.

In Table 5.13 the estimates are presented for both the selection model (a) and the multistep production function model (b). The significant estimates for foreign-owned firms in the Finnish and the Swedish samples produced by the selection model disappear when the multistep model is used. Only in Norway the estimated influence on productivity from foreign-owned firms is robust in both models.

A possible explanation to our divergent results is the extensive set of firm characteristics and the exploitation of econometric methods appropriate for the peculiarities in the data set. A complementary explanation is out method of distinguishing between uninational domestic firms and multinational

domestic firms. Is should, however, be noticed, that we find some indication (at the 5% level of significance in Norway, at the 10% level in Finland, and just outside the 10% level in Denmark) that Nordic multinationals are more productive than other firms in these three Nordic countries.

Table 5.13

Hypothesis 12a: *Log value added per employee (Selection equation)*

Hypothesis 12b: *Log value added per employee (Multistep model)*

	Denmark		Finland		Iceland		Norway		Sweden	
Equat	12a	12b	12a	12b	12a	12b	12a	12b	12a	12b
UN	Reference		Reference		-		Reference		Reference	
DM	-0.09	-0.07	0.13	-0.08			0.06	-0.06	0.02	-0.10
NM	0.50	0.48	0.14	0.17*			0.37***	0.20**	0.10	0.01
ASM	0.55	0.21	0.31**	0.12			0.21*	0.07	0.26**	0.16
EOM	0.47	0.27	0.16	0.11			0.23**	0.09	-0.06	-0.05
DOM										
FOR	-	-	-	-	-0.11-	0.32-	-	-	-	-

6. Concluding discussion

This study investigates whether foreign takeovers imply benefits for the five Nordic countries in terms of transmission of technological knowledge and economic performance at the firm level. These questions are important because a recent debate has focused on the importance of domestic owners, the localization of headquarters, cross-border moves of jobs, externalities and the roles of various key actors in national innovation systems.

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

Recent empirical findings on the importance of foreign-owned 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-owned 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.

Some main candidates for explaining differences in productivity between domestic and foreign-owned firms are that foreign companies focus their investment on firms with superior technology or productivity, sectors with high productivity, the positive effects of mergers and acquisitions per se, or efficiency due to scale production, specialization or global coordination.

There are several methodological difficulties in assessing the importance of foreign-owned firms in the context of gain or drain of productive resources.

One is that we don't know what would have happened with the acquired firms had they not been takeover. For comparison analysis commonly domestic firms are used as control group. However, only if we can assume that they really are representative of what would have happened to the acquired firms had they not been taken over, are we comparing comparable groups. Otherwise we need to use different statistical techniques in order to increase the comparability between domestically owned and foreign-owned firms. Moreover, the difficulties to properly capture and measure knowledge spillovers, is perhaps even more challenged than the issue of reliable control groups.

This study contributes to the assessment studies of foreign-owned firms in several respects.

First, the analysis is one of the first attempts ever to use original data from the international harmonized Community Innovation Survey for a cross-country study comparing innovation behaviour in foreign and domestic firms at the firm level.

Second, applying an identical econometric approach of data sets of identical nature in five different countries with a large degree of cultural homogeneity increases the possibility of identifying systematic and robust patterns.

Third, the analyses are based on an extensive set of data from approximately 5 300 Nordic firms and they constitute about half the population of manufacturing and service firms in Denmark, Finland, Iceland and Sweden with 10 or more employees. In Norway data are based on a compulsory survey meaning that almost all existing firms are covered by the study.

Finally, the present study explores the issue of corporate ownership in three dimensions. Basically, domestic and foreign-owned firms are compared. A distinction is then made between (i) firms owned by other Nordic companies, (ii) firms with Anglo-Saxon owners, (iii) other firms which mostly have owners from other European countries and (iv) domestic multinationals (firms with foreign affiliates) and domestic uninational (firms belonging to a group with only domestic affiliates).

When not controlling for any firm specific or industry specific differences, the initial descriptive statistics show a robust pattern on superiority of foreign owned firms for all five Nordic countries.

The foreign owned firms in the Nordic countries are distinguished by having (i) larger proportion of innovative firms, (ii) higher R&D intensity, (iii) higher level of innovation sales per employee, (iv) larger proportion of firms applying for patents, (v) larger proportion of firms possessing patents, (vi) larger proportion of firms conduction R&D on regular basis, (vii) larger export intensity, (viii) stronger focus on global markets, (ix) more human capital in terms of well educated people as a share of total employment, (x)

higher level of labor productivity, (xi) stronger dependence on sources of knowledge for innovation from other enterprises within the group.

The findings on embeddedness in national innovation systems are more mixed. In Denmark, Finland and Norway, the domestic-owned firms are more integrated than foreign-owned firms in the national innovation system. The integration is measured as the share of the firms that collaborate with host-country partners on innovation activities.

Three parts of the national innovation system are considered: The scientific system, vertical partners in the value chain and horizontal partners in the value chain. Within Iceland and Sweden a lager proportion of foreign-owned firms are integrated in the innovation system than domestic firms. Within Iceland and Sweden a larger percentage of the foreign-owned firms is found to collaborate on innovation with domestic (host-country) partners, compared to other firms.

In the regression part of the analysis the heterogeneity within the observed five samples was taken into account. The study was divided into two parts: a possible gap in engagement in innovation and technological activities between foreign and domestic firms, and a possible gap in the results of economic activities.

The concluding finding from the first part was that no systematic differences in the propensity to be innovative could be found. However, among the innovative firms, multinationals invest more than other firms. Here we controlled for sector, firm size, market orientation (local, national or global), innovation orientation (product or process), the firms' R&D-history, probability of receiving governmental R&D and R&D support.

The business literature, and various branches of economic literature stress the importance of embeddedness in the local network of suppliers, competitors, customers research institutes, government agencies, for the development, dynamics and competitiveness of individual firms.

In the study we utilize several indicators in an attempt to capture the extent of embeddedness (and possible knowledge spillovers) in the domestic national innovation system. The evidence on collaboration with actors in the national innovation system, whatever measure, is close to unanimous on the higher degree of embeddedness of domestic multinational firms. Not surprisingly domestic multinational firms have a larger propensity of receiving public R&D support than other firms. However, more research needs to be conducted to find the underlying mechanism leading to the large differences in funding between firms.

When the results of engagement in innovation activities are considered, for the Nordic area altogether, we cannot find that the foreign-owned firms engage systematically differently in innovation than their domestic uninational counterparts. Note that the ceteris paribus assumption means

that we control for differences in size, sector, persistence in RD engagement, public R&D support etc.

Considering the innovation output in terms of the firms' propensity to patent, we find quite strong evidence that Anglo-Saxon owned firms tend to patent more than domestically owned firms. The evidence for all other groups of companies is mixed.

In terms of radical innovations, domestic multinationals outperform the domestic uninationals. In Denmark and Sweden also the Anglo-Saxon owned companies tend to market radical innovations more frequently. The analysis of the returns to innovation shows a quite strong superiority of foreign owned firms.

In Norway and Denmark they even outperform the domestic multinationals. The result of the impact of foreign ownership on the labor productivity depends somewhat on the methodology employed. We find that domestic multinationals do not exhibit a higher labour productivity than the domestic uninationals do. By and large foreign owned firms seem to have a higher labour productivity, everything else equal.

Improving the integration of foreign multinational firms in the domestic national innovation systems, and eliminating the bias in R&D support towards domestic-owned firms seems to promise two things: (i) a larger absorption of ideas with origin outside the own country, and (ii) increase in the rate of the return to innovation efforts

Give and take

We see that the foreign owned firms do not invest more in RD than the domestically owned uninational firms do. However, by and large foreign owned firms yield higher returns to innovation. Also foreign owned firms make more use of the group internal knowledge sources.

The combination of these findings gives rise to the specific advantage hypothesis: Multinational firms possess specific assets that can be transferred within the firm at no or low cost. In the study utilization of the specific assets is proxied by group-internal knowledge sources. These are important for the innovation performance and productivity performance of the firm.

Also the fact that we do not find superior innovation performance of the domestic multinationals points in this direction – firms specific assets can not be thought of flowing from the subsidiaries to the headquarter, we rather imagine they flow from the headquarter to the subsidiaries. So the Nordic owned *foreign owned firms* show a superior performance, although their mother companies - the domestic multinationals in the Nordic countries - do not.

We observe that foreign owned companies do not collaborate less frequently with domestic partners than domestic uninational firms. This can suggest

two different lines of reasoning. First, if collaboration for innovation is part of the routinized innovation behaviour of firms it is not very likely to change after companies changed the ownership from domestic to foreign.

The second line of reasoning builds on the assumption that collaboration is in fact subject to optimization considerations. We see that foreign owned firms do utilize other firms in the corporate group more often than domestic uninational firms do. Yet, they do not show a lower rate of collaboration with domestic partners. Domestic collaboration partners seem to offer knowledge, which does by and large not lead to substitution out of domestic knowledge sources. This finding would lend some support for the asset-seeking hypothesis of internationalization of corporate activity.

The last finding, however, does by no means suggest that foreign ownership is bad, because local assets are sought and exploited. Looking at the previous finding we would argue rather for the contrary. Firm specific assets are supplied to the foreign owned firms, where they certainly spill over into the immediate environment. Our analysis here suggests that foreign ownership leads to a situation of give and take rather than to a situation of being exploited. It seems that the utilization of the incoming knowledge and the capabilities depends on a vivid exchange with the foreign owned firm. Collaboration seems to be the crucial determinant.

Our final remark concerns only a comparison between domestic and foreign multinational firms. Based on the literature we would *a priori* expect that the foreign-owned firms would outperform domestic firms in terms of productivity and that no robust evidence could be found on knowledge spillover from foreign-owned 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 systematic significant difference in productivity between foreign and domestically owned firms in the study. The finding is 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-owned multinationals are partly returns on activities created in their home countries.

Part II: Analysis for All Nordic countries

7. Denmark

This section reports the basic analysis of the Danish CIS data. The Danish Community Innovation Survey is conducted by Analyseinstitut for Forskning in Århus. The third wave of the CIS, which this analysis bases on, is launched in 2001 and refers to the years 1998 to 2000. The survey was sent to 5,133 firms, which yielded a response rate of 31% (Analyseinstitut for Forskning 2003)

7.1 Descriptive statistics for all firms

The descriptive statistics in this section includes all firms in the sample regardless of their carrying out innovative activities.

Table 7.1

Sample distribution

		Observations Total	Innovative firms[1]	Percent
	Total observations	844	471	55.81
DU:	Domestic uninational	574	299	52.09
DM:	Domestic multinationals	47	47	100.00
NM:	Nordic multinationals	83	46	55.42
ASM:	Anglo-Saxon multinationals	51	30	58.82
EOM:	European multinationals and other multinat.	89	49	55.06
DOM:	Domestically owned firms	621	346	55.72
FOR:	Foreign ownership	223	125	56.05

Note: This table reports only about firm 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 innovators share of 100% of the domestic multinationals is due to the construction of the domestic multinational indicator.

Table 7.1 shows composition of the data. The Danish data consists of 844 observations 26% of which are foreign owned firms. The proportion of innovative firms is almost identical for domestic and foreign owned firms. Table 7.2 shows summary statistics of firm characteristics and behavior for all five national groups and the foreign owned and domestically owned groups.

Table 7.2

Firm characteristics and innovation activities

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
Size	292	1975	187	297	182	419	210
Sales	9.89	11.24	9.96	9.87	10.06	10.02	9.98
Labour prod.	5.18	4.97	5.33	5.03	5.38	5.16	5.27
Exports	1.03	1.77	1.51	1.97	1.54	1.09	1.63
Investment	0.57	0.72	0.78	0.81	0.77	0.58	0.78
Innov. input	0.59	1.76	0.56	0.84	0.46	0.68	0.58
Innov. output	1.05	2.98	1.52	2.11	1.43	1.20	1.62
Human. cap.	0.08	0.12	0.11	0.19	0.14	0.09	0.14

Note: The table reports the averages of innovation activities and firm characteristics. Size is measured by employment. Sales, labor productivity, exports and investments in tangible goods are given in logs. Innovation input is the log of innovation expenditure per employee. Innovation output is the log of sales from new or significantly modified products per employee. The share of highly educated employees approximates human capital.

The average Danish firm is about twice as large as the average foreign owned firm. (See Table 7.2). This is mainly explained by the Danish multinational firms which have about 2000 employees in average, compared to 200-300 for the other categories of firm.

Even among the foreign owned firms we detect some striking differences and similarities. Anglo-Saxon owned firms are identical to non-multinational Danish firms. Nordic owned and European owned firms are strikingly smaller, though. On the average they employ more than 100 people less than the Anglo-Saxon owned firms.

The descriptive statistics shows that sales per capita is about the same for domestic and foreign owned firms. The aggregate figures in the right part of the table show that foreign owned firms have a slightly larger productivity, higher exports and slightly higher gross investments, than Danish owned firms.

Looking at innovation input and innovation output we find that Danish multinational firms are separated from other firms by a considerable lager degree of innovativeness. Foreign owned firms and in particular Anglo-Saxon firms are more human capital intensive when compared to the average Danish firm.

Table 7.3

Sectoral distribution with ownership categories

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
HI M	3.3	4.3	3.6	2.0	0.0	3.4	1.8
HM M	14.1	31.9	16.9	13.7	13.5	15.5	14.8
LM M	13.6	12.8	10.8	9.8	13.5	13.5	11.7
LO M	17.9	12.8	7.2	15.7	6.7	17.5	9.0
KIS	17.9	25.5	21.7	25.5	19.1	18.5	21.5
OS	33.1	12.8	39.8	33.3	47.2	31.6	41.3
Total	100%	100%	100%	100%	100%	100%	100%

Notes: The figures are in percentage. 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 7.3 summarizes the sectoral distribution in the Danish economy. The most striking pattern is the high concentration in the service sector when Nordic, Anglo-Saxon and European and other multinational firms are considered. For all three categories of ownership six in 10 firms are in the service sector. Also the uninational Danish firms have their largest concentration in services, together with low technology manufacturing. On the contrary the domestic multinational firms have their largest concentration in high medium technology followed by knowledge intensive services.

Table 7.4

Firms' most significant market

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
Local	21.0	10.6	19.3	7.8	9.0	20.3	12.6
National	43.4	31.9	50.6	37.2	64.0	42.5	52.9
Global	35.5	57.4	30.1	54.9	27.0	37.2	34.5
	100	100.	100	100	100	100	100

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

7.2 Descriptive statistics for the innovative firms

This section discusses the characteristics and the behaviour of innovative firms in Denmark. Innovativeness here relates more to carrying out innovation related activities rather than being successful in introducing new processes or new products. It gives a more detailed picture of the firms' innovative strategies and the related activities.

Table 7.5

Innovation activities

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
Innovation expenditure	72.9	91.5	71.7	76.7	63.3	75.4	69.6
Innovation sales	87.3	97.9	82.6	100.0	93.9	88.7	91.2
Product innovation	84.9	97.9	82.6	100.0	93.9	86.7	91.2
Process innovation	69.6	85.1	60.9	66.7	57.1	71.7	60.8
Continuous R&D	21.4	59.6	15.2	46.7	26.5	26.6	27.2
Public Funding for R&D	27.7	45.7	9.3	21.4	12.8	31.0	13.6

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

The indicators depicted in Table 7.5 revels no salient differences in innovativeness between the average domestic and the average foreign firm in Denmark. Somewhat higher shares of the Danish firms are process innovators and a slightly higher percentage of the foreign-owned firms are product innovators.

It is notable that the largest share of firms conducting continuous R&D can be found in the Danish and Anglo-Saxon owned firms. The difference compared to other firms is considerable. About three in 10 Danish firm received public R&D subsidies compared to a little more than one in 10 foreign owned firms. As could be expected the largest share of R&D subsided firms can be observed within the Danish Multinational firms (46%).

Table 7.6

Methods of protection

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
Patent (Valid)	18.4	40.4	26.1	40.0	30.6	21.4	31.2
Patent (Application)	13.7	44.7	30.4	36.7	22.4	17.9	28.8
Design patterns	17.6	29.7	18.4	32.1	23.7	19.6	24.0
Trademarks	49.2	59.5	31.6	67.9	52.6	50.9	49.0
Copyright	12.8	29.7	10.5	46.4	21.1	15.6	24.0
Secrecy	34.2	70.3	34.2	42.9	52.6	40.2	43.3
Complexity of design	19.3	40.5	31.6	35.7	31.6	22.8	32.7
Lead-time advantage	46.5	64.9	50.0	57.1	63.2	49.6	56.7

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

Danish and Anglo-Saxon multinational companies are more likely to utilize all the eight different methods of protection listed in Table 6-6 than other firms. No large differences are found between Danish uninational firms, Nordic and European and other multinational firms. In aggregate figures the

right part of Table 7.6 shows that foreign-owned firms are more likely to possess valid patents, design patterns and copyright, and apply for patents. In addition, the share of foreign-owned firms reporting complexity of design and lead-time advantage is also larger among foreign owned firms.

Table 7.7

Innovation Input and Innovation Output

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
Input							
Mean	8.6	14.1	8.5	13.5	5.9	9.4	8.8
St.dev	21.3	24.9	20.3	28.0	15.5	21.9	21.0
Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Max	100	100	89.1	100	82.7	100	100
Output							
Mean	24.8	27.0	27.2	31.8	20.1	25.2	25.7
St.dev	27.0	25.8	29.6	20.0	18.8	26.8	24.0
Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Max	100	100	100	80.0	75.0	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. For the 219 observations with missing sales it is projected for this table using the sectoral mean labour productivity.

Table 7.7 reports the summary statistics of the innovation input and the innovation output. Innovation input is measured by the innovation expenditure relative to sales. The innovation output is measured by the share of sales generated by new and significantly modified products.

As mentioned in the note to the table the sales for 219 observations had to be imputed as they are missing in the original data. The innovation output also seems particularly high when compare to for instance the innovation output of Finland (see Section 7) and Sweden (see Section 11). One could suspect that companies intentionally overestimated the innovation output or that companies with no or low innovation return choose not to report the share of sales generated by new or significantly modified products. What we can deduce from the summary, though, is that Anglo-Saxon owned companies are most similar to Danish multinationals. The European owned companies are most similar to the Danish owned uninational companies.

Table 7.8

Cooperation on innovation

		DOMESTIC		FOREIGN			TOTAL	
		DU	DM	NM	ASM	EOM	DOM	FOR
Within the group	D	13.4	42.6	17.4	0.0	4.1	17.3	8.0
	G	0.0	100.0	32.6	43.3	20.4	13.6	30.4
Suppliers	D	17.1	59.6	21.7	23.3	14.3	22.8	19.2
	G	11.4	44.7	21.7	23.3	16.3	15.9	20.0
Customers	D	17.7	57.4	17.4	16.7	16.3	23.1	16.8
	G	10.4	51.1	17.4	20.0	8.2	15.9	14.4
Competitors	D	6.4	12.8	4.3	0.0	4.1	7.2	3.2
	G	6.0	19.1	6.5	6.7	0.0	7.8	4.0
Consultancies	D	13.7	57.4	15.2	20.0	10.2	19.7	14.4
	G	5.0	38.3	15.2	13.3	6.1	9.5	11.2
Priv. R&D Labs	D	9.7	36.2	8.7	3.3	2.0	13.3	4.8
	G	6.7	31.9	6.5	16.7	2.0	10.1	7.2
Universities	D	11.7	57.4	10.9	23.3	8.2	17.9	12.8
	G	6.0	48.9	10.9	20.0	2.0	11.8	9.6
Public R&D Org.	D	12.0	38.3	8.7	20.0	4.1	15.6	9.6
	G	3.7	19.1	4.3	3.3	2.0	5.8	3.2
Domestic								
- collaboration		29.43	89.36	34.78	33.33	22.45	37.57	29.60
- vertical coll.		24.75	70.21	23.91	30.00	20.41	30.92	24.00
- horizontal coll		6.35	12.77	4.35	0.00	4.08	7.23	3.20
- scientific coll.		15.72	59.57	15.22	30.00	8.16	21.68	16.00

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.

The upper part of Table7.8 shows that the evidence is unanimous as regards a complex and intensive cooperation network on innovation of Danish multinational firms in both domestic and global dimension. Only a minor difference in the pattern of domestic (in Denmark) cooperation on innovation between uninational firms and foreign owned firms is observed. In aggregate terms a somewhat larger share of the Danish firms are cooperating for innovation with vertical, horizontal and scientific partners within the Danish innovation system than foreign owned firms do.

Table 7.9

Sources of information for innovation.

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
Within the firm	54.7	71.7	58.5	60.7	55.0	57.8	57.8
Within the group	26.1	54.3	39.0	42.9	40.0	31.3	40.4
Suppliers	28.6	21.7	22.0	10.7	22.5	27.3	19.3
Customers	50.7	60.9	53.7	46.4	47.5	52.6	49.5
Competitors	19.2	26.1	22.0	10.7	22.5	20.5	19.3
Universities	8.4	17.4	4.9	3.6	7.5	10.0	5.5
Government	3.4	4.3	0.0	3.6	2.5	3.6	1.8
Prof conferences	10.8	32.6	14.6	7.1	2.5	14.9	8.3
Fairs, exhibitions	8.4	23.9	22.0	3.6	5.0	11.2	11.0

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

The general pattern depicted above is confirmed by the descriptive statistics given in Table 7.9. A closer association with a broad network collaboration partner characterizes the Danish multinational firms.

This broader approach translates into a broader utilization of knowledge sources for the innovation process. In particular differences are observed between Danish multinational firms and other firms when scientific knowledge (universities and professional conferences) are considered as well as and sources of knowledge within the group and within the firm. Comparing foreign-owned firms and domestically owned firms we find that their own firms and customers are the most importance sources of knowledge for both categories. The percentage of firms reporting this is nearly the same for both categories of firms. Notable is the low share of Nordic owned firms (5%) and Anglo-Saxon firms (4%) which regard to Danish Universities as an important source of information for innovation.

7.3 Regression results

This section reports the results of the multivariate analysis.

7.3.1 Selection models

As discussed in Section 4, we first estimate the effect of foreign ownership and the effects of different underlying governance styles by means of sample selection models, which allow us to distinguish the decision to be innovation active, i.e. to carry out innovation activity at all, from the decision about the level and the characteristic of the innovation activities.

Table 7.10

Innovation activities, two equation selection models (selection equation)

	Innovation activities
Equation	(0)
Foreign ownership	-0.104
Size	0.164 ***
Local markets	Reference
National markets	0.174
Global markets	0.274 **
Labor productivity	0.050 **
Recently established	-0.182
Recently merged	0.462 **
Human capital	0.984 ***
Investment	0.046
Constant	-1.013 ***

Note: This table reports the results of the selection equation for innovation activities when estimating equation (1) and (0) simultaneously. *** (**, *) Indicates significance at the 1% (5%, 10%) level

Innovation decisions

The selection equation[12] reported in Table 7.10 estimates how the innovation decision depends on exogenously given firm characteristics and firm behaviour. The most interesting result here is that neither foreign nor domestic ownership influence on the decision to innovate.

However, we see that innovators command a higher endowment of human capital and that investment in intangible capital is associated with tangible investments. On the average, recent events in the firm history such as mergers or establishment affect the decision to be innovation active as well as the profit of the firm, approximated by labour productivity. In addition, and not surprisingly companies focusing on global markets are more likely to carry out innovation activities than companies focusing on local and national markets. Confirming evidence from the literature we find that the propensity to be an innovative firm is an increasing function of firm size.

[12] We exemplarily report the selection equation of the selection model regressing the innovation input (hypothesis 1). The findings here hold for the selection equations in all other regression models testing hypothesis 2 to hypothesis 10.

Table 7.11

Innovation activities, two equation selection models

Dependent variable	Innovation input per worker	Domestic collaboration	Domestic vertical collaboration	Domestic horizontal collaboration	Utilization of domestic science system
Est. method	HR	HP	HP	HP	HP
DU			Reference		
DM	-0.077 ***	1.433 ***	0.668 ***	-0.220	0.535 **
	(0.009)	(0.322)	(0.228)	(0.282)	(0.258)
NM	-0.322 *	0.282	0.032	-0.193	0.220
	(0.189)	(0.224)	(0.225)	(0.335)	(0.284)
ASM	0.336 *	-0.196	-0.066	-	0.321
	(0.176)	(0.299)	(0.277)	-	(0.333)
EOM	0.011	-0.217	-0.163	-0.070	-0.515
	(0.174)	(0.245)	(0.236)	(0.311)	(0.367)
Innov. input	-	0.084	0.009	-0.067	0.148 **
Size	0.056	0.267 ***	0.192 ***	0.153	0.347 ***
Local markets			Reference		
Reg. markets	0.237	-0.242	-0.215	-0.256	-0.124
Glob. markets	0.478 **	-0.122	-0.111	-0.060	0.009
Product orient.	0.315 ***	0.229	0.444 **	0.282	0.658 ***
Process orient.	0.165	0.211	0.091	0.141	0.048
Contin. R&D	0.415 ***	0.643 ***	0.381 *	0.225	0.566 ***
Public Funding	0.396 ***	0.912 ***	0.480 *	0.993 **	0.979 ***
Constant	-1.534	-2.270	-1.811	-2.398	-3.703
Wald test	124.9 ***	95.9 ***	70.2 ***	19.8	125.9 ***
LR test	0.1	0.2	0.58	1.52	0.1

Note: The table gives the coefficient estimates, (*std.err* are reported only for the nationality dummies). *** (**, *) Indicates significance at the 1% (5%, 10%) level. DU= Domestic firms, DM= domestic multinational; NM= Nordic multinational, ASM= Anglo-Saxon multinational; EUM= European and other multinationals. 6 sector dummies included in the regression, not reported here. 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.

Innovation behaviour

Tables 7.11 and 7.12 report the result from the second step of the selection model. Step one gives the determinants to innovation and step two estimates determinants to innovation indicators, innovation input, innovation output and productivity for innovative firms. Our main interest is to compare the five categories of firms: uninational Danish firms, multinational Danish firms, foreign owned firms by Nordic firms, Anglo-Saxon firms and European and other firms. Uninational Danish firms are used as a reference. In addition nine control variables are used in the regressions.

Starting with (log) *innovation input per worker*, depicted in Table 6-11 column 1, we find that the point estimate for Danish multinational firms is highly significant and quite unexpected as the sign of the estimate is negative with an order of magnitude of -0.07. The reference group is uninational Danish firms. Ceteris paribus, or everything else being equal, the innovation intensity is larger in Danish firms with no subsidiaries abroad than in multinational Danish firms.

The sign on the point estimate is negative also for Nordic firms and the size of the estimate is -0.32, however only significant at the 10% level. The estimated association between the size of innovation input per employee and Anglo-Saxon firms, is positive, albeit only weakly significant. The estimated innovation input is not significantly different between European multinationals and uninational Danish firms. In addition we find that innovation input per employee is an increasing function of global market orientation and product orientation. Firms investing in R&D continuously have on the average higher R&D expenditures than firms only focusing on R&D periodically. Public R&D is positively associated with private R&D expenditures.

In columns 2-5 four different classifications of *collaborating on innovation* are considered. We see that domestic collaboration in total, as well as domestic vertical collaboration and collaboration with the domestic scientific system is significantly more frequent among Danish multinational firms compare to other firms.

Columns 6-7 present estimates on determinants to the probability to apply for *patent* and to launch *radical innovations* respectively. With domestic own firms as reference we find highly significant and positive estimates for Nordic firms and a positive albeit on weakly significant estimate for Anglo-Saxon firms. Norwegian and Anglo-Saxon firms have significant lager likelihood of introducing radical innovation in the market than other firms.

Column 8 gives the point estimate for *innovation sales* per capita. Using this monetary measure on innovation output it is shown that Danish multinational firms are significant more efficient in retrieving earnings (or more precisely sales income) from innovation than all other categories of firms with the exception of Anglo-Saxon multinationals.

In column 9 we observe the determinants to *labour productivity*. Here we find no difference between the five groups of firms. Finally column 10 presents the estimates for determinants to the probability to receive *public funding for R&D*. The most interesting finding here is that likelihood of receiving public funding is about the same for domestic and foreign-owned firms.

Table 7.12

Innovation activities, two equation selection models (continued)

Dependent variable	Patent application	Products new to the market	Returns to innovation per worker	Labor productivity	Public funding
Est. method	HP	HP	HR	HR	HP
DU			Reference		
DM	0.181	1.411 ***	0.331	-0.085	0.349
	(0.263)	(0.448)	(0.301)	(0.304)	(0.224)
NM	0.818 ***	0.090	0.575 **	0.499	-0.470
	(0.252)	(0.179)	(0.287)	(0.320)	(0.295)
ASM	0.606 *	0.866 **	1.101 ***	0.552	-0.343
	(0.313)	(0.344)	(0.349)	(0.370)	(0.301)
EOM	0.427	0.044	0.378	0.465	-0.506 *
	(0.261)	(0.181)	(0.284)	(0.312)	(0.277
Innov. input.	0.049	0.085 **	0.141 **	-0.006	
Size	0.203 ***	0.118 ***	0.146 **	0.132	(0.056
Local markets			Reference		
Reg. markets	0.165	0.025	-0.012	-0.342	0.144
Glob. markets	0.150	-0.003	0.054	-0.084	0.389
Product orient.	0.400	0.726 ***	0.931 ***	0.158	0.148
Process orient.	0.394	0.210	0.485	0.131	0.364
Contin. R&D	0.854 ***	-0.056	0.353	0.198	0.824 ***
Public Funding	0.685 ***	-0.199	-0.085	0.185	
Const	-3.186	0.000	1.449 ***	5.316 ***	-1.836
Wald test	72.8 ***	133.1 ***	118.4 ***	102.6 ***	62.0 ***
LR test	0.1	22.5 ***	10.2 ***	29.5 ***	0.3

Note: The table gives the coefficient estimates, (*std.err.* are reported only for the nationality dummies) *** (**,*) indicates significance at the 1% (5%, 10%) level. DU= Domestic firms; 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. 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.

7.32 Multi step production function model

The purpose of using the multistep production model is to investigate the robustness of some of the results presented above by exploiting an econometric framework taking both selectivity bias and simultaneous bias into account. The results are presented in Tables 7.13 and 7.14

Step 1. Selection equation: Dependent variable: Probability of being engaged in innovation

As could be expected the probability of being innovative increases with firm size and with the share of employment with a university degree. See the upper part of Table 7.13. Contrary to the selection model used for the 10 Heckman equations presented above we now don't find that firms focused on global market have a larger propensity of being than other firms.

Step 2. Innovation input equation: Dependent variable: Logarithm of innovation expenditure per employee.

In the investigation of the importance of ownership the uninational Danish firms are used as a reference. The estimates given in the lower part of Table 7.13, produce only weak evidence of Anglo-Saxon firms investing more in innovation expenditures than other firms, ceteris paribus. Moreover, the regression results show that innovation expenditures are an increasing function of global market orientation, public R&D funding and a continual R&D engagement.

Step 3. Innovation output equation: Dependent variable: Logarithm of innovation sales per employee.

The coefficient estimates presented in upper part of Table 7.14 indicate a positive relationship between innovation and sales, however the estimate is not significant at any acceptable degree of significance. Moreover, we find a positive feedback effect from labour productivity to innovation sales. In accordance with the findings from our selection above (Table 7.12) we find that the Anglo-Saxon firms have a significant larger innovation sales per employee compare to other firms.

Step 4: Productivity equation: Dependent variable: Logarithm sale per employee.

The results from the productivity equation are presented in the lower part of Table 7.14. The most interesting finding here is that is we still do not find any difference in labour productivity between domestic and foreign-owned firms when not only accounting for possible selection bias but also simultaneity bias.

Hence, when controlling for sector, size, capital investment, human capital, product innovation and process innovation, neither of Nordic, Anglo-Saxon or European multinationals are on the average more productive than Danish firms. As could be expected, the results show that productivity is an increasing function of investment in tangible capital. Some evidence is also given that productivity is an increasing function of innovation output, however the estimated impact is not significant different from zero. On the contrary, the productivity amongst firm in Denmark is found to increase with firm size, which is at variance with most other studies using the CDM model.

Table 7.13

Multi step production function model

	Coefficient		Std.err.
Step 1: Selection equation Dependent variable: The probability to be an innovative firm			
Foreign ownership	-0.078		0.094
Size	0.183	***	0.031
Local markets	Reference		
National markets	0.214	**	0.126
Global markets	0.276	*	0.126
Recently established	-0.093		0.137
Recently merged	0.157		0.114
Human capital	0.243	**	0.114
Investment per employee (log)	0.034		0.024
Constant	-0.906	***	0.204
Step 2: Innovation input equation Dependent variable: Log innovation expenditures per employee			
DU	Reference		
DM	0.089		0.158
NM	-0.203		0.207
ASM	0.352	*	0.211
EOM	-0.091		0.195
Size	0.068		0.054
Local markets	Reference		
National markets	0.155		0.213
Global markets	0.418	**	0.233
Public funding for R&D	0.259	**	0.116
Process innovation	-0.097		0.085
Continuous R&D	0.513	***	0.126
Constant	1.245	***	0.376

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 7.14

Multi step production function model (continued)

Step 3: Innovation Output equation Dependent variable: The log of innovation sales per capita			
	Coefficient		Std. error
Predicted labour productivity	0.436	**	0.194
Predicted innovation input	0.276		0.310
DU	Reference		
DM	0.290		0.227
NM	0.286		0.320
ASM	0.673	**	0.342
EOM	0.192		0.252
Size	-0.034		0.126
Inverted Mills' ratio from the selection. eq.	-0.707		1.393
Public funding for R&D	-0.222		0.217
Collaboration diversity	0.667		0.418
Human capital	0.485		0.536
Constant	0.881		1.736
Step 4: Productivity equation Dependent variable: Log sales per employee			
Predicted innovation output	0.404		0.385
Physical Investment per employee (log)	0.360	***	0.109
DU	Reference		
DM	-0.07		0.318
NM	0.484		0.302
ASM	0.209		0.476
EOM	0.266		0.276
Process innovation	-0.072		0.168
Size	0.352	***	0.117
Human capital	1.199	*	0.626
Constant	1.555	***	0.406

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.

8. Finland

This section reports the basic analysis of the Finnish CIS data. The Finnish Community Innovation Survey is conducted by Statistics Finland. The third wave of the CIS, which this analysis bases on, is launched in 2001 and refers to the years 1998 to 2000. The survey was sent to 3,462 firms, which yielded a response rate of 50% (Statistics Finland 2002).

8.1 Descriptive statistics for all firms

The descriptive statistics in this section includes all firms in the sample regardless of their carrying out innovative activities or not.

Table 8.1contains the distribution of the companies across the country groups. We also report the number of innovators. As innovators we define companies, which exhibit innovation activities such as having introduced a product or process innovation or companies, which are still committed to ongoing R&D projects. Companies having abandoned an R&D project and are not currently undertaking innovation activities or have not launched a product or process innovation is not considered as innovators.

In the Finnish context we observe that well beyond 60% of the companies are innovative. Domestic non-multinationals and European multinationals contain the below average fraction of innovative companies, whereas the Anglo-Saxon owned companies show the highest rate of innovators. The fraction of innovation active companies among the foreign owned companies does not differ from the share of innovative companies among the domestically owned companies.

Table 8.1

Sample distribution

		Observations Total	Innovative firms	Percent
	Total observations	818	515	63.0
DU:	Domestic non multinationals	541	303	56.1
DM:	Domestic multinationals	93	93	100.0
NM:	Nordic multinationals	72	47	65.3
ASM:	Anglo-Saxon multinationals	54	40	74.1
EOM:	European multinationals and other multinat.	58	32	55.2
DOM:	Domestically owned firms	634	396	62.5
FOR:	Foreign ownership	184	119	64.7

Note: This table reports only about firm, which 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 innovators share of 100% of the domestic multinationals is due to the construction of the domestic multinational indicator.

Table 8.2

Summary statistics of firm characteristics and innovation activities

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
Size	316.481	1835.043	165.458	218.519	162.138	539.235	179.984
Sales	9.356	11.308	9.458	10.065	9.640	9.642	9.694
Labour prod.	4.846	5.245	5.121	5.496	5.242	4.905	5.269
Exports	2.270	4.061	3.059	3.976	2.945	2.532	3.292
Investment	1.519	1.989	1.117	1.747	1.030	1.588	1.275
Innov. input	0.471	1.762	0.582	1.487	0.818	0.661	0.922
Innov. output	1.164	3.270	1.623	2.391	1.511	1.473	1.813

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

Table 8.2 shows summary statistics of firm characteristics and behavior for all five national groups and the foreign owned and domestically owned groups.

The summary shows that on the average domestically owned multinational companies are larger than any of the other companies. This is not surprising as the foreign owned multinationals are subsidiaries.

Most probably the surveyed domestic multinational companies are headquarters, although there is no indicator in the data whether the surveyed company is a subsidiary or is the headquarter of a group. A large fraction of headquarters in this group explains the size difference. Domestic multinationals do not only excel in terms of size they also excel in terms of innovation input and innovation output. In terms of investment and exports domestic multinationals are quite similar to Anglo-Saxon owned firms.

Table 8.3

Sectoral distribution with ownership categories in percent

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
HI M	4.2	9.7	1.4	16.7	1.7	5.1	6.0
HM M	14.6	42.0	22.2	33.3	36.2	18.6	29.8
LM M	20.0	14.0	8.3	11.1	10.3	19.1	9.8
LO M	14.4	9.7	20.8	16.7	15.5	13.7	17.9
KIS	22.4	20.4	23.6	7.4	5.2	22.1	13.0
OS	24.4	4.3	23.6	14.8	31.0	21.5	23.4
	100	**100**	**100**	**100**	**100**	**100**	**100**

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 8.3 ssummarizes the distribution of the companies across the classes of knowledge intensive sectors as defined by Hatzichronoglou (1997) and OECD (2001). Anglo-Saxon ownership is mostly concentrated in high technology manufacturing and less concentrated on services. With exception to medium low technology manufacturing and high technology manufacturing Nordic multinationals are equally spread across the sectors. Domestic multinational companies are predominantly concentrated in the medium high technology manufacturing. Generally, we observe that foreign owned companies are more concentrated in the high medium technology manufacturing than domestically owned companies are.

Table 8.4

Firms' most significant market

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
Local	25.5	1.1	4.2	0.0	6.9	21.9	3.8
National	47.9	21.5	63.9	44.4	48.3	44.0	53.3
Global	26.6	77.4	31.9	55.6	44.8	34.1	42.9
	100	**100**	**100**	**100**	**100**	**100**	**100**

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

In Table 8.4 we summarize what companies report as their most significant market. The most striking, yet not unexpected, difference between foreign owned and domestically owned companies is that the former concentrate less on local markets as compared to the latter. The highest percentage of companies concentrating on global markets can be found in the Finnish subsidiaries of Nordic multinationals. From what we observe here, it seems

that Anglo-Saxon owned multinationals concentrate on supplying the National markets, rather than local.

The comparably low fraction of companies reporting the global market as their most significant one suggests that, if it comes to market access, Anglo-Saxon multinationals serve national markets such as the Finnish, Russian and Swedish markets from with their Finnish subsidiary. Almost three out of four domestic multinationals report the national market to be their most significant one, including Finnish as well as Russian and Swedish markets.

8.2 Descriptive statistics for the innovative firms

The descriptive statistics in this section only focus on innovative as defined above. It gives a more detailed picture of the firm's innovative strategies and the related activities. Table 8.5 gives the percentage of firms where the given activity can be observed. Hence, it summarizes how pervasive the activity is among the innovative companies; it does not give and indication about the intensity of the innovation activity.

Table 8.5

Innovation activities

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
Innovation expenditure	96.7	98.9	93.6	100.0	100.0	97.2	97.5
Innovation sales	73.6	94.6	80.9	87.5	81.3	78.5	83.2
Product innovation	75.2	94.6	83.0	90.0	81.3	79.8	84.9
Process innovation	49.2	77.4	46.8	57.5	43.8	55.8	49.6
Continuous R&D	61.4	95.7	53.2	87.5	78.1	69.4	71.4
Public Funding for R&D	52.5	87.1	38.3	70.0	34.4	60.6	47.9

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

Not surprisingly, almost all innovative firms, in our case here more than 97% report innovation expenditure. However, on the average only less than 80% of the companies report positive sales from new or significantly modified products. The fraction of companies reporting the introduction of new or significantly modified products almost equals the fraction of companies reporting positive sales generated by those products. Domestic multinationals report the by far largest fraction of process innovations, which can probably be explained by larger size of the average company in this category. Domestic non-multinationals and foreign owned companies have approximately a similar propensity to launch process innovations. Only Anglo-Saxon owned companies stand out with an above average fraction of process innovations.

The domestic multinationals stand out as regards the propensity to carry out continuous R&D. More than three quarters of the firms report continuous

R&D. Only about one in two Nordic owned company report continuous R&D.

We also observe that the propensity to receive public funding differs between the country groups. Domestic multinationals receiving public funding for R&D is a quite a ubiquitous phenomenon. So is the case for the Anglo-Saxon owned multinationals. Nordic and European owned firms reveal a far lower propensity to receive public funding, which is considerably lower than the propensity of domestic non-multinationals to receive such support.

The sectoral composition of the foreign engagement and the existence of technology programs targeted at fostering certain sectors may explain some of the variation observed here. However, it cannot account for the large differences between Anglo-Saxon on the one side and European and Nordic owned companies on the other.

Table 8.6

Methods of protection

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
Patent (Valid)	34.0	71.0	53.2	65.0	40.6	42.7	53.8
Patent (Application)	27.7	72.0	34.0	50.0	31.3	38.1	38.7
Design patterns	13.9	34.4	31.9	22.5	15.6	18.7	24.4
Trademarks	27.1	67.7	55.3	42.5	31.3	36.6	44.5
Copyright	12.5	31.2	23.4	20.0	15.6	16.9	20.2
Secrecy	55.1	84.9	66.0	72.5	50.0	62.1	63.9
Complexity of design	34.3	49.5	34.0	47.5	15.6	37.9	33.6
Lead-time advantage	59.1	74.2	66.0	67.5	46.9	62.6	61.3

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

The CIS questionnaires also inquire about the firms' assessment of certain methods to protect inventions and innovations. Also firms are asked about whether they already hold valid patents and whether or not they have applied for patents in the years 1998 to 2000. Table 8.6 contains the percentage of firms giving positive answers to the respective questions in the questionnaire.

Here is shown that domestic multinationals are more likely to possess valid patents and to apply for patents. It also shows that domestic multinationals are more likely to use either of the given protection mechanisms. Informal protection methods such as lead-time advantages and secrecy are most favored, whereas formal protection mechanisms are least favored. Among the formal protection methods patenting plays a leading role. These

preferences do not differ between domestically owned and foreign owned companies. Neither does it differ between the country groups.

Table 8.7

Innovation Input and Innovation Output

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
Input							
Mean	6.1	9.1	3.0	10.0	8.5	6.8	6.9
St.dev	14.9	15.7	5.8	21.1	16.7	15.2	15.6
Min	0.0	0.0	0.0	0.2	0.1	0.0	0.0
Max	100	100	35.6	100	75.3	100	100
Output							
Mean	16.2	25.6	15.6	25.9	18.8	18.4	19.9
St.dev	23.6	27.5	20.1	27.8	21.7	24.9	23.6
Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Max	100	100	80.0	100	80.0	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.

Table 8.7 summarizes the innovation input and the innovation output of the innovating firms. On average domestic multinationals and Anglo-Saxon owned firms seem to show a similar pattern of innovation input and innovation output. Both invest about 10 percent of the sales in innovation and fraction of sales both realize from selling new or significantly modified products amounts to more than a quarter.

Domestic non multi-nationals as well as Nordic and European owned companies on the average show a similar behaviour. Although the Nordic owned companies reveal the lowest innovation expenditure relative to sales. Again the different sectoral distribution of the companies in the different country groups may account for the differences observed in the innovation input and the innovation output.

Table 8.8

Cooperation on innovation

		DOMESTIC		FOREIGN			TOTAL	
		DU	DM	NM	ASM	EOM	DOM	FOR
Within the group	D	41.9	74.2	21.3	15.0	12.5	49.5	16.8
	G	0.0	-[1]	48.9	57.5	53.1	23.5	52.9
Suppliers	D	37.0	77.4	40.4	37.5	31.3	46.5	37.0
	G	22.4	64.5	40.4	35.0	21.9	32.3	33.6
Customers	D	35.0	81.7	55.3	37.5	31.3	46.0	42.9
	G	16.8	78.5	23.4	40.0	25.0	31.3	29.4
Competitors	D	11.9	34.4	6.4	12.5	9.4	17.2	9.2
	G	7.3	19.4	10.6	12.5	9.4	10.1	10.9
Consultancies	D	26.4	53.8	23.4	30.0	21.9	32.8	25.2
	G	8.3	24.7	17.0	17.5	9.4	12.1	15.1
Priv. R&D Labs	D	24.4	59.1	17.0	32.5	28.1	32.6	25.2
	G	6.9	32.3	6.4	10.0	15.6	12.9	10.1
Universities	D	38.0	92.5	31.9	55.0	40.6	50.8	42.0
	G	6.3	38.7	10.6	22.5	6.3	13.9	13.4
Public R&D Org.	D	25.4	64.5	23.4	32.5	21.9	34.6	26.1
	G	5.6	35.5	4.3	7.5	9.4	12.6	6.7
Domestic								
- collaboration		59.1	98.9	70.2	70.0	53.1	68.4	65.5
- vertical coll.		46.5	91.4	59.6	55.0	43.8	57.1	53.8
- horizontal coll		11.9	34.4	6.4	12.5	9.4	17.2	9.2
- scientific coll.		41.9	95.7	38.3	65.0	46.9	54.5	49.6

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. [1]The way we defined domestic multinationals causes the global cooperation rate to be 100 percent.

Table 8.8 displays the collaboration pattern for innovation broken down by the country groups and the internationality of the collaboration partner. Regardless of company ownership Finnish domestic universities are among the most important collaboration partners. Only Nordic owned companies use Finnish universities less than vertical collaboration partners such as domestic supplies and domestic customers.

International collaboration within the corporate group is a major part of the innovation activities for all foreign owned companies. The diversity of the set of collaboration partners does not differ for the foreign owned companies and the domestic groups. However, domestically owned multinationals seem to maintain a broader network of collaboration for R&D than the other firms do.

Table 8.9

Sources of information for innovation.

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
Within the firm	50.5	68.8	44.7	62.5	53.1	54.8	52.9
Within the group	19.1	49.5	29.8	30.0	25.0	26.3	28.6
Suppliers	12.5	14.0	8.5	5.0	12.5	12.9	8.4
Customers	28.1	44.1	19.1	27.5	18.8	31.8	21.8
Competitors	4.0	3.2	4.3	12.5	6.3	3.8	7.6
Universities	4.3	6.5	12.8	15.0	3.1	4.8	10.9
Government	6.3	5.4	4.3	2.5	3.1	6.1	3.4
Prof conferences	5.0	5.4	4.3	2.5	3.1	5.1	3.4
Fairs, exhibitions	5.0	5.4	6.4	2.5	3.1	5.1	4.2

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

In Table 8.9 we report a summary of sources of information for carrying out an innovation project. We can imagine this as giving a clue about where the inspiration for the innovation comes from. For all companies regardless of their ownership the major source of innovation is the firm itself. Additionally, customers and firms within the group play a leading role. Unfortunately, the data does not contain information on the role of the inspiring firms within the group; are they intra-group customers, are they intra-group suppliers?

8.3 Regression results

This section reports the results of the multivariate analysis.

8.31Selection models

As discussed in section 4 we first estimate the effect of foreign ownership and the effects of different underlying governance styles by means of sample selection models, which allow us to distinguish the decision to be innovation active, i.e. to carry out innovation activity at all, from the decision about the level and the characteristic of the innovation activities.

Innovation decision

The selection equation[13] reported in Table 8.10 estimates how the innovation decision depends on exogenously given firm characteristics and

[13] We exemplarily report the selection equation of the selection model regressing the innovation input (hypothesis 1). The findings here hold for the selection equations in all other regression models testing hypothesi 2 to hypothesis 10.

firm behaviour. The most striking result here is that for Finnish firms foreign ownership does not have an influence on the decision to innovate.

However, we see that innovators are larger and more focused on National and global markets. They command a higher endowment with human capital, maintain larger investments and enjoy higher labor productivity. On the average, recent events in the firm history such as mergers or establishment do not affect the decision to be innovation active.

Table 8.10

Innovation decision (selection equation)

	Innovation activities
Hypothesis	0
Estimation method	HR
Foreign ownership	-0.115
Size	0.223 ***
Local markets	Reference
National markets	1.144 ***
Global markets	0.789 ***
Labor productivity	0.167 ***
Recently established	-0.004
Recently merged	-0.125
Human capital	0.361 *
Investment	0.096 ***
Constant	-0.115

Note: This table reports the results of the selection equation for innovation activities regression using a Heckman selection model. *** (**, *) Indicates significance at the 1% (5%, 10%) level

Innovation behaviour

The results of the regression the innovation activities are reported in Table 8.11 and Table 8.12.

The domestic multinationals, the Anglo-Saxon and the European owned firms have a significantly higher innovation effort per employee than firms in domestic or Nordic groups.

Domestic collaboration is more likely among domestic multinationals and Nordic multinationals than among all the other foreign owned companies.

A similar pattern is observed for vertical domestic collaboration. However, it is only the domestic multinationals that collaborate significantly more frequently with competitors.

Also, everything else being equal, domestic multinationals are more embedded in the national science system than all the other companies. Yet, interpreting the collaboration decision of a company as a decision about its embeddedness in the national innovation system, we observe from the

regressions that the market focus is a more significant determinant than the nationality of their ownership.

The more remote from local markets the most important markets are located, the smaller the propensity to collaborate with domestic partners is. This holds true for domestic collaboration as such as well as for all the collaboration types we look at.

The product innovation strategy has also a significant impact on vertical and horizontal collaboration. This again strengthens the point that strategy rather than foreign ownership matters for the utilization of the domestic national innovation system. At this stage of the discussion we see that headquarters as well as strategy matters to determine the innovation activity of firms.

Nordic and domestic multinationals tend to patent more frequently than other companies. The more intensive patenting behavior of the domestic multinationals can be explained by a headquarter effect.

We also find that public funding induces patenting.

The likelihood to innovate on a higher level depends more on market strategy and innovation strategy than it depends on the ownership. Only domestic multinationals produce high-level innovations more frequently than domestic groups. Multinationality seems to foster the development of market novelties.

Although foreign ownership does not matter for the development of high-level innovation it does have an effect on the returns of innovation; especially the Anglo-Saxon owned and the European owned companies perform significantly better than companies owned by domestic groups. Again, we find that Nordic owned companies do not differ from domestically owned ones. For domestically owned companies multinationality does matter.

Astonishingly the return to innovation decreases the more remote the companies' markets are from local markets. Product innovation strategy, however, has a large positive effect on the innovation return.

Measuring performance by productivity we find the Anglo-Saxon owned companies outperforming all the other companies. Innovation input has a positive effect on the performance of the companies.

The receipt of public funding for R&D is more likely for domestic multinationals than for companies, which are part of a purely domestic group. On the average, with exception of the Anglo-Saxon owned companies, foreign owned companies have a smaller likelihood to receive public funding than their domestic Finnish counterparts.

Table 8.11

Innovation activities, two equation selection models

Dependent variable	Innovation input per worker	Domestic collaboration	Domestic vertical collaboration	Domestic horizontal collaboration	Utilization of domestic science system
Est. method	HR	HP	HP	HP	HP
DU			Reference		
DM	0.510 ***	1.521 ***	1.023 ***	0.608 ***	1.493 ***
	(0.178)	(0.401)	(0.207	(0.205)	(0.277)
NM	0.234	0.560 ***	0.551 ***	-0.244	0.220
	(0.212)	(0.188)	(0.177	(0.328)	(0.209)
ASM	0.471 **	0.023	0.067	0.148	0.382
	(0.235)	(0.220)	(0.202	(0.288)	(0.236)
EOM	0.445 *	-0.048	0.095	0.071	0.337
	(0.254)	(0.216)	(0.214	(0.349)	(0.251)
Innov. input	0.000	0.140 ***	0.066 *	0.106 *	0.200 ***
Size	-0.413 ***	0.146 ***	0.088 ***	0.094	0.188 **
Local markets			Reference		
Reg. markets	-0.131	-0.527 ***	-0.434 ***	-0.646 **	-0.547 **
Glob. markets	-0.232	-0.614 ***	-0.694 ***	-0.861 **	-0.884 ***
Product orient.	0.723 ***	0.220	0.400 *	0.567 **	-0.088
Process orient.	1.247 ***	-0.109	0.450	-0.512	-0.532
Contin. R&D	1.046 ***	0.346 **	0.163	0.287	0.487 ***
Public Funding	0.623 ***	0.429 ***	0.122	0.252	0.805 ***
Constant	2.082 ***	-	-	-1.129	-0.775
Wald test	259.3 ***	226.63 ***	90.69 ***	52.87 ***	80.70 ***
LR test	12.7 ***	0.31	15.43 ***	1.55 ***	1.73

Note: The table gives the coefficient estimates, (*std.err* are reported only for the nationality dummies). *** (**, *) Indicates significance at the 1% (5%, 10%) level. The estimation methods are indicated as HR (regression model with sample selection) and HP (probit model with sample selection). DU= Domestic firms, non-multinational; DM= domestic multinational; NM= Nordic multinational, ASM= Anglo-Saxon multinational; EOM= European and other multinationals. The 6 sector dummies included in the regression are not reported here. 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 8.12

Innovation activities, two equation selection models (continued)

Dependent variable	Patent application	Products new to the market	Returns to innovation per worker	Labor productivity	Public funding
Est. method	HP	HP	HR	HR	HP
DU	Reference				
DM	0.412 **	0.900 ***	0.534 **	0.131	0.528 ***
	(0.178)	(0.251)	(0.223)	(0.108)	(0.176)
NM	0.367 *	0.100	0.391	0.140	-0.211 **
	(0.210)	(0.183)	(0.257)	(0.128)	(0.107)
ASM	0.079	0.159	0.675 **	0.314 **	0.069
	(0.222)	(0.203)	(0.282)	(0.142)	(0.197)
EOM	-0.115	0.172	0.538 *	0.155	-0.542 ***
	(0.272)	(0.227)	(0.295)	(0.153)	(0.199)
Innov. input.	0.243 ***	-0.006	0.150 ***	0.146 ***	
Size	0.137	0.067	-0.199 ***	-0.029	0.001
Local markets	Reference				
Nat.. markets	0.171	0.643 ***	-0.643 **	-0.257 *	-0.281 ***
Glob. markets	0.322	0.718 ***	-0.577 *	-0.238	-0.123
Product orient.	0.091	0.596 **	1.368 ***	-0.214	-0.228
Process orient.	0.065	0.213	0.275	-0.152	0.811 ***
Contin. R&D	0.384 **	0.167	-0.132	-0.082	0.370 ***
Public Funding	0.410 ***	0.332	-0.164	-0.142 *	
Const	-1.908	-1.718	4.453 ***	6.040 ***	0.505
Wald test	44.1 ***	116.4 ***	90.5 ***	112.1 ***	56.1 ***
LR test	1.1	3.7 **	24.5 ***	27.6 ***	6.2 **

Note: The table gives the coefficient estimates, (*std.err.* are reported only for the nationality dummies) *** (**, *) indicates significance at the 1% (5%, 10%) level. The estimation methods are indicated as HR (regression model with sample selection) and HP (probit model with sample selection).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. 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.

8.32 Multi step production function model

Our main interest in the multistep is to investigate the importance of ownership of the firms with respect to innovation and economic performance in an econometric framework taking both selectivity bias an simultaneous bias into account and controlling for factors suggesting in the innovation literature such as firm size, physical capital, human capital and various market indicators.

Step1: Selection equation. Dependent variable: Probability of being engaged in innovation

As could be expected and in line with the innovation literature (See Cohen and Klepper 1996 and Klette and Kortum 2002) the probability of being innovative increases with firm size. Moreover, the firms' market orientation is an important determinant to product innovations. A firm with a global or national market orientation has a significantly higher probability of introducing new innovations compared to firms acting mainly on the local market.

Not surprisingly the likelihood of being innovative is an increasing function of the level of human capital. Investment in R&D and other intangible capital is also closely associated with investment in tangible capital. See the upper part of Table 8.13

Step 2:Innovation input equation. Dependent variable: Logarithm of innovation expenditure per employee.

Whereas the likelihood of being innovative is an increasing function of firm size, the amount of innovation engagement among the firms in Finland, defined as innovation expenditures per employee, decreases with firm size. See the lower part of Table 8.13. This finding is also consistent with the results presented by Janz et al (2004) and Lööf and Heshmati (2004).

Looking at the importance of ownership, it is shown that domestic Finnish multinational firms invest significantly more than other firms. The reference group is domestic uninational firms. The estimate for Anglo-Saxon firms is significant at the 10% level. Moreover, the results depicted in tab in Table 8.13 shows that public funding for R&D and continuously R&D engagement is positively associated with the size of R&D investments.

Step 3: Innovation output equation. Dependent variable: Logarithm of innovation sales per employee.

A priori we would expect that innovation output is an increasing function of R&D-investment. Table 8.14 shows that the size of this estimate is 0.22, however non-significant. On the contrary we find a strong and significant association between Finnish multinationals and innovation output. For the four other groups of firms this relationship is non-significant (uninational firms, Nordic firms and European and other firms) or only significant at the

10% level. Interestingly the composite variable for collaboration diversity is highly significant, indicating the importance of networking in the Finnish innovation system. Somewhat unexpected, it is shown that R&D funding has a weakly (10% level) negative effect in innovation output. The latter is at variance with 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 R&D variable, which was estimated in step 2.

Step 4: Productivity equation. Dependent variable: Logarithm sale per employee.

The results from the productivity equation, presented in the lower part of Table 8.14, show that innovation output, expressed as innovation sales per employee, is an important contributor to productivity after controlling for sector, size, capital investment, human capital, process innovation. The effect is significant at the 5% level. The size of the estimate is within the range of what previously has been found in the literature. A 10% increase in innovation output increases the level of productivity by about 2 percent.

Interestingly we find almost a non-relationship between productivity and the 5 different corporate ownership variables. The Nordic firms are an exception, however only at the 10% level of significance.

The important conclusion here is that foreign-owned firms are not more or less productive than uninational firms. Finally, in the Finnish sample consisting of both manufacturing firms and services it is found that labor productivity is a increasing function of not only knowledge capital (innovation output) but also, human capital and physical capital

Table 8.13

Multi step production function model

Step 1: Selection equation Dependent variable: The probability to be an innovative firm			
	Coefficient		Std.err.
Foreign ownership	-0.077		0.118
Size	0.216	***	0.038
Local markets	Reference		
National markets	0.869	***	0.140
Global markets	1.184	***	0.158
Recently established	0.046		0.170
Recently merged	-0.094		0.141
Human capital	0.460	**	0.199
Investment per employee (log)	0.149	***	0.033
Constant	-1.970	***	0.236
Step 2: Innovation input equation Dependent variable Log innovation expenditures per employee			
DU	Reference		
DM	0.532	***	0.183
NM	0.208		0.215
ASM	0.454	*	0.238
EOM	0.399		0.257
Size	-0.427	***	0.050
Local markets	Reference		
National markets	-0.110		0.250
Global markets	-0.164		0.278
Public funding for R&D	0.634	***	0.132
Process innovation	0.189		0.123
Continuous R&D	1.134	***	0.150
Constant	2.107	***	0.453

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 8.14
Multi step production function model (continued)

Step 3: Innovation Output equation Dependent variable: The log of innovation sales per capita			
	Coefficient		Std. error
Predicted labour productivity	0.328		0.278
Predicted innovation input	0.225		0.175
DU	Reference		
DM	0.496	**	0.224
NM	0.294		0.259
ASM	0.545	*	0.294
EOM	0.238		0.31
Size	-0.153		0.111
Inverted Mills' ratio from the sel. equn.	-0.873	*	0.742
Public funding for R&D	-0.396	*	0.23
Collaboration diversity	1.555	***	0.349
Human capital	-0.553		0.371
Constant	1.527		2.232
Step 4: Productivity equation Dependent variable: Log sales per employee per employee			
Predicted innovation output	0.202	**	0.086
Physical Investment per employee (log)	0.269	***	0.038
DU	Reference		
DM	-0.084		0.111
NM	0.174	*	0.101
ASM	0.122		0.159
EOM	0.107		0.159
Process innovation	-0.101		0.070
Size	-0.009		0.035
Human capital	0.639	***	0.147
Constant	4.261	***	0.190

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.

9. Iceland

This section contains the detailed country analysis of the Icelandic CIS data. The Community Innovation Survey was carried out by Statistics Iceland in early 2002. The reference period is 1998 to 2000.

The size of the Icelandic economy required and enabled Statistics Iceland to carry out a special sampling procedure. Statistics Iceland collected *all* 798 Icelandic companies above with 10 employees or above and conducted a telephone survey on whether or not they carry out innovation activities. Subsequently the CIS questionnaire was sent to the 471 innovation active companies with a response of 223 companies. 60 of the responding companies turned out to be not innovation active, although having claimed to carry out innovation activities in the telephone survey (Statistics Iceland 2003).

9.1 Descriptive statistics for all firms

In the first step of the detailed analysis we present the descriptive statistics for all firms, which are part of a corporate group. All firms, not being part of a corporate group are disregarded for the analysis below.

Table 9.1

Sample distribution

		Observations Total	Innovative firms[1]	Percent
	Total observations	107	56	52.3
DU:	Domestic non multinationals	78	38	48.7
DM:	Domestic multinationals	2	2	100.0
NM:	Nordic multinationals	8	4	50.0
ASM:	Anglo-Saxon multinationals	10	7	70
EOM:	European multinationals and other multin.	9	5	55.6
DOM:	Domestically owned firms	80	40	50.0
FOR:	Foreign ownership	27	16	59.2

Note: This table reports only about firm, which 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 innovators share of 100% of the domestic multinationals is due to the construction of the domestic multinational indicator.

Table 9.2 summarizes the composition of the used data set. It gives the number of domestic and the number of foreign owned firms both in the whole sample and in the subsample of innovation active firms. Based on our procedure to single out domestic multinationals we only detect two companies which qualify for a domestic multinational among the 80 domestically owned firms. According to Statistics Iceland's sampling and surveying methodology the 56 included in the analysis here are about one

third of the valid responses received from innovation active firms. Although the absolute number of observations for each country group, particularly the domestic multinationals and the Nordic multinationals are rather small we include them in the breakdown in the summaries below. Among foreign owned companies innovation activities seem to slightly more common then they are among all of the domestically owned companies in the sample.

Table 9.2
Summary statistics of firm characteristics and innovation activities

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
Size	74.58	180.50	55.25	150.80	27.56	77.23	81.41
Sales	8.79	10.06	8.83	8.44	7.82	8.82	8.35
Labour prod.	5.09	4.94	5.28	5.21	4.68	5.09	5.05
Exports	0.90	2.44	2.98	2.04	0.89	0.94	1.94
Investment	1.92	2.47	1.20	2.96	1.40	1.93	1.92
Innov. input	0.63	2.00	0.92	2.10	1.07	0.66	1.41
Innov. output	1.01	3.30	1.93	1.83	1.53	1.07	1.76
Human cap	0.20	0.14	0.38	0.46	0.26	0.20	0.37

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

Table 9.2 displays the summary of the company characteristics for the domestic and the foreign owned firms. On the average the domestic multinationals are larger than all the other companies. The Anglo-Saxon owned firms however seem to be most similar to the domestic multinationals in terms of size. Both Anglo-Saxon and Nordic owned firms share the feature of high productivity. All other firms lag behind. In particular the domestic multinationals are on the average not more productive than the companies, which are a part of a domestic corporate group.

Domestic multinationals, Nordic owned companies and Anglo-Saxon owned companies show exports, which by far exceed the exports of domestic and European owned firms. Measured by innovation input and innovation output the domestic multinationals are most similar to the Anglo-Saxon owned firms. On the average Anglo-Saxon owned and Nordic owned companies are endowed with the highest human capital.

Focusing on the domestic/foreign dichotomy we observe that domestically owned firms and foreign owned firms are comparable in size, turnover, investment and labor productivity. Foreign owned firms, however, have higher exports and larger human capital endowment than firms with Icelandic ownership. By and large, the summary statistics here support an innovation input gap and innovation output gap, as innovation spending per worker and innovation return per worker is higher in the foreign owned firms. Yet, the summary statistics would not support the hypothesis of a

productivity gap. As the subsample of foreign owned firms contains a higher share of innovation active companies, the asserted gaps could be a result of the different shares of innovators.

Table 9. 3

Sectoral distribution with ownership categories in percent

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
HI M	2.6	0.0	0.0	10.0	0.00	2.5	3.7
HM M	1.3	50.0	12.5	0.0	22.2	2.5	11.1
LM M	7.7	0.0	12.5	10.0	11.1	7.5	11.1
LO M	26.9	0.0	25.0	10.0	0.00	26.3	11.1
KIS	35.9	0.0	25.0	50.0	44.4	35.0	40.7
OS	25.6	50.0	25.0	20.0	22.2	26.3	22.2
	100.0	100.0	100.0	100.0	100.0	100.0	100.0
FOOD	15.4	0.0	25.0	10.0	0.00	15.0	11.1

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).

In Iceland the foreign ownership is more concentrated in certain sectors than in others. Four out of ten foreign owned firms in Iceland belong to the knowledge intensive service sector. Only two out of ten belong to the traditional services and only one out of ten is from high low technology manufacturing, low medium technology manufacturing and high medium technology manufacturing. Among the Icelandic owned companies the low technology manufacturing sectors and the traditional service sectors have a higher share, whereas the knowledge intensive services are represented less.

More than 25% of the firms in Iceland with more than 10 employees belong to the food-processing sector (Nace 15) more than 50% of which are companies processing and preserving fish and fish products. About 14% of those companies are part of a corporate group and hence part of the analysis here. The food processing industry's fraction of the companies is displayed in the bottom row of Table 9.3. The food processing industry's share within the group of foreign owned and domestically owned firms does not differ from its share in the sample.

Table 9.4

Firms' most significant market

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
Local	55.13	50.00	25.00	40.00	55.56	55.00	40.74
National	24.36	0.00	37.50	0.00	22.22	23.75	18.52
Global	20.51	50.00	37.50	60.00	22.22	21.25	40.74

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

Table 9.4 summarizes the most significant market for the companies in the sample. Icelandic owned companies focus more on local and national markets, whereas foreign owned put a stronger focus on global markets. The share of companies that regard global markets as their most significant ones are is twice as high among the foreign owned companies than it is among the Icelandic ones.

9.2 Descriptive statistics for the innovative firms

This section discusses the characteristics and the behaviour of innovative firms in Iceland. Innovativeness here relates more to carrying out innovation related activities than to being successful in introducing new processes or new products. It gives a more detailed picture of the firms' innovative strategies and the related activities.

Table 9.5 gives the percentage of firms, where the given activity can be observed. Hence, it summarizes how pervasive the certain types of innovation related activity are among the innovative companies; it does not give and indication about the intensity of the innovation activity, though.

Table 9.5

Innovation activities

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
Innovation expenditure	97.4	100.0	100.0	100.0	100.0	97.5	100.0
Innovation sales	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Product innovation	92.1	100.0	100.0	71.4	100.0	92.5	87.5
Process innovation	68.4	100.0	75.0	57.1	80.0	70.0	68.8
Continuous R&D	52.6	100.0	75.0	71.4	60.0	55.0	68.8
Public Funding for R&D	22.2	50.0	50.0	33.3	20.0	23.7	33.3

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

Almost all companies reporting innovation projects also show positive innovation expenditure. Also all companies do indeed report positive sales generated by new or significantly modified products. Product innovation,

defined as the introduction of new or significantly modified products is rather high. For Anglo-Saxon owned firms, however, we observe a lower likelihood to product innovate than for all the other companies. The average probability of product innovation of an average foreign owned firm in Iceland falls about 5 percentage points behind the probability of a domestically owned Icelandic company. In terms of process innovation we do not see a striking difference. Continuous engagement in R&D is more common among foreign owned firms than it is among Icelandic owned firms. Interestingly, relatively more foreign owned firms receive public funding for R&D than Icelandic owned firms do.

At this stage, when measuring the output of innovative activities by product innovations, we find support for differences in the innovation output between foreign owned firms and Icelandic owned firms. The lower rate of product innovations among foreign owned firms is caused by the lack of product innovativeness of Anglo-Saxon owned companies. We do not find a clear difference in innovation input, though.

Table 9.6

Methods of protection

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
Patent (Valid)	11.1	50.0	25.0	42.9	20.0	13.2	31.3
Patent (Application)	5.6	50.0	0.0	57.1	20.0	7.9	31.3
Design patterns	5.7	0.0	0.0	0.0	25.0	5.4	6.7
Trademarks	44.4	100.0	25.0	71.4	50.0	47.4	53.3
Copyright	11.4	0.0	0.0	28.6	75.0	10.8	33.3
Secrecy	44.4	50.0	75.0	66.7	80.0	44.7	73.3
Complexity of design	22.2	0.0	0.0	0.0	50.0	21.1	14.3
Lead-time advantage	38.9	50.0	50.0	33.3	50.0	39.5	42.9

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

In Table 9.6 we find that patenting and copyright plays a stronger role in the protection strategies of foreign owned firms than they do in the strategies of Icelandic owned firms. Foreign owned firms also rely more on secrecy than Icelandic owned firms do. More than 20% of the domestic rely on complexity of the design, as a protection mechanism; yet, none of the Nordic owned firms and none of the Anglo-Saxon owned firms do so.

Table9.7

Innovation Input and Innovation Output

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
Input							
Mean	21.3	7.6	19.5	58.3	67.0	20.6	51.3
St.dev	35.2	7.8	31.6	44.9	42.7	34.5	43.2
Min	0.0	2.1	0.5	2.0	5.2	0.0	0.5
Max	100.0	13.1	66.6	100.0	100.0	100.0	100.0
Output							
Mean	23.1	20.0	47.5	56.6	61.3	22.9	55.2
St.dev	25.0	7.1	38.0	34.1	34.7	24.2	32.9
Min	0.0	0.2	0.2	0.1	0.3	0.0	0.1
Max	100.0	25.0	100.0	100.0	100.0	100.0	100.0

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.

The innovation input and the innovation output are summarized in Table 9.7.

In contrast to Table 9.6 we do not merely investigate the existence of innovation input and innovation output. Instead we investigate the level of input and output. Innovation input is measured here in innovation expenditure per worker.

It is notable that the analysis above does not produce and conclusive differences between domestically owned companies and foreign owned companies. Looking at the level of innovation input we clearly see an innovation input gap. Foreign owned companies spend more on innovation than Icelandic owned companies. The summary of the innovation output measured by the per worker sales of new and significantly modified products, reveals an innovation output gap in favor of the foreign owned firm.

Table 9.8

Cooperation on innovation

		DOMESTIC		FOREIGN			TOTAL	
		DU	DM	NM	ASM	EOM	DOM	FOR
Within the group	D	39.5	0.0	25.0	28.6	20.0	37.5	25.0
	G	0.0	100.0	50.0	71.4	40.0	5.0	56.3
Suppliers	D	34.2	0.0	25.0	28.6	40.0	32.5	31.3
	G	23.7	50.0	50.0	28.6	20.0	25.0	31.3
Customers	D	28.9	50.0	25.0	14.3	0.0	30.0	12.5
	G	13.2	50.0	25.0	28.6	20.0	15.0	25.0
Competitors	D	21.1	0.0	0.0	0.0	0.0	20.0	0.0
	G	0.0	50.0	25.0	28.6	0.0	2.5	18.8
Consultancies	D	26.3	0.0	25.0	14.3	0.0	25.0	12.5
	G	5.3	0.0	25.0	14.3	20.0	5.0	18.8
Priv. R&D Labs	D	5.3	0.0	50.0	14.3	0.0	5.0	18.8
	G	7.9	0.0	25.0	14.3	20.0	7.5	18.8
Universities	D	13.2	50.0	50.0	28.6	0.0	15.0	25.0
	G	7.9	50.0	0.0	28.6	20.0	10.0	18.8
Public R&D Org.	D	21.1	50.0	75.0	14.3	0.0	22.5	25.0
	G	0.0	0.0	50.0	0.0	0.0	0.0	12.5
Domestic								
- collaboration		63.16	50.00	75.00	85.71	40.00	62.50	68.75
- vertical coll.		42.11	50.00	50.00	42.86	40.00	42.50	43.75
- horizontal coll		21.05	0.00	0.00	0.00	0.00	20.00	0.00
- scientific coll.		28.95	50.00	75.00	42.86	0.00	30.00	37.50

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 9.8 summarizes the collaboration for R&D. The summary of the collaboration pattern does not reveal any striking difference between Icelandic owned companies and foreign owned companies. From this we do not find support for the embeddedness hypothesis.

Table 9.9

Sources of information for innovation.

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
Within the firm	71.4	50.0	75.0	42.9	60.0	70.3	56.3
Within the group	18.8	0.0	25.0	33.3	50.0	17.6	35.7
Suppliers	12.9	50.0	0.0	42.9	40.0	15.2	31.3
Customers	46.9	50.0	100.0	33.3	40.0	47.1	50.0
Competitors	12.1	50.0	0.0	0.0	40.0	14.3	14.3
Universities	0.0	0.0	0.0	0.0	20.0	0.0	6.7
Government	3.3	0.0	0.0	0.0	0.0	3.2	0.0
Prof conferences	9.1	0.0	0.0	0.0	20.0	8.6	6.7
Fairs, exhibitions	12.5	50.0	0.0	0.0	20.0	14.7	6.7

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

Investigating the sources of information utilized by companies in their innovation efforts, Table 9.9 reveals a striking difference between foreign owned and Icelandic owned companies. The corporate group as a source of inspiration seems to play a larger role for foreign owned firms than for Icelandic owned firms. Firm internal information sources are utilized in Icelandic owned firms to a larger degree than they are utilized in foreign owned firms.

The source of inspiration for Icelandic owned firms is therefore domestic, whereas the foreign owned firms seem to draw information for their innovation activities from abroad. This suggests that foreign owned firms function generate an inflow of knowledge or at least an inflow of innovative ideas into the Icelandic innovation system.

9.3 Regression results

This section reports and comments the regression results.

9.31 Selection models

Table 9.10

Innovation activities, two equation selection models (selection equation)

	Innovation activities	
Equation	(0)	
Foreign ownership	0.066	
Size	0.676	***
Local markets	Reference	
National markets	0.037	
Global markets	1.325	**
Labor productivity	-0.392	***
Recently established	0.168	
Recently merged	0.616	
Human capital	0.116	
Investment	-0.221	*
Constant	-0.538	

Note: This table reports the results of the selection equation for innovation activities when estimating equation (1) and (0) simultaneously. *** (**, *) Indicates significance at the 1% (5%, 10%) level

Table 9.10 summarizes the results for the selection equation (0). Essentially it analyzes the determinants of the companies' decision to carry out innovation activities at all.

The probability of companies to carry out innovation activities is about 19.5%[14] higher for companies which have recently merged; for companies which have been established in between 1998 and 2000 the probability to carry out innovation activities is 4.5% less, everything else equal.

A company with a focus on global markets enjoy a probability of carrying out innovation activities which is about 36.8% higher than, everything else equal, a company with a focus on local markets. A company with a focus on national markets is about 10% more likely to carry out innovation activities. Although not being significant, we observe an innovation gap here, which is about 4.6%. Foreign owned companies, again everything else equal, enjoy a higher likelihood of carrying out innovation activities.

[14] The marginal effects are not reported in the table above.

As none of the foreign owned companies has collaborated with domestic competitors a regression of the domestic horizontal collaboration does on foreign ownership does not make sense. Not collaboration is explained fully by foreign ownership.

Table 9.11

Innovation activities, two equation selection models

Dependent variable	Innovation input per worker	Domestic collaboration	Domestic vertical collaboration	Utilization of domestic science system
Est. method	HR	HP	HP	HP
For. ownership	0.455	0.092	-0.323	0.085
	(0.388)	(0.429)	(0.477)	(0.444)
Innov. input	-	-0.033	0.265	-0.102
Size	-0.356 **	-0.054	-0.282	-0.064
Local markets		Reference		
Reg. markets	0.738	0.207	-0.038	0.285
Glob. markets	1.225 ***	0.239	-0.633	0.746
Product orient.	1.278 **	0.315	1.177	0.034
Process orient.	-0.625	-0.041	0.016	-0.263
Contin. R&D	1.265 ***	0.249	-0.173	0.663
Public Funding	-0.732	0.356	0.263	0.063
Constant	0.738	0.207	-0.038	0.285
Wald test	83.54 ***	3.99	11.89	10.84
LR test	21.73 ***	0.10	0.10	0.65

Note: The table gives the coefficient estimates, (std.err are reported only for the foreign ownership dummy). *** (**,*) indicates significance at the 1% (5%, 10%) level. The estimation methods are indicated as HR (regression model with sample selection) and HP (probit model with sample selection). 4 sector dummies included in the regression, are not reported here. 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 9.11summarizes the results of the regressions of equation (1) in the case of the innovation input per worker and of equation (2) in the case of the domestic collaboration. The regression of innovation expenditure per worker tests for the innovation input gap.

The coefficient estimate, although not being significant, indicates that foreign ownership increases the innovation expenditure per worker by 57% relative to domestic ownership.[15] We also observe that the innovation strategy as captured and the global market orientation are a strong determinant of innovation expenditure. They increase innovation expenditure per worker by more than 200%.

[15] As we measure the innovation effort per worker in logarithm the multiplicative effect of foreign ownerhsip is quantified by exp(0.455).

Here, as in other comparable studies such as Ebersberger, Lööf and Oksanen (2004) we find that strategy matters more in the determination of the innovation expenditure than ownership does.

The regression of the domestic collaboration does not show any statistically significant indication of an embeddedness gap. As such it conforms to the observation in the exploratory analysis above. Yet, everything else being equal, foreign owned companies have a 3.5 percentage points higher probability of collaborating with partners in the Icelandic innovation system. We also note that – although the model is has joint significance for the innovation input – the variables used do not jointly determine the collaboration decision of the companies.

Table 9.12

Innovation activities, two equation selection models (continued)

Dependent variable	Products new to the market	Returns to innovation per worker	Labor productivity	Public funding
Est. method	HP	HR	HR	HP
For. ownership	-0.263	0.012	-0.105	0.046
	(0.471)	(0.428)	(0.240)	(0.645)
Innov. input	0.119	0.381 **	0.013	-
Size	-0.189	0.013	0.115	-0.531 **
Local markets				
Reg. markets	0.435	-0.396 *	-0.756 **	2.374 **
Glob. markets	0.844	0.813 **	0.099	2.026 **
Product orient.	1.290 *	1.175	-0.061	2.549 **
Process orient.	0.431	-0.034	-1.230 ***	-1.303
Contin. R&D	-0.230	1.472 ***	0.277	0.589
Public Funding	-0.796	0.024 ***	-0.486	-
Constant	0.435	-0.396	-0.756 ***	-
Wald test	12.93	204.81 ***	46.26 ***	10.86
LR test	0.12	33.41 ***	0.06	0.35

Note: The table gives the coefficient estimates, (*std.err* are reported only for the foreign ownership dummy). *** (**,*) indicates significance at the 1% (5%, 10%) level. The estimation methods are indicated as HR (regression model with sample selection) and HP (probit model with sample selection). 4 sector dummies included in the regression, are not reported here. 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.

In Table 9.12 we investigate both the innovation output gap and the productivity gap. Foreign ownership has both a statistically and economically insignificant impact on the innovation output. Here again we find that the market strategy of the company has a strong influence on the innovation output.

We also observe that the persistence of innovation efforts translate into innovation output. Consistent with the evolutionary theory of the firm we find that for firm performance, measured by innovation output, not only does the presence matter – current innovation input, that is – but so does the firms' history.

In regressing the productivity we find that the foreign ownership does not have a statistically significant impact on the labor productivity. Double checking the result in the production function model, we also find no significant impact of foreign ownership on the labor productivity of firms.

9.32 Multi step production function model

Step 1: Selection equation: Dependent variable: Probability of being engaged in innovation

As could be expected and in line with the innovation literature (See Cohen and Klepper 1996 and Klette and Kortum 2002) the probability of being innovative increases with firm size.

The firm s' market orientation is not an important determinant to product innovations among firms in Iceland.

Investment in R&D and other intangible capital is found to be closely associated with investment in tangible capital, see upper part of Table 9.13

Step 2:Innovation input equation: Dependent variable: Logarithm of innovation expenditure per employee.

At variance with the estimate in the selection equation presented in Section 9.31, the multistep estimate is positive and significant for the elasticity of R&D expenditures with respect to foreign ownership. That is, innovative firms in Iceland invest significantly more than Icelandic owned firms, every thing else being equal.

The results, presented in the bottom part of Table 9.13, also shows that innovation expenditures on Iceland is an increasing function of global market orientation and the firms history of previous R&D investments.

Step 3:Innovation output equation: Dependent variable: Logarithm of innovation sales per employee.

Using CIS databases and alternative versions of the so-called CDM-model a stable pattern between innovation sales and productivity has been found. In a similar framework this literature also estimate the relationship between innovation input and innovation output. Kleinknecht and Mohnen (2003) survey this literature.

A priori we would expect that innovation output is an increasing function of R&D-investment. This is also confirmed by the results presented in the bottom part of Table 9.14. The estimate for innovation input is highly significant and the order of magnitude is 0.85.

It should also be noticed that the Mills' variable is significant at the 10% level, indicating the importance of accounting for selectivity bias in the model.

Step 4: Productivity equation. Dependent variable: Logarithm sale per employee.

The results from the productivity equation presented in the lower part of Table 9.14 show that innovation output, expressed as innovation sales per employee, is an important contributor to productivity after controlling for sector, size, capital investment, human capital, process innovation. The effect is significant at the 5% level. The size of the estimate is within the range of what previously has been found in the literature. A 10% increase in innovation output increases the level of productivity by about 2 percent.

Interestingly we find no impact from the ownership variables. The conclusion here is that foreign-owned firms are not more or less productive than uninational firms or domestic multinational firms at the margin when using the control variables suggested in the Schumpeterian literature. Somewhat surprisingly, Table 9.15 reports a negative relationship between human capital and labor productivity.

Table 9.13

Multi step production function model

Step 1: Selection equation Dependent variable: The probability to be an innovative firm			
	Coefficient		Std.err.
Foreign ownership	0.135		0.361
Size	0.732	***	0.162
Local markets		Reference	
National markets	0.264		0.390
Global markets	1.039	*	0.440
Recently established	0.277		0.429
Recently merged	0.395		0.354
Human capital	0.677		0.780
Investment per employee (log)	-0.211	**	0.106
Constant	-2.820		0.687
Step 2: Innovation input equation Dependent variable Log innovation expenditures per employee			
Foreign ownership	0.518	**	0.340
Size	0.374		0.155
Local markets		Reference	
National markets	0.287		0.432
Global markets	1.032	**	0.406
Public funding for R&D	-0.254		0.402
Process innovation	-0.189		0.283
Continuous R&D	1.628	***	0.308
Constant	1.202		0.826

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 9.14

Multi step production function model (continued)

Step 3: Innovation Output equation Dependent variable: The log of innovation sales per capita			
	Coefficient		Std. error
Predicted labour productivity	1.328		1.153
Predicted innovation input	0.854	***	0.293
Foreign ownership	-0.260		0.460
Size	0.443		0.281
Inverted Mills' ratio from the sel. equn.	1.808	*	0.920
Public funding for R&D	-0.284		0.749
Collaboration diversity	2.710		1.704
Human capital	2.397		1.876
Constant	-8.354		6.357
Step 4: Productivity equation Dependent variable: Log sales per employee per			
Predicted innovation output	0.223	**	0.101
Physical Investment per employee (log)	-0.134		0.111
Foreign ownership	0.316		0.223
Process innovation	-0.015		0.283
Size	0.149		0.090
Human capital	-1.320	***	0.471
Constant	4.176	***	0.474

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.

10. Norway

10.1 Descriptive statistics for all firms

The Norwegian data used in this study consists of a subsample of the observations from the third Community Innovation Survey. The current sample refers only to firms belonging to a group. The total number of observed firms is 2,327 of which of which approximately one in 3 is a foreign controlled firm.

Table 10.1

Sample distribution

		Observations Total	Innovative firms[1]	Percent
	Total observations	2 327	1 120	48.1
DU:	Domestic non multinationals	1 556	747	48.1
DM:	Domestic multinationals	55	55	100.0
NM:	Nordic multinationals	239	109	45.6
ASM:	Anglo-Saxon multinationals	119	72	60.5
EOM:	European multinationals and other multin.	358	137	38.3
DOM:	Domestically owned firms	1 642	814	49.6
FOR:	Foreign ownership	685	306	44.7

Note: This table reports only about firm which 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 innovators share of 100% of the domestic multinationals is due to the construction of the domestic multinational indicator.

Table 10.1 gives the sample distribution of the different category of owners considered: domestic non multinationals (1 556 observations), domestic multinationals (55), Nordic multinationals (239 firms with headquarter in Denmark, Finland, Iceland or Sweden), Anglo-Saxon (119) and European and other multinationals (358).

Among the Norwegian firms 50 percent are classified as “innovative firms”; they have launched at least one process innovation or product innovation during the period 1998-2000, or they were reporting ongoing innovation activities in year 2000. The corresponding figure for foreign controlled firms is 45 percent.

Note the large differences in share of innovative firms among the domestically owned firms; while five in 10 of the observed non-multinationals are innovative, all Norwegian multinationals are innovative.

A large difference in share of innovative firms is observed among the foreign controlled firms. The Anglo-Saxon enterprises have the largest proportion (61%) and European and other multinationals the smallest

proportion (38%). Firms controlled by Nordic neighbours are somewhat less innovative than Norwegian firms in this respect (46%).

Table 10.2

Summary statistics of firm characteristics and innovation activities

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
	N=1 556	N=55	N=239	N=119	N=358	N=1642	N=685
Size	149	406	206	223	225	158	222
Sales	11.393	12.356	11.823	11.907	11.718	11.432	11.785
Labour prod.	7.223	7.415	7.429	7.499	7.220	7.234	7.332
Exports	2.568	6.134	2.812	4.193	3.385	2.700	3.333
Investment	3.046	3.722	2.991	3.302	3.120	3.065	3.117
Innov. input	1.493	4.611	1.094	2.399	1.260	1.589	1.410
Innov. output	2.092	5.441	1.990	2.807	1.715	2.202	1.989
Human capital	0.243	0.423	0.298	0.399	0.276	0.249	0.305

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

Table 10.2 reports summary statistics of key economics and innovation variables. Starting with firm size the right part of the table shows that the average number of employees is about 160 in domestic compared to 220 employees in foreign owned firms. The average Norwegian multinational firm is 2.7 times larger than the average uninational firm. When size is expressed as sales a similar pattern is shown as in the case of employment.

Expressed in intensity terms (per capita) the right part of the table shows that foreign-owned firms outperform Norwegian firms when labor productivity, export, physical investments and human capital are considered. The lower domestic mean values can all be explained by uninational Norwegian firms. The Norwegian multinational firms have considerable higher export figures for export other firms. They are also more productive and invest more than other firms.

Unanimously Norwegian multinationals outperforms other firms as regards innovation input and innovation output. Among foreign controlled multinationals the Anglo-Saxon controlled firms are the most innovative. In aggregate figures the average Norwegian firm has invest more innovation activities and receive more sales income from new and significantly improved products than the average foreign firm.

Table 10.3

Sectoral distribution with ownership categories in percent

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
	N=1 556	N=55	N=239	N=119	N=358	N=1642	N=685
HI M	2.6	12.7	1.7	7.6	3.3	2.9	3.7
HM M	7.5	29.1	8.4	23.5	15.4	8.3	14.4
LM M	15.8	5,4	14.2	9.2	14.5	15.8	12.4
LO M	28.0	21.8	15.9	5.9	15.1	27.6	13.6
KIS	19.3	18.2	27.2	30.3	21.2	19.3	25.0
OS	26.9	12.7	32.6	23.5	30.4	26.1	30.9
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0

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 10.3 shows the distribution of manufacturing and service firms across technology intensity. About six in ten Norwegian and Anglo-Saxon multinational firms belong to high or high medium technology sectors or the knowledge intensive service sector. The corresponding share is 40 percent for European controlled firms, 37 percent for Nordic multinationals and 29 percent for Norwegian uninational firms. The conclusion here is that foreign controlled firms are evidently more oriented towards knowledge intense manufacturing and service production than the average Norwegian firm.

Table 10.4

Firms' most significant market

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
	N=1 556	N=55	N=239	N=119	N=358	N=1642	N=685
Local	39.4	5.5	32.2	16.8	30.7	38.3	28.3
National	40.4	23.6	50.2	43.7	45.3	39.8	47.0
Global	20.2	70.9	17.6	39.5	24.0	21.9	24.7
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0

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

In Table 10.4 we summarize what companies report as their most significant market.

The most striking finding is that 71 percent of the Norwegian multinationals are focusing on the global market compare to 18-40 percent for other multinational enterprises. For about eight in 10 Nordic and European firms

Norway is the most significant market. The figure is more or less the same as for uninational firms. More than 60 percent of the Anglo-Saxon firms consider Norway as their most significant market.

10.2 Descriptive statistics for the innovative firms

This section discusses the characteristics and the behaviour of innovative firms in Iceland. Innovativeness here relates more to carrying out innovation related activities than to being successful in introducing new processes or new products. It gives a more detailed picture of the firms' innovative strategies and the related activities.

Table 10.5

Innovation activities

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
	N=747	N=55	N=109	N=72	N=136	N=813	N=305
Innovation expenditure	93.7	98.1	84.4	93.0	92.7	93.9	89.0
Innovation sales	82.0	90.9	78.8	81.9	81.0	82.8	80.0
Product innovation	83.6	92.7	78.8	80.5	81.7	84.3	80.0
Process innovation	68.1	72.7	66.0	69.4	60.5	68.7	63.3
Continuous R&D	33.3	70.9	35.7	54.1	43.7	36.3	42.4
Public Funding for R&D	23.8	54.5	16.5	23.6	25.7	25.8	22.2

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

Tables 10.5 to 10.9 give descriptive statistics only for innovative firms.

Table 10.5 reports the percentage of firms where the given activity can be observed.

As could be expected the vast majority of all firms defined as innovative in this study reported innovation expenditures and innovation sales in year 2000. Product innovations are in general somewhat more common than process innovations.

It is notable that only a minority of the innovative uninational Norwegian firms and the multinational Nordic and European firms are conducting R&D on a continuous basis. The share of regular R&D firms is also somewhat unexpectedly low among Norwegian multinationals (71%) and Anglo-Saxon firms (54%).

The propensity to receive public funding for R&D is about the same for foreign owned firms as for non-multinational domestic firms; however it is about two times higher for Norwegian multinational firms compared to other firms.

Table 10.6

Methods of protection

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
	N=747	N=55	N=109	N=72	N=136	N=813	N=305
Patent (Valid)	93.7	98.1	84.4	93.0	92.7	93.9	89.0
Patent (Application)	82.0	90.9	78.8	81.9	81.0	82.8	80.0
Design patterns	83.6	92.7	78.8	80.5	81.7	84.3	80.0
Trademarks	68.1	72.7	66.0	69.4	60.5	68.7	63.3
Copyright	33.3	70.9	35.7	54.1	43.7	36.3	42.4
Secrecy	23.8	54.5	16.5	23.6	25.7	25.8	22.2
Complexity of design	93.7	98.1	84.4	93.0	92.7	93.9	89.0
Lead-time advantage	82.0	90.9	78.8	81.9	81.0	82.8	80.0

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

The descriptive statistics on methods of protections, given in Table 10.6, reveals that the propensity to hold and to apply for patens is larger for foreign-owned firms. Interestingly, a larger share of both Nordic and Anglo-Saxon firms possess patent than Norwegian multinationals.

For the other six methods of protection investigated (design patterns, trademarks, copyrights, secrecy, complexity of design and lead-time advantage), the general picture is that a higher percentage of the Norwegian multinationals are using intellectual protection methods and methods of protection than other firms.

Table 10.7

Innovation Input and Innovation Output

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
Input							
Mean	7.1	16.7	4.7	13.9	9.3	7.8	8.8
St.Dev.	16.8	26.3	12.2	23.1	21.6	17.7	19.7
Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Max	100.0	100.0	22.6	100.0	100.0	100.0	100.0
Output							
Mean	20.5	30.8	18.5	26.0	24.0	21.3	22.6
St.Dev.	24.6	28.5	21.4	29.8	27.0	25.0	26.3
Min	0	0.0	0.0	0.0	0.0	0.0	0.0
Max	100.0	100.0	100.0	100.0	100.0	100.0	100.0

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.

The innovation input and the innovation output is summarized in Table 10.7. In contrast to Table 10.5 we do not merely investigate the existence of innovation input and innovation output. Instead we investigate the level of input and output. Innovation input is measured here as innovation expenditure per worker.

Although the difference are small between the aggregate of foreign and domestic firms respectively (the right part of the table) some interesting gaps can be noticed. The level of innovation input as a share of sales is considerable higher for Norwegian multinationals than for Nordic and European and other multinationals. Looking at innovation output in the lower part of the table, it is shown that the average share for Nordic multinationals is 0.19 compare to 0.24-0.31 for other multinational firms in Norway. The proportion of innovation output for uninational firms is 0.25.

Table 10.8

Cooperation on innovation

		DOMESTIC		FOREIGN			TOTAL	
		D	DM	NM	ASM	EOM	DOM	FOR
Within the group	D	20.7	43.6	7.3	6.9	15.3	22.2	10.4
	G	-	-	11.0	36.1	25.5	-	23.2
Suppliers	D	19.5	54.5	11.9	19.4	20.4	21.8	17.3
	G	10.4	65.4	9.2	16.7	16.7	14.2	14.0
Customers	D	17.0	43.6	22.0	27.8	21.1	19.9	22.5
	G	7.6	52.7	6.4	25.0	9.4	10.8	11.7
Competitors	D	4.7	7.3	5.5	5.5	5.8	4.9	5.5
	G	2.7	14.5	7.3	5.5	4.4	3.4	5.9
Consultancies	D	16.0	43.6	10.1	18.0	10.9	17.8	12.4
	G	2.4	21.8	5.5	9.7	5.8	3.8	6.5
Priv. R&D Labs	D	8.0	32.7	6.4	18.0	13.1	9.7	12.1
	G	2.7	23.6	4.6	11.1	3.6	4.2	5.5
Universities	D	11.1	58.1	10.0	20.8	17.5	14.4	15.7
	G	2.2	29.0	3.7	15.3	5.8	4.2	7.2
Public R&D Org.	D	14.1	50.9	13.8	22.2	19.7	16.8	18.0
	G	2.9	21.8	2.8	8.3	1.5	4.3	3.3
Domestic								
- collaboration		41.2	85.4	27.5	47.2	37.9	44.1	36.6
- vertical coll.		27.2	65.4	22.9	33.3	29.9	29.8	28.1
- horizontal coll		4.7	7.3	5.5	5.5	5.8	4.9	5.5
- scientific coll.		18.3	65.4	16.5	26.4	25.5	21.6	22.5

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.

Recent literature, see for example Pavitt and Patel 1999, emphasize the importance of innovation systems for performance of individual firms. Table 10.8 gives indicators on domestic and global collaboration on innovation with eight different categories of partners.

Norwegian multinationals are most involved in cooperative innovation activities both on the global and the national scene, and regardless of type of partner. Domestic uninational firms have a lower degree of domestic as well as global collaboration on innovation compared to foreign owned firms. The table depictures a large similarity in domestic (Norway) and global networking on innovation between the average uninational Norwegian firm and the average foreign controlled firm.

Table 10.9

Sources of information for innovation.

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
	N=747	N=55	N=109	N=72	N=136	N=813	N=305
Within the firm	53.0	70.9	49.5	66.6	50.7	54.4	53.4
Within the group	15.8	40.0	32.1	43.0	25.0	17.9	30.8
Suppliers	20.3	23.6	20.1	11.1	16.9	20.8	16.0
Customers	36.0	47.2	37.6	37.5	36.7	36.9	37.0
Competitors	12.0	10.9	10.0	11.1	6.6	12.0	8.5
Universities	2.5	10.9	2.7	4.1	5.1	3.0	4.2
Government	4.7	9.0	4.5	8.3	5.9	5.0	5.9
Prof conferences	12.1	21.8	7.3	15.3	12.5	12.7	11.4
Fairs, exhibitions	10.5	18.1	8.3	8.3	7.3	10.9	7.8

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

In Table 10.9 we report a summary of sources of information for carrying out an innovation project. For all companies regardless of their ownership the major source of innovation is the firm itself. Additionally, customers and firms within the group play a leading role. The aggregate figures in the right part of the table reveal only minor differences in the profile of knowledge sources between domestic and foreign owned firms.

10.3 Regression results

10.31 Selection models

Table 10.10

Innovation activities, two equation selection models (selection equation)
Dependent variable: The probability to be engaged in innovation activities

	Coeff	Significance	Std Err
Foreign ownership	-0.283	***	0.061
Size	0.165	***	9.023
Local markets			Reference
National markets	0.299	***	0.063
Global markets	0.503	***	0.078
Labor productivity	0.059	**	0.025
Recently established	0.094		0.079
Recently merged	0.350	***	0.082
Human capital	0.994	***	0.134
Tangible investments	0.130	***	0.014
Constant	-2.019	***	0.209

Note: This table reports the results of the selection equation for innovation activities when estimating equation (2) and (3) simultaneously. *** (**, *) Indicates significance at the 1% (5%, 10%) level

The selection equation reported in Table 10.10 estimates how the innovation decision depends on exogenously given firm characteristics and firm behaviour. The most interesting result here is that foreign ownership is highly significant and negative associated with the decision to innovate when we control for sector, seize, market orientation, human capital, physical capital, labor productivity and the recent history of the firms in terms of establishment, mergers and acquisition. Hence, every thing else equal, foreign controlled firms in Norway have a lower propensity to engage in innovation activities compared to Norwegian firms.

The parameter estimates from the selection equation shows that the decision to invest in R&D and other innovation activities is positively associated with (i) non local market orientation, (ii) the level of productivity, (iii) the level of human capital, (iv) the size of tangible investment and (v) the firm's recent history in terms of mergers and acquisitions.

Table 10.11

Innovation activities, two equation selection models

Dependent variable	Innovation input per worker		Public Funding		Utilization of corporation sources	
Est. method	HR		HP		HP	
UN	Reference					
DM	0.613	***	0.376	**	0.762	***
	(0.215)				(0.191)	
NM	-0.318	**	-0.329	*	0.541	***
	(0.151)				(0.151)	
ASM	0.538	***	-0.298		0.812	***
	(0.186)				(0.175)	
EOM	0.257	*	-0.117		0.331	**
	(0.142)				(0.146)	
Innov. input	-		-		-0.032	
Firm size	-0.472	***	0.065		-0.052	
Local markets	Reference					
Nat. markets	-0.170		0.065		0.080	
Glob. markets	0.028		***		0.108	
Product orient.	0.216		***		0.193	
Process orient.	0.465	***	***	***	0.228	
Contin. R&D	1.162	***		***	0.014	
Public Funding	0.448	***	***	***	-0.078	
Constant	5.303	***		**	-1.252	*
Wald test	482.6	***	***	**	61.57	***
LR test	73.4	***			0.021	

Note: The table gives the coefficient estimates, (*std.err* are reported only for the nationality dummies). *** (**, *) Indicates significance at the 1% (5%, 10%) level. The estimation methods are indicated as HR (regression model with sample selection) and HP (probit model with sample selection). 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, are not reported here. 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 10.12

Innovation activities, two equation selection models

Dependent variable	Domestic collaboration	Domestic vertical collaboration	Domestic horizontal collaboration	Utilization of domestic science system
Est. method	HP	HP	HP	HP
DM	0.929 ***	0.761 ***	0.262	0.896 ***
	(0.213)			(0.204)
NM	-0.217 *	-0.014	0.026	-0.011
	(0.128)			*(0.178)*
ASM	0.155	0.219	0.170	0.141
	(0.147)			*(0.196)*
EOM	-0.032	0.182 *	0.121	0.170
	(0.111)			*(0.146)*
Innov. input	0.053 **	0.036	0.001	0.123 ***
Firm size	0.013	-0.013	0.152 **	0.199 ***
Nat. markets	-0.145 *	-0.261 ***	-0.221	0.046
Glob. markets	-0.407 ***	-0.677 ***	-0.447 **	-0.063
Product orient.	0.164	0.272 **	-0.065	-0.080
Process orient.	0.194	0.059	0.324	0.167
Contin. R&D	0.182 **	0.093	-0.051	0.245 **
Public Funding	0.570 ***	0.427 ***	0.633 ***	0.912 ***
Constant	-	-	-2.819	-2.444 ***
Wald test	154.7 ***	99.7 ***	36.0 ***	148.6 ***
LR test	116.2 ***	131.8 ***	0.9	0.422

Note: The table gives the coefficient estimates, (*std.err.* are reported only for the nationality dummies) *** (**, *) 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. 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 10.13

Innovation activities, two equation selection models (continued)

Dependent variable	Patent application		Products new to the market		Returns to innovation per worker		Labor productivity	
Est. method	HP		HP		HP		HP	
DM	0.361	*	0.339	*	0.192		0.059	
					(0.253)			
NM	0.315	**	-0.151		0.544	**	0.370	***
					(0.215)			
ASM	0.713	***	0.160		0.494	**	0.213	*
					(0.247)			
EOM	0.449	***	0.074		0.626	***	0.234	**
					(0.208)			
Innov. input.	0.029		0.041		0.036		0.067	***
Size	0.009		-0.052		-0.589	***	-0.027	
Reg. markets	0.134				-0.299			0.517
Glob. markets	0.242				-0.801	***		0.618
Product orient.	0.512		***		1.037	***		0.521
Process orient.					-0.003			0.126
Contin. R&D			***		0.334	***	**	0.545
Public Funding					-0.130		***	-
Const					9.351			-1.610
Wald test	***	139.2	***	153.9	153.9	***	***	102.4
LR test	**	0.9		217.6	217.6	***	***	0.1

Tables 10.11 through 10.13 report the result from the second step of the selection model. Step one gives the determinants to innovation and step two estimates determinants to innovation indicators, innovation input, innovation output and productivity for innovative firms.

Tables 10.11-10.13 present the results from the second step of the selection model. Starting with Table 10.11, (log) innovation input per worker, depicted in column 1, we find that the point estimates for Norwegian multinational firms and Anglo-Saxon firms are highly significant and the order of magnitude of the estimate is 0.6 and 0.5 respectively. The reference group is the uninational Norwegian firms. Interestingly, it is found the estimate is negative and significant for Nordic multinationals.

It may seem that European and other multinationals invest more in R&D than the reference group, every thing else being equal. The indicator variables for process oriented innovations, continuous R&D engagement and receiver of public R&D funding are all highly significant and positive associated with the size of innovation input. On the contrary, the amount of innovation output per worker is a decreasing function of firm size.

The main finding from the funding equation is that among firms classified as innovative, domestic multinationals have a significant larger likelihood of receiving public R&D subsidies than other groups of firms. Next we see that knowledge flow from affiliates within the group is an important source of information for innovation for all multinational firms. This characteristic separates multinational firms significantly from uninational firms.

In Table 10.12 four different classifications of *collaborating on innovation* are considered. We find that domestic collaboration in total, as well as domestic vertical collaboration, and collaboration on with the domestic scientific system is significantly more frequent among Norwegian multinational firms compared to other firms. For horizontal collaboration no difference between the five groups of firms can be established.

Table 10.13, columns 1-3, present estimates on determinants to the probability of applying for *patent*, for launching *radical innovations* and the determinants for *innovation sales*. The figures show that foreign-owned firms have a larger propensity to apply for patents and a larger return to innovation (innovation sales) compared to the Norwegian firms, *ceteris paribus*. No significant differences (at the 1% and 5% level respectively) between the groups can be found regarding the propensity to launch radical innovation.

In column 4 we observe the determinants to *labor productivity*. Here we find evidence indicating that foreign owned firms, every thing else equal, are superior to Norwegian firms. The estimate for *Nordic* multinationals is highly significant and the order of magnitude is 0.4. The size of the

estimate is 0.2 for European and other multinationals and Anglo-Saxon, however at the 5% level of significance. At the 10 percent level of significance it is shown that also the Anglo-Saxon firms are more productive than Norwegian firms.

10.32 Multi step production function model

Our main interest in the multistep is to investigate the importance of ownership with respect to innovation and economic performance in an econometric framework taking both selectivity bias an simultaneous bias into account and controlling for factors such as firm size, physical capital, human capital and various market indicators.

Step 1 Selection equation: Dependent variable: Probability of being engaged in innovation

The results presented in the upper part of table 10.14 confirms that foreign controlled firms have a significant lower propensity to be engaged in innovation than Norwegian when we control firm size, sectors, human capital, physical capital, market orientation and the recent history of the firms.

Moreover, as could be expected and in line with the innovation literature (See Cohen and Klepper 1996 and Klette and Kortum 2002) the probability of being innovative increases with firm size. The firms' market orientation is an important determinant of product innovations. A larger market is positively associated with innovation engagement.

Not surprisingly the likelihood of being innovative is an increasing function of the level of human capital. Investment in R&D and other intangible capital is also closely associated with investment in tangible capital. We also find weak evidence that firms with a recent history of mergers or acquisitions have a larger probability of being innovative.

Step 2 Innovation input equation: Dependent variable: Logarithm of innovation expenditure per employee.

The estimated influence of corporate ownership show that all four groups of multinational firms have significant larger innovation input than the control group of uninational Norwegian firms, every thing else being equal.

Consistent with the findings by Crepon, Duguet and Mairesse (1998) and Lööf, Heshmati, Asplund and Nås (2003) innovation expenditures per employee is a decreasing function of firm's size. The coefficient estimates for public R&D funding and continuous R&D are both highly significant and positive. See the bottom part of Table 10.14.

Step 3 Innovation output equation: Dependent variable: Logarithm of innovation sales per employee.

In accordance with previous studies we find that innovation output increases significantly with innovation input. See the upper part of Table 10.15. The coefficient of the estimate indicates that a 10% increase in innovation expenditure per employee increases innovation sales by 7%. The size of the estimate is in the upper bound of what has been reported in the literature.

The estimated elasticity of innovation output with respect to the four groups of firms reported in the selection equations, showed a larger return to innovation for foreign controlled firms. However, when we exploit the CDM-model and control also for possible simultaneity bias the difference between domestic and foreign-owned firms disappear.

I addition the results show that collaboration diversity has a positive impact on innovation output whereas R&D funding somewhat unexpected has the opposite effect. The latter is at variance with 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.

Step 4 Productivity equation: Dependent variable: Logarithm sale per employee.

The results from the productivity equation are presented in the lower part of Table 10.15. Controlling for firm size, sector, physical capital, human capital, knowledge capital (innovation output) and process innovation we find that Nordic multinationals are significantly more productive than Norwegian firms as well as other foreign controlled firms. The elasticity of productivity with respect to physical capital is positive, however no significant association between innovation output and productivity can be found.

Table 10.14

Multi step production function model

Step 1: Selection equation Dependent variable: The probability to be an innovative firm			
	Coefficient		Std.err.
Foreign ownership	-0.281	***	0.061
Size	0.163	***	0.023
Local markets	Reference		
National markets	0.312	***	0.0632
Global markets	0.517	***	0.078
Recently established	0.098		
Recently merged	0.363	***	0.083
Human capital	1.029	***	0.134
Investment per employee (log)	0.143	***	0.013
Constant	-1.644	***	0.128
Step 2: Innovation input equation Dependent variable Log innovation expenditures per employee			
D	Reference		
DM	0.639	***	0.216
NM	0.329	**	0.152
ASM	0.526	***	0.187
EOM	0.268	*	0.143
Size	-0.480	***	0.042
Local markets	Reference		
National markets	-0.179		0.121
Global markets	0.034		0.149
Public funding for R&D	0.478	***	0.106
Process innovation	0.171	*	0.090
Continuous R&D	1.195	***	0.102
Constant	5.350	***	0.287

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 10.15

Multi step production function model (continued)

Step 3: Innovation Output equation Dependent variable: The log of innovation sales per capita			
	Coefficient		Std. error
Predicted labour productivity	-0.363		0.414
Predicted innovation input	0.677	***	0.138
DU	Reference		
DM	-0.475		0.386
NM	0.488		0.298
ASM	-0.478		0.351
EOM	-0.018		0.273
Size	0.027		0.108
Inverted Mills' ratio from the sel. equn.	0.996		
Public funding for R&D	-0.668	***	0.222
Collaboration diversity	2.398	***	0.529
Human capital	0.704		0.501
Constant	4.769		3.949
Step 4: Productivity equation Dependent variable: Log sales per employee per employee			
Predicted innovation output	0.064		0.051
Physical Investment per employee (log)	0.208	***	0.019
DU	Reference		
DM	-0.056		0.160
NM	0.197	**	0.092
ASM	0.069		0.106
EOM	0.085		0.085
Process innovation	-0.036		0.085
Size	0.043	*	0.024
Human capital	0.308		0.187
Constant	5.991	***	0.218

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.

11. Sweden

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 generation of the CIS, which this analysis is based on was launched in 2001 and refers to the years 1998 to 2000. The survey was sent to 4, 266 firms, which yielded a response rate of 48% (Statistics Sweden 2002).

11.1 Descriptive statistics for all firms

The descriptive statistics in this section includes all firms in the sample regardless of their carrying out innovative activities

Table 11.1

Sample distribution

		Observations Total	Innovative firms[1]	Percent
	Total observations	1 197	694	58.0
DU	Domestic non multinationals	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 other multin.	140	93	66.4
DOM:	Domestically owned firms	814	446	54.8
FOR:	Foreign ownership	383	248	64.8

Note: This table reports only about firms, which 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 innovators share of 100% of the domestic multinationals is due to the construction of the domestic multinational indicator.

The Swedish data used in this study consists of a subsample of the observations from the third Community Innovation Survey. The current sample refers only to firms belonging to a corporate group. The total number of observed firms is 1, 197 of which 814 (68%) is domestically owned firms. See Table 11.1

In the study the firms are grouped into five different categories; domestic uninational firms (752 observations), domestic multinationals (62), Nordic multinationals (138 firms with headquarter in Denmark, Finland, Norway or Iceland), Anglo-Saxon (105) and European and other multinationals (140). Taken as a group, the domestic and foreign owned multinationals, play a pronounced role in the Swedish economy. Fors and Svensson (2002) reported that they accounted for around 60% of industrial output and overall export, and almost 90% of Sweden's industrial R&D in 1990.

A majority of the firms (55% of the domestic firms and 65% of the foreign owned firms) are classified as "innovative firms", i.e. they have launched at

least one process innovation or product innovation during the period 1998-2000, or they have reported ongoing innovation activities in year 2000.

Note the large differences in share of innovative firms among the domestically owned firms; while six in 10 of the observed non-multinationals are innovative, the corresponding share for multinationals is ten in 10.

Table 11.2

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 11.2 reports summary statistics of key economics and innovation variables.

The firm size figures in the right part of the table show that the average number of employees is about 350 in domestic as well as in foreign owned firms. However, the left part of Table 3 reveals a large size difference between non-multinational and multinational domestic firms. While the average firms in the first category has 276 employees the average multinational firms is nearly five times larger.

Expressed in intensity terms (per capita) the right part of the table shows that sales, labor productivity, export, physical investments, R&D and other innovation input and innovation sales is larger among foreign owned firms than in domestic firms. With exception of labor productivity, domestic uninational firms can explain the relatively low domestic figures. The Swedish multinational firms outperform all other category of owners when sales, tangible and intangible investments and innovation output are considered. Notable is that both categories of domestic firms has, on the average, lower labor productivity compare to foreign owned firms.

Comparing the three categories of foreign owned firms, we find that the average Anglo-Saxon firm is the largest in term of employment. It has also the largest figures in all the economic and innovation performance variables considered. Swedish, Anglo-Saxon and European and other multinational

firm are more intensive in human capital (21-22 %) than uninational firms (18 %) and Nordic multinational companies (14%)

Table 11.3

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 11.3 shows the distribution of manufacturing and service sector firms across technology intensity. Comparing first domestic and foreign owned firms the right part of the table shows a large similarity in distribution, with the exception of high medium manufacturing technology (a larger concentration among foreign owned firms) and knowledge intensive service (domestic firms have the largest concentrations).

Considering then the two classes of domestic firms, we find that multinationals are especially concentrated in high medium and low medium manufacturing technology, while 44% of the non multinationals belong to the service sector.

Looking finally at the foreign owned firms the middle section of the table it is shown that Nordic multinational are relatively more concentrated in service sectors than other foreign owned firms.

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

Table 11.4
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.

The right part of Table 11.4 below indicates that the most significant market for domestically owned firms is the national market, while the global market dominates the focus of foreign owned firms.

Decomposing the two overall categories of ownership we find that that the domestic national market (Sweden) is the most significant market for domestic non-multinationals as well as for Nordic multinationals. Swedish multinationals and Anglo-Saxon are concentrated on the global market.

The European and other multinationals report that they are equally focused on the Swedish and the global market.

11.2 Descriptive statistics for the innovative firms

Similar to the previously reported country studies the descriptive statistics in this section only focus on innovative companies as defined above.

Table 11.5
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 11.5 gives the percentage of firms where the given activity can be observed. As can be expected row 1 shows that nearly all firms defined as innovative in this study reported innovation expenditures year 2000.

However, when innovation sales are considered, a significant difference is found between the two groups of domestic firms. Only six in 10 uninational firms report innovation sales, compared to nearly nine in 10 multinational firms. On the average, 70 percent of the foreign-owned firms report innovation sales compare to 60 percent of the domestic firms.

The corresponding proportions are approximately the same regarding firms reporting continuous R&D, i.e., the average foreign firm is somewhat more R&D intensive than the average domestic firm.

About one half of the firms surveyed report that they introduced a new or significantly improved process into the market during the period 1998-2000. The 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 11.6

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 11.6 gives descriptive statistics on the methods of protecting intellectual properties. For every single method of protection, ranging from patents to lead-time advantage, we find considerable larger figures among domestic multinational firms and a considerable smaller protection propensity among domestic non multinational firms compared to Nordic, Anglo-Saxon and European and other multinational firms.

Table 11.7

Innovation Input and Innovation Output

	DOMESTIC		FOREIGN			TOTAL	
	DU	DM	NM	ASM	EOM	DOM	FOR
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.

Table 11.7 summarizes the innovation input and the innovation output of the innovating firms. The average uninational firm and the average Anglo-Saxon owned firms and European and other multinationals invest about 7-8 per cent of the sales in innovation activities (R&D and other innovation activities). The innovation effort is considerable larger in the average domestic multinational firm (15%).

The innovation input in the Nordic owned firms is only 3 per cent of sales. In total we find an average input ratio of 9.4 per cent among Swedish firms compared to 6.2 percent for foreign owned firms.

The lower part of Table 11.7 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 with 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 11.8

Cooperation on innovation

		DOMESTIC		FOREIGN			TOTAL	
		DU	DM	NM	ASM	EOM	DOM	FOR
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.

Recent literature, see for example Pavitt and Patel (1999), emphasizes the importance of innovation systems for performance of individual firms. Table 11.8 gives indicators on domestic and global collaboration on innovation with eight different categories of partners.

The evidence on networking, whatever partner, is unanimous as regards the more intense cooperation of Swedish multinationals on both the domestic and the global scene. Swedish uninational firms have a lower degree of domestic as well as global innovation collaboration compared to foreign owned firms. It is notable that foreign owned firms report closer cooperation with the Swedish scientific network (universities and public R&D organisations) than uninational Swedish firms.

Table 11.9

*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. .

In Table 11.9 we see that all categories of innovative firms are largely dependent on external sources of information for innovation activities. In agreement with the information on collaboration above (Table 11.8), the Swedish multinationals are also drawing more on external sources of knowledge compared to other firms. They are also relying somewhat more on the internal knowledge base, which presumably is a size effect. The average Swedish multinational firm is considerable larger than the corresponding foreign and uninational firm.

The aggregate figures in the right part of the table reveal only minor differences as regards use of knowledge sources between domestic and foreign owned firms.

11.3 Regression results

This section reports the results of the multivariate analysis

11.31 Selection models

Table 11.10

Innovation activities, two equation selection models (selection equation)

	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

Note: This table reports the results of the selection equation for innovation activities when estimating equation (1) and (0) simultaneously. *** (**, *) Indicates significance at the 1% (5%, 10%) level

The selection equation reported in Table 11.10 gives the determinants to the firm's probability to engage in innovation activities.

First, when controlling for firms size, market orientation, productivity (as a proxy for internal financial resources for R&D investments), newly establishments and newly merged, gross investments and human capital (approximated by the share of employment with a university education), we find no evidence that foreign ownership influence the decision to engage in innovative activities.

The main determinants for innovation are presence on global or national market and the human capital indicator. We also find some weak evidence (significant at the 10% level) indicating that the propensity to be innovative is positively correlated with profit and merger and acquisition.

11.32 Innovation behavior

Tables 11.11-11.13 report the result from the second step of the selection model. Starting with Table 11.11, (log) innovation input per worker, depicted in column 1, it is shown that the point estimate for Swedish multinational firms are highly significant and the order of magnitude of the estimate is 0.7. The reference group is the uninational Swedish firms.

The Anglo-Saxon owned firms invest significant more in R&D than the reference group at the 5% level of significance, and European and other multinationals at the 10% level of significance.

The indicator variables for global markets, continuous R&D engagement and receiver of public R&D funding are all significant and positive associated with the size of innovation input. We also see that physical capital investments are positively associated with R&D investments. On the contrary, the amount innovation output per worker is a decreasing function of firm size.

The main finding from the funding equation is that for firms classified as innovative, domestic multinationals have a significant larger likelihood of receiving public R&D subsidies than other groups of firms.

Next we see that knowledge flow from affiliates within the group is an important source of information for innovation for all multinational firms. This characteristic separate multinational firm from uninational firms in a significant way.

Looking at the aggregate indicator on embeddedness in the national innovation system the evidences are unanimously that domestic multinationals are more integrated in the national innovation system (NIS) than any other or the investigated firms. See Table 11.12.When de-composing the embeddeddness in vertical, horizontal and scientific innovation systems the following results in shown:

First, both Swedish multinationals and European and other foreign controlled are collaborating more closely with suppliers and customers on innovation than with other groups of firms.

Second, domestic multinationals are significantly more involved in cooperation on innovation with competitors and suppliers compared to uninational firms and foreign-owned firms.

Third, the scientific innovation system (universities, private and governmental R&D laboratories) seems to be the most attractive for foreign-owned firms in Sweden. Together with domestic multinationals both Anglo-Saxon and Nordic controlled firms are significantly more integrated in the scientific innovation system than uninational firms. It is notable that 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.

Column 6 indicates that knowledge flow from affiliates within the group is an important source of information for innovation for all multinational firms. This characteristic separate multinational firms from uninational firms in a significant way.

Table11.13 reports the summary finding from the performance equations. Column 1 and Column 2 show that Swedish multinationals and European and other multinational have a significant larger probability to patent and to introduce radical innovations than other firms. The point estimate for Anglo-Saxon is only significant different from the reference group at the 10% level of significance.

Interestingly column 3 shows that the Swedish multinational firms are not more innovative in terms on innovation sales per employee compared to foreign owned multinationals. This is highly unexpected in the light of an extensive difference in R&D investments between Swedish multinationals on the one hand and Nordic, Anglo-Saxon and European and other multinationals on the other. I addition, we would also have expected that the large divergence regarding integration in national innovation system should have resulted in differences in innovation sales.

At variance with most other studies reported in the literature, we do not find any strong evidence on productivity difference between domestically owned firms and foreign firm in the Swedish economy. See column 4. The selection equation indicates that only Anglo-Saxon firms are more productive that other firms (at the 5% level of significance). And as we will se below, when estimating with the multistep model the difference between domestic and foreign-owned firms is vanishing completely. This finding is not only at variance with what Modén (1998) Karpati and Lundberg (2004) has shown for firms in Sweden, but also with the majority of previous empirical studies reported in the literature. Some possible explanation to 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, (ii) our research methodology with a production function model capturing the relations between decision to invest and R&D-investments, between R&D investments and innovation output, and between innovation output and productivity, (iii) our method of distinguishing 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, (v) the cross-sectional nature of our data.

Table 11.11

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: The table gives the coefficient estimates, *** (**, *) Indicates significance at the 1% (5%, 10%) level. The estimation methods are indicated as HR (regression model with sample selection) and HP (probit model with sample selection). 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 11.12

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		

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 11.13

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.

11.33 Multi step production function model

Our main interest in the multistep is to investigate the importance of ownership of the firms with respect to innovation and economic performance in an econometric framework taking both selectivity bias and simultaneous bias into account and controlling for factors suggested in the innovation literature, such as firm size, physical capital, human capital and various market indicators.

Step1: Selection equation. Dependent variable: Probability of being engaged in innovation

As could be expected – and in line with the innovation literature (See Cohen and Klepper 1996 and Klette and Kortum 2002) – the probability of being innovative increases with firm size. Moreover, the firm s' market orientation is an important determinant to product innovations. A firm with a global or national market orientation has a significantly higher probability of introducing new innovations compared to firms acting mainly on the local market.

Not surprisingly the likelihood of being innovative is an increasing function of the level of human capital. Investment in R&D and other intangible capital is also closely associated with investment in tangible capital. The upper part of table 11.13 gives also weak evidence 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.

Step 2: Innovation input equation. Dependent variable: Logarithm of innovation expenditure per employee.

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 the lower part of Table 12. This is also consistent with the results presented by Janz et al (2004) and Lööf and Heshmati (2004).

The estimates in Table 11.13 show that the dummy variable for Swedish multinational has a significant larger association with the innovation input variable than the reference group consisting of Swedish uninational firms. The estimates for all three categories of foreign owned firms are non-significant.

Innovation output equation: Dependent variable: Logarithm of innovation sales per employee.

Confirming previous studies we find that innovation output increases significantly with innovation input. The coefficient of the estimate indicates that a 10% increase in innovation expenditure per employee by 3% for firms belonging to a group. Looking then at the variables capturing ownership of firms, with uninational owned firms as the reference group, we find a highly significant and positive association between innovation output and Nordic multinational firms. The estimate is also positive but only weakly significant for Swedish multinational firms. The reaming two ownership variables are not significant.

Furthermore, as can be gathered from the upper part of Table 11.14 collaboration diversity has a positive impact on innovation output whereas R&D funding somewhat unexpected has the opposite effect. The latter is at variance with 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.

Productivity equation: Dependent variable: Logarithm sale per employee.

The results from the productivity equation presented in the lower part of Table 11.14 show that innovation output, expressed as innovation sales per employee, is an important contributor to productivity after controlling for sector, size, capital investment, human capital, process innovation. The effect is highly significant. The size of the estimate is within the range of what previously has been found in the literature. A 10% increase in innovation output increases the level of productivity by about 2 percent. Interestingly we find no impact from the ownership variables.

The conclusion here is that foreign-owned 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.

11.34 Multi step production function model

Table 11.14

Multi step production function model

Step 1: Selection equation Dependent variable: The probability to be an innovative firm			
	Coefficient		Std.err.
Foreign ownership	0.070		0.085
Size	0.190	***	0.029
Local markets	Reference		
Regional markets	0.331	***	0.106
Global markets	0.607	***	0.114
Recently established	-0.039		0.140
Recently merged	0.228	*	0.118
Human capital	0.581	***	0.200
Investment per employee (log)	0.080	***	0.024
Constant	-1.432	***	0.183
Step 2: Innovation input equation Dependent variable Log innovation expenditures per employee			
D	Reference		
DM	0.672	***	0.234
NM	0.020		0.197
ASM	0.127		0.218
EOM	0.116		0.192
Size	-0.355	***	0.054
Local markets	Reference		
Regional markets	0.201		0.217
Global markets	0.624	**	0.254
Public funding for R&D	0.494	***	0.178
Process innovation	0.302	**	0.123
Continuous R&D	1.186	***	0.139
Constant	1.230	**	0.601

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 11.15

Multi step production function model (continued)

Step 3: Innovation Output equation Dependent variable: The log of innovation sales per capita			
	Coefficient		Std. error
Predicted labour productivity	0.529	*	0.293
Predicted innovation input	0.331	***	0.122
D		Reference	
DM	0.524	*	0.268
NM	0.592	***	0.209
ASM	0.362		0.257
EOM	0.306		0.226
Size	-0.093		0.113
Inverted Mills' ratio from the sel. equn.	-0.894		0.799
Public funding for R&D	-0.545	***	0.198
Collaboration diversity	1.044	***	0.385
Human capital	0.830	*	0.469
Constant	-0.424		2.337
Step 4: Productivity equation Dependent variable: Log sales per employee			
Predicted innovation output	0.221	**	0.087
Physical Investment per employee (log)	0.183	***	0.050
D		Reference	
DM	-0.103		0.156
NM	0.013		0.113
ASM	0.160		0.131
EOM	-0.051		0.112
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.

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Appendix: Determining the home countries of firms

The grouping for the home country variable in the analysis is basically distilled from two variables in the CIS questionnaire. The first question asks whether or not the surveyed company is a part of a corporate group. We select only those companies answering this question positively. We drop companies giving no answer or a negative answer. The second variable used contains the information about the home country of the company. We take out all companies where no country code is given.

We distinguish the domestically owned companies in companies belonging to domestically owned corporate groups and domestically owned domestic groups. As there is no variable in the CIS indicating the multi-nationality of domestic corporate groups we have to derive this information from other details in the questionnaire. In the CIS questionnaires innovative companies are asked about their collaboration partners for R&D by the location of the collaboration partner. If a domestically owned company reported innovation collaboration within the corporate group but outside the home country we regard the company to be a domestically owned multi-national company.

This procedure clearly underestimates the number of domestically owned multinational companies. However, if we find significant influence of the multinationality on innovation activities we are on safe ground as the control group of domestically owned companies certainly also contains companies that are domestic multinationals.

Although the procedure is rather sensitive towards differences in national collaboration culture, we argue that the national differences in collaboration culture should not be too dominating in a multinational firm, hence, we conjecture that the bias induced by different collaboration cultures may not be too large.