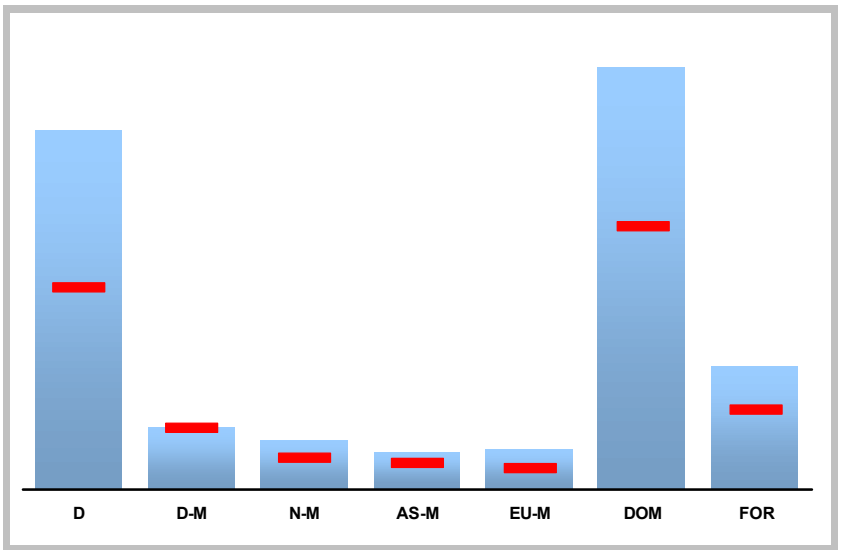

Does Foreign Ownership Matter for the Innovation Activities of Firms in Finland?

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ISBN 951–38–6578–9 (URL: http://www.vtt.fi/inf/pdf/)
ISSN 1459–7683 (URL: http://www.vtt.fi/inf/pdf/)

JULKAISIJA – UTGIVARE – PUBLISHER

VTT, Vuorimiehentie 5, PL 2000, 02044 VTT
puh. vaihde 020 722 111, faksi 020 722 4374

VTT, Bergsmansvägen 5, PB 2000, 02044 VTT
tel. växel 020 722 111, fax 020 722 4374

VTT Technical Research Centre of Finland, Vuorimiehentie 5, P.O.Box 2000, FI–02044 VTT, Finland
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VTT Teknologian tutkimus, Kemistintie 3, PL 1002, 02044 VTT
puh. vaihde 020 722 111, faksi 020 722 7007

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VTT Technology Studies, Kemistintie 3, P.O.Box 1002, FI–02044 VTT, Finland
phone internat. +358 20 722 111, fax +358 20 722 7007

Technical editing Maini Manninen

Published by

Series title, number and
report code of publication

VTT Working Papers 26
VTT–WORK–26

Author(s)
Ebersberger,Bernd, Lööf, Hans & Oksanen, Juha

Title

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Abstract

In this study we investigate the impact of foreign ownership on the innovation activities of Finnish firms. We analyse the impact on innovation input and on innovation output. Additionally, we analyse the effect foreign ownership has on the companies' embeddedness in the innovation system and the effect foreign ownership has on public R&D funding. Finally, we investigate the firms' productivity and its dependence on foreign vs. domestic ownership. The study contributes three features to the literature. First, it investigates multiple indicators to find the effects of foreign ownership on the companies' performance. Second, the study distinguishes between different types of foreign ownership based on country of ownership; by doing so, the study accounts for home country effects through different governance styles, which are precluded in a mere foreign / domestic dichotomy. The study also singles out domestic multinational firms so as to investigate the impact multinationality has on the innovation activities. Finally, the study employs sample selection models, as well as a multiequation production function model in the vein of Crepon, Duguet and Mairesse (1998), to investigate the impact of foreign ownership.

Keywords
foreign ownership, innovation activities, innovation gaps, CIS, innovation input, innovation output, companies, public R&D funding, Finland

Activity unit
VTT Technology Studies, Kemistintie 3, P.O.Box 1002, FIN–02044 VTT, Finland

ISBN		Project number
951–38–6578–9 (URL: http://www.vtt.fi/inf/pdf/)		P2SU00143
Date April 2005	Language English	Pages 42 p. + app. 5 p.
Name of project Dynamics/FotoN	Commissioned by National Technology Agency of Finland Tekes/ Ministry of Trade and Industry KTM/N.I.C.E.	
Series title and ISSN VTT Working Papers 1459–7683 (URL: http://www.vtt.fi/inf/pdf/)	Publisher VTT Information Service P.O.Box 2000, FI–02044 VTT, Finland Phone internat. +358 20 722 4404 Fax +358 20 722 4374	

Preface

This study has been conducted as part of the ProACT research project "Dynamic Pattern of Innovative Activities of Finnish Firms". The core of the project deals with determinants of innovative activities and innovative success over time. Looking at the topic of the analysis presented here, it becomes evident that the temporal dimension is missing in the methodology employed; even more obviously, the cross-section data used also lacks any temporal dimension. However, we believe that the study summarized in this paper is inherently dynamic. The paper developed out of numerous discussions among the authors about the effect foreign take-overs have on the companies' innovative activities: What changes over time are induced by the take-over of companies by a foreign mother company? The discussions were initiated by a project conducted for the Nordic Innovations Center (N.I.C.E.) on the impact of foreign take-over in the Nordic countries.

In a way, these discussions, which were intensified when Lööf stayed at VTT for a couple of days in early 2004, took up the public preconception that a foreign take-over is detrimental for the innovative activities as a foreign take-over sells a firm's capabilities and knowledge, implying all the adverse effects for the innovation system and the economy.

Strongly doubting the reality of the public preconceptions, the discussions soon revolved around how one could possibly analyze these types of questions. The methodological problem is that the impact of foreign take-overs is not observable. We see the impact on innovative activities as the difference between two states of a company: the state of being taken over and the state of not being taken over. Both states are not observable simultaneously. We have to approximate the state of not being taken over and the state of being taken over. The most intuitive solution is to approximate the state of being taken over by companies that are foreign-owned and to approximate the state of not being taken over by domestically owned companies. With this rather crude approximation we hope to shed some light on the question that sparked our interest: What are the changes in innovative activities induced by a foreign take-over.

Not to generate too high expectations by using a title reflecting the outset of the question, we rather put our actual approach on the centre of the stage in this paper: Does foreign ownership matter for the innovative activities of companies?

This research is the result of a joint effort. Aside from the authors, many others have contributed to this research. Most notably, the authors thank Statistics Finland for the data preparation. In particular, we are indebted to Olavi Lehtoranta for countless and very fruitful discussions on the innovative activities of Finnish firms. Gabriel Benito

and Sverre Johan Herstad contributed with insightful comments. The idea to break down foreign ownership into country groups based on cultural similarity and comparable governance styles came from Sverre Johan Herstad. Nina Rilla and Raimo Lovio also contributed with numerous discussions. However, all the remaining errors are the authors'. A large part of the research was carried out when Ebersberger was with VTT Technology Studies. He extends his gratitude to the warm, inspiring and professional environment he found there. The authors gratefully acknowledge the financial support by the Finish Technology Agency (Tekes), the Finnish Ministry of Trade and Industry and the Nordic Innovation Center.

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1. Introduction

In recent years foreign ownership issues have sparked both academic and policy attention. Foreign ownership of domestic companies is an issue on the global scale. Exports from foreign affiliates of multinational corporations represent more than a third of the total word trade (Grossman et al. 2003).

The current discussion about the sources and consequences of foreign direct investment starts to highlight the interrelatedness of technology, innovation and FDI. Serapio and Dalton (1999), for example, 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. However, Patel (1995) has shown that one of the main mechanisms for this globalization of R&D is merger and acquisitions. Change of ownership may have an influence on both the acquiring firm's as well as the acquired firm's innovation activities. This study highlights the differences between Finnish-owned firms and foreign-owned firms in Finland.

The study presented here is structured as follows. In section 2 we elaborate on the key questions posed in this study. In particular, we build on the discussion of the difference between domestic-owned firms and foreign-owned firms, and develop some hypothesis about innovation and technology gaps between foreign-owned firms and domestic-owned firms. Section 3 introduces the data and the methodology used in the main part of the study. In addition to the two equation selection models we use in the main part of the text, we report the results of a multi-step production function model in the Appendix. Section 4 presents the empirical analysis, where, in sections 4.1 and 4.2 we get a feeling for the data in an extensive explorative analysis followed by the results of the regression models. Section 5 concludes.

2. Key questions

Lipsey (2002) notices that much of the earlier economic literature on foreign direct investment - and subsequently foreign ownership - treats it as a part of the general theory of international capital movements, based on the differences among countries in the endowment 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), the relationship between multinational firms, national innovation systems, geographical proximity, industrial clusters and global networks is discussed - see, for example, Jaffe et al. (1993), Feldman and Audretch (1995), Pavitt and Patel (1999) and Cantwell and Janne (1999). Only if we allow for heterogeneity in institutional arrangements and in space, only if we allow for networks and clusters and the associated effects can we think about the differences between foreign-owned and domestic-owned companies.

The topic of the present study places it in the broad category of studies relating to the gap between domestic-owned firms and foreign-owned firms. Pfaffermayer and Bellak (2000) and Bellak (2004) provide an extensive overview of the literature relating to the gap hypothesis and distinguish between gaps in profitability, labour relation gaps, productivity gaps, growth gaps and technology gaps, where the productivity gap, the technology gap and, consequently, the growth gap relate most to the discussion in this study. Given the gap hypothesis, the initial question is: why is it that there is a difference between foreign-owned and domestic-owned firms? Based on theoretical reasoning, we distinguish various types of technology and innovation gaps.

2.1 Technology and innovation gaps

The first line of arguments giving rise to technology and innovation gaps relates to firm-specific assets. Multinational firms possess firm-specific assets, such as specific know-how on production processes, reputation, brands or management capabilities (Caves 1996). Those assets are transferable and fully appropriable within the firm, but they are not accessible from outside the firm. The transferability applies both to domestic and to foreign affiliates. As such, this theoretic rationale does not provide an argument for gaps between domestic and foreign-owned firms; rather, it provides reasoning for a gap between independent firms and firms being part of a corporate group. Activities such as R&D generating firm-specific assets are mostly being carried out at the headquarters location (Patel and Pavitt 1991, Markusen 2002, Castellani and Zanfei 2004). Only this observation in combination with the assumption of firm-specific assets leads to a hypothesis on the differential innovation behaviour of domestic and foreign-owned firms; foreign-owned firms are then more likely to have a lower level of innovation

activities than domestic-owned firms. If, however, the firm-specific assets are to be exploited abroad, some adjustments to local habits, regulations and standards may be required. Additional development activities, which are denoted as "asset exploiting" R&D activities (Dunning and Narula 1995), may be required for these adjustments. In this case, R&D and other innovation-related activities are demand-driven as the increased intensity of the R&D activities are then the result of the internationalization of sales (see e.g. Vernon 1966, Vernon 1977, Von Zedtwitz and Gassmann 2002). The whole line of arguments leads us to a hypothesis on *innovation input gaps*.

Once again picking up the idea of firm-specific assets that have a pure spill-over nature within the firm, firm-specific assets from the headquarters to the foreign affiliate will increase the company's innovation performance once the innovation input is controlled for, as the spill-overs are not accounted for, resulting in an hypothesis on *innovation output gap*. This innovation output gap is also supported if there are advantages in the scale and scope of the R&D that can be utilized by the foreign-owned company and the multinational network it is a part of (see Caves 1996 e.g.). Then there is a positive gap, the foreign-owned companies being ahead of the domestic-owned ones. If, however, there is coordination of R&D activities between the foreign headquarters and the affiliate, and the R&D activities are more likely to be carried out at the headquarters location, a negative gap will open up. The previous arguments, however, relate more to companies being part of a corporate group than they relate to the foreign-owned/domestic-owned dichotomy.

Lichtenberg's (1992) matching theory of take-overs posits that some owners fit better with certain firms / establishments than others do. The fit is the major factor in determining the performance of the company or the establishment, and productivity can be used as a proxy for the quality of the fit (Ali-Yrkkö and Ylä-Anttila 2001). The rate of greenfield investment being comparably low, we can think of the ownership change being a means of increasing the productivity of a company. So, foreign-owned firms should, on average, yield a superior performance compared with the domestic firms. This supports the notion of a *productivity gap*. A productivity gap is found by Girma et al. (2001), and Doms and Jensen (1998) for US and UK data. Harris and Robinson (2002) find that selecting high-productivity firms for acquisition results in a superior performance ex post. As previous innovative performance plays a role in the attractiveness to be acquired (Lehto and Lehtoranta 2002), the selection of high performing innovators for foreign acquisition may be reflected in a superior innovation performance of foreign-owned companies.

Apart from the demand-related issues sketched above, supply-side effects also enter the picture. Large multinational enterprises can better utilize the division of labour in production as well as in research and development (Antràs and Helpman 2003). Supply-

side effects relate to the science and technology environment in the host country. Increasing emphasis has been put on these factors recently (Cantwell 1995, Dunning and Narula 1995, Kuemmerle 1999); strategies focusing on these factors are termed "asset-augmenting" (Dunning and Narula 1995). As for successful innovation, the mastering of an increasing number of technologies becomes vital; the division of labour in research and development enables companies to excel in this respect as the asset-augmenting strategy offers access to new and complementary assets. Also, by being present on the global market, multinational enterprises have a more comprehensive view of the global market situation (e.g. de Meyer 1993). Hence they are more likely to deliver product innovations to the market. Both Frenz and Ietto-Gilles (2004) and Castellani and Zanfei (2004) find support for a related hypothesis on Italian and UK firms, giving rise to an *innovation output gap*.

When pursuing the asset-augmenting strategy, multinational companies can rely on a broader range of partners to build up their assets. It is less costly for them to source knowledge internationally. Given easier access to knowledge, foreign-owned companies are less dependent on sourcing knowledge locally. A *local embeddedness gap* would hence state that foreign-owned firms are less embedded in the local or national innovation system and interaction with domestic partners is supposedly lower for foreign-owned companies. On the other hand, it has been argued that locally specific factors can be the source of the company's competitive advantage if the heterogeneity of the sources is managed and utilized appropriately (Narula and Zanfei 2004, Furu 2001, Andersson 1997, Hedlund 1986, Kogut 1989). Appropriate management and utilization may result in an increased embeddedness though. Essentially, the underlying hypothesis does not relate to foreign ownership; rather, it relates to multinationality. So, even among the domestic firms, multinational firms should be distinguished. If the foreign-owned affiliate performs a monitoring activity to utilize external scientific knowledge and technological capabilities (see Dunning and Narula 1995, Kuemmerle 1999, Florida 1997), the embeddedness will be positively affected; It is then a direct result of the foreignness of the ownership

If the local embeddedness hypothesis holds, we may also find a *funding gap*. This may be due to the fact that foreign-owned companies have a larger selection of potential sources they can draw from to finance their innovation activities. As the funding decision is strongly influenced by the potential impact of the funding, the funding is less likely to occur if it can be assumed that the applied project is carried out anyway and financed with the abundance of sources multinationals supposedly have at their disposition.

2.2 Home country effects

Even though we observe an increasing internationalisation of activities among multinational enterprises, it has been argued that the home country of the companies still matters in determining their internationalization, their strategy and their activities abroad (e.g. Porter 1990, Benito et al. 2002 fig. 1). Pavitt and Patel (1999) and le Bas and Sierra (2002) find that most multinational corporations tend to locate their R&D activities in their home country. Therefore, the national system of innovation in the home country affects the pattern of innovation in their foreign affiliates. This home country may be even more dominating as firms tend to locate their technology abroad in the core areas in which they are strong at home.

The division of decision power, amongst other things the power to shape the strategic orientation of the company, depends on the cultural distance between the home country and the country of the affiliate (Dunning 1993). Traditionally, the literature distinguishes between the German, the European and the Anglo-Saxon systems of corporate governance. The differences in governance style can best be exemplified by looking at the control and corporate goals. Typically, the German and European corporate governance is characterized by concentrated ownership of listed companies; some argue about the weak minority protection of the German system. Companies also tend to follow a strategy of maximizing the stakeholder value, whereas the Anglo-Saxon system is thought to follow a shareholder value maximizing approach. The Anglo-Saxon system is also characterized by a strong minority protection and dispersed ownership.

The demand-led innovation activities by foreign affiliates discussed above imply a flow of knowledge from the home country to the foreign affiliate. The technological level, the expertise and the performance of the affiliate is largely affected by the performance of the company in the home country. Narula and Zanfei (2004) argue that in the case of the asset exploiting R&D strategy the strategic decisions are rigidly centralized in the headquarters, even increasing the effect the home country culture and governance style has on the innovation activities of the foreign affiliates.

The tacitness of the knowledge of both production and innovation implies that locational proximity matters when transmitting this knowledge from the headquarters to the affiliates and vice versa (Blanc and Sierra 1999).

2.3 Selected empirical findings

There is still a small but growing amount of literature on foreign ownership and innovation relying on Community Innovation Survey data – see, for example, Frenz and Ietto-Gilles (2004), Castellani and Zanfei (2004) and Balcet and Evangelista (2004). As the study below relies on the Finnish Community innovation survey, these studies are closest in terms of the data source used.

A common research topic is the innovativeness of foreign-owned firms versus domestic-owned firms. Using a dataset of 1,115 observations from CIS 2, Balcet and Evangelista (2004) show that companies under foreign ownership were more innovative than domestic firms in Italy during the period 1994–1996. The authors explain the greater innovativeness of the foreign firms by a larger concentration in science-based sectors and by being larger in size when compared with domestic firms. However, in the majority of technologically intensive sectors domestic firms outperform foreign-owned firms, especially in terms of R&D intensity, while an opposite pattern characterizes 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 the strengths and weaknesses of the innovation systems in the Italian host country; the attractiveness of Italy is low in the case of most science-based and scale-intensive sectors, while the foreign-owned firms seem to be attracted by the competencies and know-how accumulated in all the traditional and mechanical engineering industries, where Italy holds a clear competitive advantage. Drawing on the same data source as Balcet and Evangelista (2004), Castellani and Zanfei (2004) follow a different methodological approach. Their analysis finds innovation and technology gaps between Italian multinationals and domestic non-multinationals. However, there are no gaps between domestic non-multinationals and foreign-owned firms in Italy.

Frenz and Ietto-Gillies (2004) use a UK 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 with firms being part of a uninational company they find that those enterprises which belong to a multinational corporation are more likely to engage in innovation activities, and that this engagement is on a continuous basis rather than only occasionally.

2.4 Research questions

Based on the discussion in sections 2.1 and 2.2, we can distil a hypothesis on the potential gaps between foreign-owned firms and domestic-owned firms.

Hypothesis IIG: Foreign-owned firms and domestic-owned firms differ in the level of their innovation input (*innovation input gap*).

Hypothesis LEG: Foreign-owned firms and domestic-owned firms differ in the intensity of their embeddedness in the local innovation system (*local embeddedness gap*).

Hypothesis IOG: Foreign-owned firms and domestic-owned firms differ in their innovation output (*innovation output gap*).

Hypothesis PG: Foreign-owned firms and domestic-owned firms differ in the level of their productivity (*productivity gap*).

Hypothesis FG: Foreign-owned firms and domestic-owned firms differ in their propensity for receiving public funding for their innovative activities (*funding gap*).

Based on the discussion about differences in governance styles and the home country effect, each of the above hypotheses has to be differentiated so as to refer not only to foreign ownership but also to the different home countries of the foreign-owned firms. In addition to the differentiation of the home countries, the discussion above requires treating domestic multinationals and domestic multinationals differently.

3. Data and methodology

In the following section we introduce the data source and the methodology used to test the various gap hypotheses discussed above.

3.1 Data

The research questions relate innovation activities to foreign ownership and constitute a facet of the broad topic of the internationalization of R&D. Basically, most of the data sources about the internationalization of corporate R&D contain some information with which to analyze the questions at stake. Table 1 contains a brief assessment of the available data sources, their strengths and weaknesses.

Table 1. 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)

As the analysis 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 represents such data sources.

Community Innovation Survey data is increasingly being used as a key data source in the study of innovation at the firm level in Europe. Within Europe, CIS surveys are usually conducted every five years. The third and most recent wave of the CIS was carried out in 2001, and covers the years 1998 to 2000. CIS surveys follow the 'subject-

oriented' approach because they ask individual firms directly whether they were able to produce an innovation. The CIS is widely piloted and tested before implementation and the questionnaire has been continuously revised since it was first used in the early 1990s. The CIS is based on previous experience of innovation surveys, including the Yale survey and the SPRU innovation database (Klevorick et al., 1995; Pavitt et al. , 1987) and provides an opportunity to investigate patterns of innovation across a large number of industrial firms.

Although far from being perfect, the CIS data does provide a useful complement 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 enables an assessment of the innovation-induced performance changes in firms. Compared with the R&D and patent data, the innovation output indicators in the CIS have the advantage of measuring innovation directly (Kleinknecht et al. 2002). The new indicators in the CIS capture the market introduction of new products and services and their relative importance for the innovators' sales.[1]

The dataset used here is the Finnish Community Innovation Survey conducted by Statistics Finland. The third wave 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 3,462 firms, which yielded a response rate of 50% (Statistics Finland 2002). Basic descriptive statistics of the variables used can be found in Table 2, 3 and 4, where the endogenous and exogenous variables are described and summarized.

3.2 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 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

[1] As some part of this research will be replicated in other Nordic countries in the context of a project funded by the Nordic Innovation Center, it is important to note that the CIS data offers internationally comparable data that enables international comparative studies, a feature which – with few exceptions, such as Janz et al. (2003), Lööf and Heshmati (2003) or Czarnitzki et al. (2004) – has not been utilized extensively.

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 domestic-owned firms.

We have tried to give the 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 – to be reported below. Additionally, we employ a complete production function model in the vein of Crepon et al. (1998) – and report the results in Appendix B.

To analyze the hypothesis given in section 2.4 above – depending on the type of exogenous variable – we use two different, yet quite comparable, econometric models. The common idea of the econometric model 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 company 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 is a continuous variable, we use the Heckman selection model described in equations (1) and (0). If the dependent variable is a dummy variable, we use the Heckman probit model described in (2) and (0).

Heckman selection model

$$z_i^* = \gamma' \mathbf{w}_i + u_i \text{ , where } z_i = 1 \text{ if } z_i^* > 0,\ z_i = 0 \text{ otherwise} \qquad (0)$$

$$^{c}y_i = \beta' \mathbf{x}_i + \varepsilon_i \text{ , where } ^{c}y_i \text{ is only observed if } z_i = 1 \qquad (1)$$

Heckman Probit model

$$z_i^* = \gamma' \mathbf{w}_i + u_i \text{ , where } z_i = 1 \text{ if } z_i^* > 0,\ z_i = 0 \text{ otherwise} \qquad (0)$$

$$y_i^* = \beta' \mathbf{x}_i + \varepsilon_i \text{ , where } ^{d}y_i = 1 \text{ if } y_i^* > 0,\ ^{d}y_i = 0 \text{ otherwise} \qquad (2)$$

In equation (0) z_i^* s the unobserved propensity to innovate based on the exogenous company characteristics $\mathbf{w}_i$. z_i is the observed state of the company carrying out innovative activities or not; $^{c}y_i$ is a continuous innovation activity variable in equation (1). In equation (2) $^{d}y_i$ is a dummy variable indicting certain innovation activities; $\mathbf{x}_i$ is the vector of exogenous company characteristics determining the $^{d}y_i$. The variables z_i, $^{c}y_i$, $^{d}y_i$, $\mathbf{w}_i$. and $\mathbf{x}_i$ are specified below.

Endogenous variables

Table 2 summarizes the endogenous variables used to test the hypothesis discussed in section 2.4. It also contains the variables in the CIS data, which are used to construct the variables. To analyse the innovation input gap we use the various indicators to approximate the innovation input of the firms. First, we use an indicator of whether the company carries out innovation activities at all. The gap hypothesis can be analysed for all firms in the sample. This indicator is also used to estimate the selection equation (0). Second, we use an indicator for the size of the innovation efforts. This and the analyses of all other gaps can only be carried out for those companies that carry out innovation activities. The local embeddedness gap is tested using various indicators, such as embeddedness in the national innovation system, the embedding of the domestic parts of the company's value chain, the companies' embeddedness in the domestic industry structure and the utilization of the domestic science and research environment. The innovation output gap is measured by the patenting behaviour[2] of the firm and by the firm's ability to launch a product innovation that is new to the market. The productivity gap is assessed by the labour productivity; the analysis of the funding gap utilizes the information on whether or not the companies have received public funding.

[2] Based on Hagedoorn and Cloodt (2003), we use patents as a proxy for innovative output.

Table 2. Endogenous variables.

Hyp,	Endogenous variable	… approximated by …	…constructed using the CIS variables	Mean
IIG	Innovation activity	Product innovation or process innovation or ongoing R&D project (dummy)	inpdt, inpcs, inon	0.630
IIG	Innovation input	Innovation effort per worker (log)	rtot, emp	0.720
LEG	Embeddedness in the domestic innovation system	Domestic collaboration for R&D (dummy)	co$i$1 $i \in \{1 \ldots 8\}$	0.427
LEG	Embedding of the domestic value chain	Vertical domestic collaboration for R&D (dummy)	co21, co31	0.355
LEG	Embeddedness in the domestic industry	Horizontal domestic collaboration for R&D (dummy)	co41	0.096
LEG	Embeddedness in the domestic science base	Collaboration with domestic universities or research institutes (dummy)	co71, co81	0.337
IOG	Patenting behaviour	Patent application (dummy)	paap	0.258
IOG	Quality level of innovation	Product new to the market (dummy)	inmar	0.417
IOG	Innovation output	Sales from new / modified products per worker (log)	turning, turn, emp	1.549
PG	Productivity	Sales per worker (log)	turn, emp	4.987
FG	Funding	Public funding (dummy)	funloc, fungmt	0.364

Exogenous variables

Based discussion above, we expect 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, which are supposed to yield similar corporate governance styles; we group together companies that are part of Anglo-Saxon-owned corporate groups, including UK-owned, US-owned, Irish, Canadian and South African corporate groups. As Finland is embedded in the group of Nordic countries, so we group, Danish, Finnish, Icelandic, Norwegian and Swedish-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. In estimating the selection equation, and in the descriptive statistics below, we differentiate between foreign-owned and domestic-owned companies. Within the domestic-owned companies we differentiate the domestic-owned companies and companies which are a part of a domestically owned multinational

group. As all companies in the sample belong to a corporate group, companies which are not part of a domestically owned multinational are supposed to be groups with only domestic facilities.[3] Table 3 and Table 4 summarize the exogenous variables used in the selection models.

Table 3. Exogenous variables for the selection equation (*0*).

Variable	Mean
Foreign ownership	0.225
Size (log employment)	4.667
Productivity (log labour productivity)[1]	4.987
Significant market area - local (dummy)[0]	0.178
Significant market area - regional (dummy)	0.322
Significant market area - global (dummy)	0.500
Established (dummy)	0.073
Merged (dummy)	0.137
Human capital (share of highly educated empl)	0.355
Tangible investment (log)	1.518
High-technology manufacturing sector (dummy)	0.053
Medium high-technology manuf. sectors (dummy)	0.211
Medium low-technology manuf.sectors (dummy)	0.147
Low-technology manufacturing sectors (dummy)[0]	0.200
Knowledge-intensive services (dummy)	0.170
Other services (dummy)	0.219

Note: [0]variable used as reference category [1]variable not in regression for the productivity gap hypothesis.

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

Table 4. Exogenous variables for the regressions of equation (1) and (2).

Variable	Mean	Std.dev.	Min	Max
Domestic non-multinational (dummy)	0.661	0.474	0.000	1.000
Domestic multinational (dummy)	0.114	0.318	0.000	1.000
Nordic multinational (dummy)	0.088	0.283	0.000	1.000
Anglo-Saxon multinational (dummy)	0.066	0.248	0.000	1.000
European multinational or other (dummy)	0.071	0.257	0.000	1.000
Size (log employment)	0.720	1.412	-3.521	5.937
Innovation input per worker (log)[1]	4.667	1.469	2.303	10.117
Significant market area - local (dummy) [0]	0.178	0.383	0.000	1.000
Significant market area - regional (dummy)	0.322	0.467	0.000	1.000
Significant market area - global (dummy)	0.500	0.500	0.000	1.000
Product-oriented innovation strategy (dummy)	0.079	0.204	0.000	1.000
Process-oriented innovation strategy (dummy)	0.032	0.128	0.000	1.000
Continuous R&D (dummy)	0.440	0.497	0.000	1.000
Public funding (dummy)	0.364	0.482	0.000	1.000
High-technology manufacturing sector (dummy)	0.053	0.223	0.000	1.000
Medium high-technology manuf. sectors (dummy)	0.211	0.409	0.000	1.000
Medium low-technology manuf. sectors (dummy)	0.147	0.354	0.000	1.000
Low-technology manufacturing sectors (dummy)[0]	0.200	0.401	0.000	1.000
Knowledge-intensive services (dummy)	0.170	0.376	0.000	1.000
Other services (dummy)	0.219	0.414	0.000	1.000
Agriculture food and fishery (dummy)	0.661	0.474	0.000	1.000
Oil and gas sector (dummy)	0.114	0.318	0.000	1.000

Note: [0]variable used as reference category [1]variable not in regression of the innovation input.

4. Empirical analysis

This section presents the results of the empirical analysis. Section 4.1 reports the descriptive statistics for all firms; in section 4.2 we concentrate on the innovative firms; in section 4.3 we finally report and discuss the results of the sample selection models testing the gap hypothesis.

As this analysis endeavours to establish the difference between foreign-owned and domestic-owned firms, we restrict the firms in our sample to the firms belonging to a corporate group.[4]

4.1 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 5. Sample distribution.

		Observ. Total	Innov. firms	Percent
	Total observations	818	515	63.0
D:	Domestic non-multinationals	541	303	56.1
D-M:	Domestic multinationals	93	93	100.0
N-M:	Nordic multinationals	72	47	65.3
AS-M:	Anglo-Saxon multinationals	54	40	74.1
EU-M:	European and other multinationals	58	32	55.2
DOM:	Domestic-owned firms	634	396	62.5
FOR:	Foreign ownership	184	119	64.7

Note: This table is based on the sample of firms that are 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 (See Appendix A).

Table 5 contains the distribution of the companies across the country groups. We also report the number of innovators. We define innovators as companies that exhibit innovation activities, such as having introduced a product or process innovation, or

[4] 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 domestic-owned firms are part of a corporate group though. Observing a difference between foreign-owned firms and domestic-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 in talking about firms we implicitly mean firms belonging to a corporate group.

companies that are still committed to ongoing R&D projects. Companies having abandoned an R&D project and not currently undertaking innovation activities, or who have not launched a product innovation or process innovation, are not considered innovation active.

In the Finnish context we observe that well beyond 60% of the companies carry out innovation activities. Domestic non-multinationals[5] and European-owned companies contain the below average fraction of innovative companies, whereas the Anglo-Saxon-owned companies show the highest rate of innovation active companies. The fraction of innovation active companies among the foreign-owned companies does not differ from the share of innovative companies among the domestic-owned companies.

Table 6. Summary statistics of firm characteristics and innovation activities.

	D	D-M	N-M	AS-M	EU-M	DOM	FOR
Size	316	1835	165	218	162	539	180
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. prod.	1.164	3.270	1.623	2.391	1.511	1.473	1.813

Note: The table reports the averages of the firms' main economic characteristics and innovation activities. All categories except the size are in logs.

Table 6 shows the summary statistics of firm characteristics and behaviour for all five national groups and the foreign-owned and domestic-owned groups. The summary shows that on average domestic-owned multinational companies are larger than any of the other companies. This is not surprising as the foreign-owned multinationals are subsidiaries. Most probably some part of the surveyed domestic multinational companies are headquarters, although there is no indicator in the data whether the surveyed company is a subsidiary or a headquarters of a group; a large fraction of headquarters in this group explains the size difference. In terms of investment and exports domestic multinationals are quite similar to Anglo-Saxon-owned firms.

Domestic multinationals do not only excel in terms of size, they also excel in terms of innovation input and innovation output measured by the innovation effort per employee, and by the sales from new (and significantly modified) products per employee respectively. Also, the innovation input and the innovation output of the Anglo-Saxon-

[5] In the discussion below we also use the term domestic non-multinationals to refer to companies that are domestically owned and not grouped into the domestic multinationals category.

owned firms exceed the respective performance of all of the other foreign-owned companies and the domestic mono-nationals. Here we would argue in favour of an innovation input and an innovation performance gap. However, for a more convincing analysis we have to control for various other effects, as the country groups are not comparable in various company characteristics and sectoral composition. Additionally, we need to investigate whether the gaps are caused by differences in the likelihood of carrying out innovative activities or whether the gap is caused by different innovation intensity. However, at this stage we can see some indication of potential innovation and technology gaps.

Table 7. Sectoral distribution with ownership categories in percentages.

	D	D-M	N-M	AS-M	EU-M	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
	100.0	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), medium high-technology manufacturing (HM M), medium low-technology manufacturing (LM M), low-technology manufacturing (LO M), knowledge-intensive services (KIS) and other services (OS); see Hatzichronoglou (1997).

Table 7 summarizes 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 (medium) high-technology manufacturing and less concentrated on services. With the exception of 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 medium high-technology manufacturing than domestic-owned companies are.

Table 8. Firms' most significant market.

	D	D-M	N-M	AS-M	EU-M	DOM	FOR
Local	25.51	1.08	4.17	0.00	6.90	21.92	3.80
National	47.87	21.51	63.89	44.44	48.28	44.01	53.27
Global	26.62	77.42	31.94	55.56	44.83	34.07	42.93
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

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

In Table 8 we summarize what companies report as their most significant market. The most striking, yet not unexpected, difference between foreign-owned and domestic-owned companies is that the former concentrate less on local markets compared with the latter. Still, the focus on national markets by all foreign-owned companies is strikingly high; on average, more than 50% of the firms argue that their most important market is local or national. This focus is even more striking given the small size of the national market. If companies follow an asset exploiting strategy, we would certainly find a strong focus on local and national markets. The most internationally oriented companies are the domestic multinationals. More than three-quarters of those firms regard the international markets as most important for them. They are followed by the Anglo-Saxon-owned companies, where more than half of the sample focuses on global markets. Nordic-owned companies, however, focus on national markets more than any of the other group.

4.2 Descriptive statistics for the innovative firms

The descriptive statistics in this section only focus on innovative companies as defined above - this gives a more detailed picture of the firm's innovative strategies and the related activities. Table 9 gives the percentage of firms where the given activity can be observed. Hence it summarizes how pervasive the activity is among the innovative companies, although it does not give an indication of the intensity of the innovation activity.

Table 9. Innovation activities.

	D	D-M	N-M	AS-M	EU-M	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 firms' share in percentages 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 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 largest fraction of process innovations, which can probably be explained by the larger size of the average company in this category.

Domestic non-multinationals and foreign-owned companies have an approximately similar propensity to launch process innovations. Only Anglo-Saxon-owned companies stand out with an above-average fraction of process innovations.

With regard to continuous R&D, the domestic multinationals and Anglo-Saxon-owned companies stand out. More than four out of five companies are involved in R&D activities on a continuous basis. Only about one in two Nordic-owned companies show continuous R&D. We also observe that the propensity to receive public funding differs between the country groups. Among the domestic multinationals, receiving public funding for R&D is a quite ubiquitous phenomenon - as it is 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 that of domestic non-multinationals. 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.

On the basis of the innovation activities, the average Anglo-Saxon-owned company is most similar to the domestic multinational. The innovation activities of the Nordic-owned companies and the European-owned companies are most similar to the domestic non-multinationals.

Table 10. Methods of protection.

	D	D-M	N-M	AS-M	EU-M	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 use of the respective methods of protection.

The CIS questionnaire also inquires about the firms' assessment of certain methods to protect inventions and innovations. Firms are also asked about whether they already hold valid patents and whether or not they have applied for patents in the years 1998 to 2000. Table 10 contains the percentage of firms giving positive answers to the respective questions in the questionnaire. Here it shows 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 favoured, whereas formal protection mechanisms are least favoured. Among the formal protection methods, patenting plays a leading role. The ranking of the preferences does not differ between domestic-owned and foreign-owned companies. Neither does it differ between the country groups. However, it becomes obvious that there are group-specific differences in the rate of usage of the protection mechanisms. The Anglo-Saxon-owned firms again most resemble the domestic multinationals. The European multinationals are most similar to the domestic mono-nationals.

Table 11. Innovation Input and Innovation Output.

	D	D-M	N-M	AS-M	EU-M	DOM	FOR
Input							
Mean	6.1	9.1	3.0	10.0	8.5	6.8	6.9
Std.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	100.0	100.0	35.6	100.0	75.3	100.0	100.0
Output							
Mean	16.2	25.6	15.6	25.9	18.8	18.4	19.9
Std.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	100.0	100.0	80.0	100.0	80.0	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.

Table 11 summarizes the innovation input and the innovation output of the innovating firms. The innovation input is measured by the fraction of sales spent on innovation activities. The innovation output is represented by the sales from new and significantly modified products relative to total sales. 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 per cent of their sales in innovation, and the fraction of sales both realize from selling new or significantly modified products amounts to more than a quarter. On average, domestic non-multinationals and both Nordic-owned and European-owned companies show similar behaviour, although the Nordic-owned companies reveal the lowest innovation expenditure relative to sales.

Relating the summary statistics found in Table 11 to the gap hypothesis, and disregarding any statistical significance issues, we can assert an innovation input gap between Anglo-Saxon-owned firms and domestic non-multinationals. We also find an innovation input gap between the domestic multinationals and the domestic mono-nationals, the Nordic multinationals and the European multinationals. And there seems

to be an innovation input gap between the Anglo-Saxon-owned firms and the other foreign-owned firms. The innovation output gap follows the same pattern.

Table 12. Cooperation on innovation.

		D	D-M	N-M	AS-M	EU-M	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 percentage 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 per cent.

Table 12 displays the collaboration pattern for innovation broken down by the country groups and the internationality of the collaboration partner. Regardless of the ownership, Finnish domestic universities are among the most important collaboration partners. Only Nordic-owned companies tend to use Finnish universities less than their vertical collaboration partners, such as domestic supplies and domestic customers. International collaboration within the 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 between 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.

In the lower part of Table 12 we see a local embeddedness gap between Anglo-Saxon-owned and Nordic-owned companies, and the domestic non-multinationals and the European-owned firms. The domestic multinationals show the deepest embedding in the domestic system of innovation. The integration of domestic suppliers and customers in the innovation process is more common in domestic multinationals than in any other group; however, it shows that Anglo-Saxon-owned companies and the Nordic-owned companies maintain a higher involvement of suppliers and customers than the European-owned companies and the domestic non-multinationals. Embeddedness in the domestic industrial environment, as measured by horizontal collaboration for R&D, is equally low for foreign-owned companies, with the Nordic-owned companies being the least embedded. The domestic multinationals enjoy the deepest embedding. The embeddedness in the domestic science system reveals a gap between the domestic multinationals and the other companies, where the Anglo-Saxon-owned companies seem to be more deeply embedded than the Nordic-owned, the European-owned and the domestic-owned companies.

The summary of the cooperation for innovation reveals an embeddedness gap between the domestic multinationals and all other Finnish companies. There is also a gap between the Anglo-Saxon-owned companies and the other foreign-owned companies. We cannot see a clear indication of an embeddedness gap between the domestic-owned companies and the other foreign-owned companies.

4.3 Regression results

As discussed in section 3.2 above, we estimate the effect of foreign ownership and the effects of different underlying governance styles / home countries 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 characteristics of the innovation activities.

4.3.1 Innovation input gap

The selection equation[6] reported in Table 13 estimates how the innovation decision depends on exogenously given firm characteristics and firm behaviour. The most striking result here is that foreign ownership of firms does not have an influence on the

[6] We exemplarily report the selection equation of the selection model regressing the innovation input. The findings here hold for the selection equations in all other regression models testing the other gap hypotheses.

decision to innovate. However, we see that the innovators are larger; they command a higher endowment of human capital, maintain larger investments and enjoy higher labour productivity. On average, recent events in the firm's history, such as mergers or establishment, do not affect the decision to be innovation active. The key finding here is that ownership does not matter in determining whether or not to be innovation active. What does matter, though, is the market orientation of the company. Companies focusing on national and global markets are more likely to carry out innovation activities than companies focusing on local markets. The marginal effects[7] show that the focus on global markets has a stronger effect on the probability to innovate than the focus on the national market.

Table 13. Innovation decision (selection equation).

	Innovation activities (IIG)		
	Coeff.		Marg. eff.
Foreign ownership	-0.115		-0.044
Size	0.223	***	0.086
Local markets	Reference		
National markets	1.144	***	0.282
Global markets	0.789	***	0.372
Labour productivity	0.167	***	0.051
Recently established	-0.004		0.012
Recently merged	-0.125		-0.025
Human capital	0.361	*	0.068
Investment	0.096	***	0.023
Constant	-0.115		-
Est. method	HR		

Note: This table reports the results of the selection equation for innovation activities regression using a Heckman selection model. It reports the estimated coefficients and the marginal effects. The related gap is given in parentheses. *** (**,*) indicates significance at the 1% (5%, 10%) level

Table 14 and 15 report the results of regressing the innovation activities in order to assess the innovation and technology gaps. The domestic multinationals, the Anglo-Saxon and the European-owned firms have a significantly higher innovation effort per employee than firms in the domestic or Nordic groups. We find no indication for an innovation input gap in the innovation decision; once a company decides to carry out innovation activities, we find an innovation input gap. Domestic non-multinationals and

[7] The marginal effects are computed at the sample means (Greene 2000, p. 816).

Nordic-owned firms lag behind in innovation effort measured in innovation expenditure per worker. Domestic multinationals, Anglo-Saxon-owned firms and European-owned firms spend significantly more resources on innovation activities per worker than the domestic non-multinationals and the Nordic-owned firms.

4.3.2 Embeddedness gap

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. Hence there is a strong embeddedness gap between domestic multinationals and domestic non-multinationals. We can also conclude an embeddedness gap between the Nordic-owned firms and the domestic non-multinationals. A higher degree of embeddedness with vertical partners seems to be the source of the deeper overall embeddedness. Yet we observe from the regressions that the market companies' focus on is a more significant determinant for their embeddedness in the domestic NIS than the nationality of their ownership.

The more remote from local markets the most important markets are located, the smaller the propensity gets to collaborate with domestic partners. This holds true for domestic collaboration as such, as well as for all the collaboration types we looked at. The product innovation strategy also has a significant impact on the 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 can see that headquarters as well as strategy matters determine the innovation activity of firms.

Table 14. Innovation activities, two equation selection models.

	Innovation input per worker (IIG)		Domestic collab. (LEG)		Domestic vertical collab. (LEG)		Domestic horizontal collab. (LEG)		Utilization of dom. science system (LEG)	
D					Reference					
D-M	0.510	***	1.521	***	1.023	***	0.608	***	1.493	***
N-M	0.234		0.560	***	0.551	***	-0.244		0.220	
AS-M	0.471	**	0.023		0.067		0.148		0.382	
EU-M	0.445	*	-0.048		0.095		0.071		0.337	
Innov. input	-		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	***
Publ. 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	
Est. method	HR		HP		HP		HP		HP	

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). 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. The related gap is given in parentheses.

4.3.3 Innovation output gap

Nordic and domestic multinationals tend to patent more frequently than other companies. The more intensive patenting behaviour of the domestic multinationals can be explained by a headquarters 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 on the ownership. Only domestic multinationals produce high-level innovations more frequently than domestic groups. Multinationality seems to foster the development of market novelties. By and large, we find no significant innovation output gap between foreign-owned and domestic-owned companies.

Although foreign ownership does not matter for the development of high-level innovation, it does have an effect on the innovation output as measured by the sales of

new and significantly modified products relative to total sales. The Anglo-Saxon-owned and the European-owned companies in particular perform significantly better than companies owned by domestic groups. Again we find that Nordic-owned companies do not differ from domestic-owned ones. For domestic-owned companies, multinationality does matter though. 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.

Table 15. Innovation activities, two equation selection models (continued).

	Patent application (IOG)		Products new to the market (IOG)		Returns to innovation per worker (IOG)		Labour productivity (PG)		Public funding (FG)	
D	Reference									
D-M	0.412	**	0.900	***	0.534	**	0.131		0.528	***
N-M	0.367	*	0.100		0.391		0.140		-0.211	**
AS-M	0.079		0.159		0.675	**	0.314	**	0.069	
EU-M	-0.115		0.172		0.538	*	0.155		-0.542	***
Innov. input.	0.243	***	-0.006		0.150	***	0.146	***	-	
Size	0.137		0.067		-0.199	***	-0.029		0.001	
Local markets	Reference									
Reg. 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	***
Publ. 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	**
Est. method	HP		HP		HR		HR		HP	

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). 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. The related gap is given in parentheses.

4.3.4 Performance gap

Measuring performance by labour 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. Here we find a performance gap between foreign-

owned companies and domestic-owned companies, regardless of their multinationality. At first sight, this result complies nicely with the argument that the Anglo-Saxon governance style focuses on measurable short-term results, which, in turn, would lead to strong investment behaviour and a reduction in personnel, resulting in the high labour productivity of the company. It also conforms nicely with the argument that Anglo-Saxon-owned companies are Anglo-Saxon-owned because of their high performance. Although the above analysis takes various factors into account to control for exogenous influences, it does not take account of the fact that innovation output may determine the labour productivity and vice versa. The high innovation output of the Anglo-Saxon-owned companies may also determine the high labour productivity. To test this relationship we estimated a production function model in the vein of Crepon et al. (1998), and report the results in the Appendix. The estimation of the model shows that once we control for the mutual determination of the innovation output and labour productivity, we do not find a productivity gap for the Anglo-Saxon companies; rather, we find a productivity gap for the Nordic-owned companies. Still, the innovation output gap for the Anglo-Saxon-owned companies remains.

4.3.5 Funding gap

Receipt of public funding for R&D is more likely for domestic multinationals than for companies that are part of a purely domestic group. On average, with exception of the Anglo-Saxon-owned companies, foreign-owned companies have less likelihood to receive public funding than their domestic Finnish counterparts. We conclude that there is a funding gap. More research needs to be conducted to find the underlying mechanisms for the gap and to assess the impact of the gap on the innovation activities of foreign-owned firms in Finland.

5. Conclusion

In the analysis we first extended the current discussion about gaps between domestic-owned and foreign-owned firms into a more detailed picture of innovation and technology gaps. Mainly theoretical considerations led us to differentiate innovation input gaps, innovation output gaps, local embeddedness gaps, productivity gaps and funding gaps. The empirical analysis utilized the Finnish Community Innovation Survey covering the years 1998 to 2000. The analysis of the gap hypothesis started with an exploratory analysis of the data, where we already found slight indications pointing to the differential behaviour of foreign-owned and domestic-owned firms. The econometric analysis mainly consisted of sample selection models that take the companies' decision whether or not to engage in innovation activities into account.

As the earlier literature does not offer a consistent picture of innovation and technology gaps, this paper is clearly in line with the current empirical literature. The picture we are drawing in this study is not undivided. Depending on the type of indicator we use for innovation input, innovation output and local embeddedness, we find support for the gap hypothesis. By and large, we would support the innovation input gap hypothesis, the innovation output gap hypothesis, the local embeddedness gap hypothesis, the productivity gap hypothesis and the funding gap hypothesis. The gap hypotheses are not unanimous among the country groups of ownership. The Nordic-owned companies seem to be the most similar to the domestic-owned mono-ationals, although they reveal stronger embedding in the local environment and a stronger preference for patenting. European-owned companies exhibit higher innovation input and innovation output, achieved by a significantly lower propensity to receive public funding. The Anglo-Saxon-owned companies also reveal a higher innovation input, which they translate into an increased innovation output. Whether or not Anglo-Saxon companies are found to be able to translate the higher innovation output into higher labour productivity depends on the econometric methodology used. The most appropriate modelling shows that Anglo-Saxon companies do not translate the higher innovation input into better productivity. Table 16 summarizes the findings of the study.

Although we found some influence of ownership on the firms' innovation activities, the most robust result in the analysis is that the market strategy of the companies, such as a focused market, are is a stronger determinant for the level of innovation activities than the ownership is.

Table 16. Findings of the study.

Gap,	Indicator	Section	Finding	Gap hypothesis supported?
IIG	Innovation activity	4.3.1	-	no
IIG	Innovation input	4.3.1	Domestic multinationals, Anglo-Saxon-owned companies and Nordic-owned companies have a higher innovation effort per worker.	yes
LEG	Embeddedness in the domestic innovation system	4.3.2	Domestic multinationals and Nordic-owned companies reveal a higher probability of collaboration with domestic partners.	yes
LEG	Embedding of the domestic value chain	4.3.2	Domestic multinationals and Nordic-owned companies reveal a higher probability of collaboration with domestic vertical partners.	yes
LEG	Embeddedness in the domestic industry	4.3.2	Domestic multinationals have a higher propensity to collaborate with competitors.	no
LEG	Embeddedness in the domestic science base	4.3.2	Domestic multinational have a higher propensity to collaborate with domestic universities and research institutes.	no
IOG	Patent behaviour	4.3.3	Domestic multinationals and Nordic-owned companies reveal more frequent patenting.	yes
IOG	Novel innovation	4.3.3	Domestic multinationals show a higher rate of innovation output measured by novel innovations.	no
IOG	Innovation output	4.3.3	Domestic multinationals, Anglo-Saxon-owned companies and European-owned companies have higher income per worker from new products.	yes
PG	Productivity	4.3.4	As measured by labour productivity- Anglo-Saxon-owned companies are more productive than all the other companies.	yes
FG	Funding	4.3.5	Domestic multinationals enjoy a higher probability of receiving public funding, whereas the Nordic-owned and the European-owned companies have a lower probability of being funded.	yes

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Appendix A:
Determining the home country 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 about whether or not the surveyed company is a part of a corporate group. We selected only those companies answering this question positively; companies giving no answer or a negative answer were dropped from the analysis. The second variable used contains the information about the home country of the company. We dropped all companies where no country code was given.

We distinguished the domestic-owned companies in companies belonging to domestic-owned corporate groups and domestic-owned domestic groups. As there is no variable in the CIS indicating the multi-nationality of the domestic groups, we had 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 domestic-owned company reported innovation collaboration within the corporate group but outside the home country, we regarded the company as being a domestic-owned multi-national company. This procedure clearly underestimates the number of domestic-owned multinational companies. However, if we find multinationality significantly influencing innovation activities, we are on safe ground as the control group of domestic-owned companies certainly also contains companies that are domestic multinationals.

Appendix B:
Multistage production function model

Model

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 et al. (1998). The model, referred to as the CDM model, includes four equations and three established relationships, including the innovation input linked to its determinants, the 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 the most common case 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 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 3.2 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:

$$g^* = \beta_0^0 + \sum_n \beta_n^0 x_n^0 + \varepsilon^0 \quad (1)$$

$$k = \beta_0^1 + \sum_m \beta_m^1 x_m^1 + \varepsilon^1 \quad (2)$$

$$t = \beta_0^2 + \beta_k k + \beta_{MR} MR + \sum_l \beta_l^2 x_l^2 + \varepsilon^2 \quad (3)$$

$$q = \beta_0^3 + \beta_t t + \sum_j \beta_j^3 x_j^3 + \varepsilon^3 \quad (4)$$

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 Mill's ratio and the predicted innovation input estimate in equation (3), 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 equations can be estimated by two stage least square or three stage least square. In this report we are utilizing the 2SLS estimator.

Results

Table B1. Multi-step production function model.

Step 1: Selection equation Dependent variable: The probability to be an innovative firm			
	Coefficient		Std.err.
Foreign ownership	-0.067		0.120
Size	0.217	***	0.038
Local markets		Reference	
Regional markets	1.230	***	0.162
Global markets	0.867	***	0.139
Recently established	0.036		0.169
Recently merged	-0.096		0.141
Human capital	0.436	**	0.199
Investment per employee (log)	0.149	***	0.032
Constant	-1.967	***	0.233
Step 2: Innovation input equation Dependent variable Log innovation expenditures per employee			
D		Reference	
D-M	0.529	***	0.183
N-M	0.210		0.215
AS-M	0.447	*	0.238
EU-M	0.398		0.257
Size	-0.429	***	0.050
Local markets		Reference	
Regional markets	-0.157		0.281
Global markets	-0.126		0.248
Public funding for R&D	0.631	***	0.132
Process innovation	0.189		0.123
Continuous R&D	1.117	***	0.150
Constant	2.119	***	0.453

Note: *** (**,*) indicates significance at the 1% (5%, 10%) level. D= Domestic firms, non-multinational; D-M= domestic multinational; N-M= Nordic multinational, AS-M= Anglo-Saxon multinational; EU-M= European and other multinationals. 6 sector dummies included in the regression are not reported here.

Table B1. 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	0.318		0.278
Predicted innovation input	0.23		0.175
D		Reference	
D-M	0.481	**	0.224
N-M	0.294		0.259
AS-M	0.545	*	0.294
EU-M	0.238		0.31
Size	-0.174		0.111
Inverted Mill's ratio from the sel. equn.	-1.113		0.742
Public funding for R&D	-0.414	*	0.23
Collaboration diversity	1.541	***	0.349
Human capital	-0.614	*	0.367
Constant	1.527		2.232
Step 4: Productivity equation Dependent variable: Log sales per employee per employee			
Predicted innovation output	0.185	**	0.087
Investment per employee (log)	0.271	***	0.038
D		Reference	
D-M	-0.068		0.111
N-M	0.184	*	0.101
AS-M	0.137		0.159
EU-M	0.117		0.159
Process innovation	-0.092		0.070
Size	-0.010		0.035
Human capital	0.641	***	0.147
Constant	4.290	***	0.190

Note: *** (**,*) indicates significance at the 1% (5%, 10%) level. D= Domestic firms, non-multinational; D-M= domestic multinational; N-M= Nordic multinational, AS-M= Anglo-Saxon multinational; EU-M= European and other multinationals. 6 sector dummies included in the regression are not reported here.

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ISBN 951–38–6578–9 (URL: http://www.vtt.fi/inf/pdf/)
ISSN 1459–7683 (URL: http://www.vtt.fi/inf/pdf/)