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OWNERSHIP, INNOVATION AND PRODUCTIVITY IN LATVIAN SMALL ENTERPRISES: APPLICATION OF THE CDM MODEL

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Abstract

In this study authors aim at answering the question whether foreign ownership affects productivity in Latvian small enterprises. Specifically, authors are interested whether the link between foreign direct investment, innovation and productivity exists. In addition, authors analyze how different characteristics of foreign owners matter. These properties include geographical belonging of the owner, whether s/he is a minority shareholder or whether s/ he is a multinational enterprise. In our study we apply the CDM model, which is helpful because it provides a good theoretical basis for the relationship between innovation and productivity, and moreover, it also effectively deals with econometric problems. We find that foreign ownership has positive effect on labor productivity, and also has positive impact on innovation via engagement in R&D; however, no relationship between innovation and productivity is found to be present in Latvia. We also spot the evidence that if a foreign owner originates from the USA, Western Europe, Central and Eastern Europe or Nordic Europe region, it is likely to positively influence labor productivity of a host company. At the same time, foreign owners from Commonwealth of Independent States countries do not impact production output. Another finding is that effect of foreign ownership on productivity is much bigger, when the company belongs to a multinational enterprise compared to foreign uninational and domestic owned firms. Finally, minority foreign owners are found to have no advantage on productivity compared to fully domestic owned firms.

Keywords: foreign ownership, innovation, productivity, the CDM model, Latvia

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List of Abbreviations

CDM – the model developed by Crépon, Duguet, Mairesse in 1998

CEE – Central and Eastern Europe

CIS – Commonwealth of Independent States

CIS – Community Innovation Survey

FDI – Foreign Direct Investment

MNE – Multinational Enterprise

NACE – Statistical Classification of economic activities in the European Community

OLS – Ordinary Least Squares

R&D – Research & Development

SIBiL – Survey of Innovative Businesses in Latvia

List of Terms

FDI – OECD (1996) offers the next definition

> Foreign direct investment reflects the objective of obtaining a lasting interest by a resident entity in one economy (‘‘direct investor’’) in an entity resident in an economy other than that of the investor (‘‘direct investment enterprise’’). The lasting interest implies the existence of a long-term relationship between the direct investor and the enterprise and a significant degree of influence on the management of the enterprise. Direct investment involves both the initial transaction between the two entities and all subsequent capital transactions between them and among affiliated enterprises; both incorporated and unincorporated (OECD, 1996, p. 7 – 8).

MNE – according to Dunning (1974), this is “firm which owns and controls income generating assets in more than one country” (Dunning, 1974, p.13)

Innovation activities – “the acquisition of machinery, equipment, software, and licenses; engineering and development work, training, marketing and R&D when they are specifically undertaken to develop and/or implement a product or process innovation” (SIBiL questionnaire, 2007, p. 4); also known as *innovation input* (Crépon, Duguet & Mairesse, 1998)

Innovation output – "patents, product or process innovations and sales from new products" (Masso & Vahter, 2008, p.3)

Intramural R&D (in-house R&D) – "Research and development is creative work undertaken within enterprise to increase the stock of knowledge and its use to develop new and improved products/services and processes (including software development)" (SIBiL questionnaire, 2007, p. 5)

Extramural R&D- "Same activities as in intramural R&D but performed by other companies (including other enterprises within your group) or by public or private research organizations and purchased by an enterprise" (SIBiL questionnaire, 2007, p

1. Introduction

According to Krugman (1997), "a country's ability to improve its standard of living over time depends almost entirely on its ability to raise output per worker" (Krugman, 1997). Understanding determinants of high productivity is, thus, very important. One of the factors that could potentially improve productivity is foreign ownership. According to the theory of FDI, when a company invests abroad, it transfers tangible and non-tangible assets to the host enterprise. Among those assets are technologies, image, marketing and management practices, networks with clients and suppliers etc. (Aitken & Harrison, 1999; OECD, 2002). Moreover, owners may provide a foreign subsidiary with lower cost of financing if they can obtain funds more cheaply in their home country (Oulton, 1998). Next, foreign controlled enterprises are often more capital intense and have better qualified employees (Oulton, 1998). In addition, foreign owners may introduce stricter rules for corporate governance (Lee, 2008).All this can positively affect a host company's productivity.

Yet, the evidence from empirical literature is rather mixed. To mention just a few studies: positive relationship between foreign ownership and productivity has been found in Estonia (Hannula & Tamm, 2002), in the UK (Oulton, 1998; Girma, Greenaway & Wakelin, 2001), in China (Li, Lu & Ng, 2009), while no effect was spotted in Bulgaria and Poland (Konings, 2000), or in Italy (Benfratello & Sembenelli, 2002). The effect of foreign ownership might be minimized or even reversed due to cultural and linguistic differences between shareholders and managers. Big distance can also be an obstacle in communication of goals (Grant, 1987).

With our study we endeavor to add to the existing literature by answering the research question *what is the effect of foreign ownership on labour productivity in Latvian small enterprises?* We limit our study to small enterprises due to data availability.

Part of the positive relationship between labor productivity and foreign ownership can be explained by the fact that foreign owners affect the introduction of new or improved products and services. Sometimes they initiate innovative activities e.g. R&D, in a host company. "Asset exploiting theory" states that if a company decides to exploit its assets abroad, then innovative activities will be performed in a foreign affiliate in order to adjust to the local market (Kuemmerle, 1999; Le Bas, 2007). Another view is that foreign companies may perform 'home-base augmenting" R&D activities in order to find new assets that would add to existing ones (Kuemmerle, 1999; Le Bas, 2007). The outcome of innovation activities - improved or new products or more efficient processes, in turn, has a positive impact on

productivity (Crépon, Duguet & Mairesse, 1998; Masso & Vahter, 2008). Sometimes foreign owners prefer to perform innovation activities at the headquarters. In such cases they do not increase R&D but transfer new or improved goods and services to their foreign affiliate and the latter introduces new products to the market (Castellani & Zanfei, 2003). Motivated by this, we formulate the sub question of our research: *does foreign ownership affect productivity in Latvian small enterprises through the channel of innovation?*

In order to answer the research question, we apply the theoretical model developed by Crépon, Duguet & Mairesse (hereinafter, CDM model) (Crépon, Duguet & Mairesse, 1998). This model has become a state of the art approach in the literature that studies innovations and productivity due to its logical explanation of the whole innovation process (Lööf & Heshimati, 2002). The model implies the logical chain: innovation activities, such as R&D and acquisitions of machinery, lead to production of innovation output (new or improved products or processes). The latter in turn affects productivity (Crépon, Mairesse & Duguet, 1998).

In our research we apply the dataset SIBiL which covers 906 small enterprises in Latvia and is compatible with Community Innovation Survey databases that are widely used across all countries in Europe for the research about innovation and productivity.

We consider our study highly relevant and novel for a few reasons. Firstly, we add to rather limited knowledge about the link between foreign ownership and productivity in Latvia. Secondly, we look at the specific channel, innovation, through which foreign ownership can impact productivity. Thirdly, we try to understand whether origin of foreign owners, multinationality of a company and size of the foreign share matter for the firm's performance. Fourthly, to our knowledge we are the first to apply CDM model in Latvia.

Our results can be useful and applicable for public institutions that are responsible for the attraction of foreign investors to Latvia. Labor productivity is very low in Latvia (for example, in 2008 it was only 52.6% of EU-27 average (Eurostat, 2010)). The knowledge about positive effect of foreign ownership on productivity can definitely be a signal for implementing FDI promotion related policies and creating more favorable business environment for foreign investors.

In our paper we find that foreign ownership indeed has a positive impact on labor productivity. Yet, this does not happen through the channel of innovation. Foreign controlled companies in Latvia are more innovative than their domestic counterparts, however, there are other advantages unrelated to innovativeness that make them more productive. In addition, we find that origin of foreign owner is also important, because, foreign investors from CIS

countries have no significant influence on productivity, while investors from the USA, Western Europe and CEE countries have strong positive effect. We also determine that multinationality is beneficial for a company, and foreign multinationals are more productive than foreign companies that perform only in Latvia. Finally, it is also important for foreign owners to have a majority stake in the firm, otherwise they are not powerful enough to increase productivity.

This study is structured as follows: in section 2 we present the theories on which we base our research. The empirical literature is reviewed in section 3, after which we formulate the hypotheses that we want to test. A discussion of the data is presented in section 5. In section 6 we elaborate on methodology. Section 7 reports the descriptive statistics. Results are discussed in section 8 and section 9 concludes.

1. Background of the Study

In this part we will shortly present two theoretical postulates on which we base our study.

Cobb-Douglas Production Function

The Cobb-Douglas production function is often used to measure productivity (Congressional Budget Office, 2005). The formula indicates "how different inputs are combined to produce output" (Congressional Budget Office, 2005).

$y = K\, x^{\alpha}_{capital}\, x^{\beta}_{labor}$, where

y = real output

K = constant that measure total factor productivity

$x_{capital}$ = physical capital

x_{labor} = labor input

α , β = elasticity of substitution and returns to scale

(Schotter, 2008)

R&D is an input that is often added to the production function (Congressional Budget Office, 2005) and then the function looks like this:

$y = K\, x^{\alpha}_{capital}\, x^{\beta}_{labor}\, R^{\gamma}$, where

R = R&D effort

γ=elasticity associated with R&D effort (Congressional Budget Office, 2005).

Many authors such as Hall and Mairesse (1995), Janz, Lööf and Peters (2004), Parisi, Schiantarelli and Sembenelli (2006) have found that R&D positively affects productivity (Hall & Mairesse, 1995; Janz, Lööf & Peters, 2004; Parisi, Schiantarelli & Simbenelli, 2006). It can be explained by the fact that knowledge from R&D helps to launch significantly better products that vary in range, meet the demand in the market, and have better quality; or improved processes that allow efficient use of different inputs of production (Masso & Vahter, 2008). However, the problem with R&D is that it does not cover all the components of innovation and this caveat is especially pronounced in data with small and medium enterprises. Even if firms launch new or improved products, they do not always record R&D activities as these activities are intangible or unobservable (Hall, Lotti & Mairesse, 2009). Our data also shows that actually 44 companies of those which reported that they had introduced new products, were not engaged in any innovation activity, like R&D, according to the survey results. Moreover, it was stated by Crépon, Duguet and Mairesse (1998) that R&D affects productivity only indirectly through innovative product and processes (Crépon, Duguet & Mairesse, 1998). Thus, a current widely accepted method is to measure how innovative output, i.e. product of innovative activities impacts productivity (Hall, Lotti & Mairesse, 2009).

The CDM model

Based on that logic we will use the model created by Crepon, Duguet and Mairesse (the CDM model), where productivity is affected by innovation output, and innovation output in turn depends on innovation input (Crépon, Duguet & Mairesse, 1998). To make it clear, innovation input is what company spends on innovation activities such as R&D, acquisition of machinery, equipment etc. Innovation output is what results from such activities, i.e. new or improved products and processes within the firm (Masso & Vahter, 2008). Apart from the fact that the model is more correct in theoretical sense, it also efficiently deals with several biases (Crépon, Duguet & Mairesse, 1998). The econometric component of CDM model is discussed in more details in the methodology part of our work.

Due to its advantages, the CDM model became popular among academics who study productivity and innovation. For example, Galia and Legros (2004) also based their study about companies in France on CDM model (Galia & Legros, 2004). Guo (2008) used it to study innovation input, innovation output and competitiveness of firms in Chinese pharmaceutical industry (Guo, 2008). Leeuwen and Klomp (2002), in turn, worked with the

data from the Netherlands (Leeuwen, & Klomp, 2002). The model, often modified, was used to make analysis of knowledge intensive manufacturing firms in Germany and Sweden (Janz, Lööf & Peters, 2004), manufacturing companies in Estonia (Masso & Vahter, 2008), firms in Russia (Roud, 2007), Italy (Hall, Lotti & Mairesse, 2009) and companies in a few other countries. The CDM model has also been used to determine the link between *foreign ownership*, innovation and productivity. Lööf, Ebersberger and Johansson (2006) studied the data on Nordic countries and Lööf, Ebersberger and Oksanen (2005) focused on the data from Finland (Lööf, Ebersberger & Johansson, 2006; Lööf, Ebersberger and Oksanen, 2005). CDM model is an important approach in the research. Its usefulness and applicability have been confirmed by a wide range of research papers based on the data from different countries around the world. The model became a base for a significant constituent of academic literature on productivity – studies "à la CDM".

2. Literature Review

In this part we discuss empirical evidence on the links between foreign ownership, innovation and productivity.

Firstly, we present two studies that use CDM model and answer the question how foreign ownership affects innovations and productivity. Next, we show the specifics of different papers on foreign ownership and productivity that are not based on the CDM model. We also present empirical evidence from several selected articles. Then we shortly describe the works that focus on Latvia.

Foreign Ownership in CDM model

To our best knowledge there are two studies that use CDM model in order to study the effect of foreign ownership on productivity.

Lööf, Ebersberger and Johansson (2006) compare how foreign owners affect innovation activities, innovation output and productivity in Finland, Sweden, Norway and Denmark. The authors also examine the origin of foreign owners. They divide them into groups according to corporate governance style: Anglo-Saxon, Nordic, and Continental European, where USA, United Kingdom, Ireland, Canada and South Africa belong to the group of Anglo-Saxon countries. Moreover, Lööf, Ebersberger and Johansson (2006) also distinguish between firms that belong to a multinational corporation and those that are uninational, motivating it by the theoretical postulate that MNE's must have some superior assets, otherwise they do not enter a foreign market (Dunning 1974; Dunning 1993; Caves

1996). These assets can augment the productivity of enterprises belonging to a multinational group (Dunning 1974; Dunning 1993; Caves 1996). The authors use Community Innovation Survey for the analysis. The time span of the article is 1998 – 2000 (Lööf, Ebersberger & Johansson, 2006).

Lööf, Ebersberger and Johansson (2006) find that in Denmark foreigners do not have effect on productivity neither through innovations nor through any other channels. In Finland Anglo-Saxon foreign owners can lead the company to higher productivity due to the fact that they produce and sell more innovation products, while foreigners from other Nordic countries have positive impact on productivity through channels other than innovation. In Norway foreigners never affect productivity through innovations, but again firms coming from other Nordic countries still positively impact productivity through other channels. Finally, in Sweden domestic multinationals and foreign companies controlled by Nordic owners achieve higher productivity due to the fact that they are more innovative (Lööf, Ebersberger & Johansson, 2006).

As one can see, the results are very mixed in four countries and positive influence of foreign ownership on productivity may happen both due to innovation and other reasons (Lööf, Ebersberger & Johansson, 2006).

Ebersberger, Lööf and Oksanen (2005) write a similar paper specifically for Finland. They also distinguish between companies coming from countries with different corporate styles and account for multinationality. Authors use Community Innovation Survey that covers years 1998 – 2000. They conclude that foreign controlled companies in Finland are not more inclined to engage in innovation projects as compared to domestic counterparts. However, domestic multinationals and Anglo-Saxon companies can lead to a higher number of innovations, when one looks only at the sample of innovative firms. They also discover that domestic multinationals and Anglo-Saxon multinationals lead to higher productivity through the channel of innovation, while companies from other Nordic countries impact productivity through some other channel (Ebersberger, Lööf & Oksanen, 2005).

Selected Specifics of Different Studies

The CDM model is a popular approach in analyzing the innovation process, however, as we saw, it is not yet widely used to investigate the effect of foreign ownership on innovations and productivity. In this section we present some studies that examine foreign ownership and productivity, but do not apply the CDM model. These papers can provide more insight into the topic.

The studies investigating ownership and productivity differ in many ways. For example, many researchers have chosen to analyze only manufacturing companies (Doms & Jensen, 1998; Hannula & Tamm, 2002; Vahter, 2004; Baldwin & Gu, 2005). However, others study both manufacturing and non-manufacturing sectors of the economy (Oulton, 1998; Djankov & Hoekman, 1999; Konings, 2000; Li, Lu & Ng, 2009), motivating it by the fact that FDI received by service companies is substantial and non-manufacturing sectors are also very important for GDP (Oulton, 1998). In 2007 non-manufacturing industries constituted 78% of Latvian GDP (Latvijas Statistika, 2010), thus it is highly relevant to include non-manufacturers into our study as well.

Some authors raise a question of whether it is foreign ownership per se or rather multinationality of a company that positively increases productivity (Baldwin & Gu, 2005; Doms & Jensen, 1998; Lööf , Ebersberger & Oksanen, 2005; Lööf, Ebersberger & Johansson, 2006) . As it was already mentioned, according to the theory of multinational enterprise, a company enters a foreign market and is ready to face big costs of entering, only when it possesses some superior assets (Dunning, 1993; Caves, 1996). These assets can be absolutely diverse. MNEs may possess experience, brand, technological capital, skills etc., which can be transferred to the host enterprise and lead to higher performance (Griffith, Redding & Reenen, 2004). Baldwin and Gu (2005) indeed find that multinationality and not foreign ownership matters for the productivity in Canadian manufacturers. They discover that domestic plants that also have operations abroad are as productive as foreign controlled plants in Canada (Baldwin & Gu, 2005). However, Griffith, Redding and Reenen (2004) in the study about productivity of British firms, spot evidence that foreign multinationals are more labor productive than domestic multinationals (Griffith, Redding & Reenen, 2004). The odd point is that authors who raise the question of multinationality assume that all foreign owned firms are MNEs; however, we cannot treat two characteristics interchangeably. Not all foreign controlled enterprises in our data agree that they are a part of an MNE. In fact, a company in Latvia that is controlled by a foreign owner might be an independent firm, which does not have a parent company or an affiliate abroad.

It is also important to analyze whether origin of foreign owners matters. According to Cantwell (1989), the smaller the difference in technology endowment between domestic and foreign enterprise the higher is the probability that the host company will receive technological advantage from its foreign owner (Cantwell, 1989). From this statement one can hypothesize that Latvian enterprises will benefit more from owners coming from other developing economies. On the other hand, opposite was confirmed by Benfratello and

Sembenelli (2002), who studied data on Italian enterprises in 1992- 1999 (Benfratello & Sembenelli, 2002). They found evidence that transfer of tangible or intangible assets can occur only when the gap between domestic and foreign company is large enough (Benfratello & Sembenelli, 2002). Thus, we can hypothesize that owners originating from the USA, Western and Nordic Europe unquestionably possess superior technologies and high expertise and thus are likely to positively affect productivity of Latvian affiliates. Several researchers tried to inspect whether the origin of foreign owner plays any role. For example, Oulton (1998) discovers that all foreign owners positively affect productivity of UK enterprises, but effect of US owners is larger (Oulton, 1998). Baldwin and Gu (2005) also emphasize superior effect of US companies as compared to other foreign investors controlling Canadian manufacturers (Baldwin & Gu, 2005). In the study about the effect of foreign ownership on productivity of US manufacturers, Doms and Jensen (1998) finds that origin of foreign owners does not matter and moreover, US companies that also operate abroad, i.e. US multinationals, are the best performers in terms of productivity (Doms & Jensen, 1998). Benfratello and Sembenelli (2002), also find that US firms are more productive than EU firms in Italy (Benfratello & Sembenelli, 2002). We will divide foreign owners in different groups based on their origin and will also try to establish whether country of ownership matters.

One more important aspect that is discussed in the literature on ownership and productivity is the simultaneous causality. Foreign owned companies may perform better just because foreign investors do “cherry picking”, i.e. choose more productive enterprises as their investment target (Arnold & Javorcik, 2009). There are several econometric techniques that can help to deal with this problem for the panel data. Vahter (2004) uses Heckman selection model to account for simultaneity bias, while Benfratello and Sembenelli (2002) as well as Li, Lu & Ng (2009) apply GMM-system technique (Benfratello & Sembenelli, 2002; Vahter, 2004; Li, Lu & Ng, 2009).

Empirical Evidence from Different Countries

Academic literature on this topic is present for different economies in the world. We have empirical evidence from such developed economies as the USA (Doms & Jensen, 1998) Great Britain (Oulton, 1998), Italy (Benfratello & Sembenelli, 2002). Evidence from the USA shows that foreign controlled plants have higher productivity than US plants, however, when one accounts for multinationality, then it occurs that foreign multinationals do not outperform domestic multinationals (Doms & Jensen, 1998). In Great Britain however, manufacturing

firms that are controlled by a foreign owner are about three times more productive than domestic ones (Oulton, 1998). The author explains this by the fact that foreign owned firms have more qualified employees, better technology and lower cost of funding (Oulton, 1998). Interesting results have been obtained by Benfratello and Sembenelli (2002) in their study about Italy. They determine that foreign ownership has not effect on productivity, however, when owners are divided into groups according to their origin, then it is found that US controlled firms are more productive (Benfratello & Sembenelli, 2002). Summing up, the evidence from developed countries is rather mixed. However, one should notice that it is important to pay attention to the multinationality of companies and country of origin of foreign owners.

We also have information about the relationship between foreign ownership and productivity in Asian countries. Foreign owned plants yield higher productivity than domestic plants in Indonesia (Arnold & Javorcik, 2009). It has been also found that foreign owned firms are more productive than domestic ones in China. More specifically, even controlling for different biases, a 10% increase in foreign ownership results in 10% increase in productivity in the Chinese companies (Li, Lu & Ng, 2009). The limited information on Asia that we have, suggests that foreign ownership is beneficial.

We do not know much about the relationship between foreign ownership and productivity in Russia, but according to the paper of Earle (1998), when relationship is measured by OLS regression, the coefficient on foreign ownership is negative, but when instrumental variables are added in order to prevent potential biases, the coefficient turns positive (Earle, 1998).

The literature that studies impact of foreign ownership on productivity in CEE countries is rather rich; however, we cannot draw univocal conclusions from it. Hannula and Tamm (2002) found that foreign manufacturing firms in Estonia are more productive than local ones (Hannula & Tamm, 2002). However, Vahter (2004) showed that market orientation is important and domestically oriented foreign firms have more than two times better labor productivity than export oriented foreign firms. The evidence from Czech Republic suggests that the foreign ownership positively affects productivity (Konings, 2000). The same result has been found in Poland, however in Bulgaria and Romania foreign ownership does not have impact on performance (Konings, 2000). To conclude, the evidence from CEE countries is mixed and thus examination of the question of foreign ownership and productivity for the companies in Latvia is relevant and may produce important knowledge.

Studies about Latvia

To our best knowledge, there are only a few studies that investigate how foreign ownership affects productivity in Latvia. Cirijevskis and Gravis (2009) have recently performed a research on this topic. They examine the spillovers from FDI and perform and industry-level analysis. They find that "Latvian economy sectors have enjoyed benefits of FDI through technology transfer linkages" (Cirjevskis & Gravis, 2009, p. 39).

Sumrova and Dijokas (2000) analyze manufacturers and construction companies in Latvia. The sample includes cross-section data on 214 companies in 1998. One of the aims of the research was to study whether there is any difference between foreign and domestic companies in terms of productivity. The authors confirmed in the paper that foreign-owned companies are more productive. Sumrova and Dijokas (2000) focus on manufacturers and construction firms, however, these companies constitute only a part of Latvian GDP (Sumrova & Dijokas, 2000). If we want to provide suggestions concerning the FDI policy in Latvia we have to base on a sample that also represents non-manufacturers that are very important for the economy.

Kairys and Urba (2005) analyze foreign ownership and the efficiency of manufacturing companies in Latvia for years 1999-2003. They perform random effects model and stochastic frontier analysis in order to find the magnitude of the impact. They find that foreign ownership leads to higher efficiency, controlling for size, marketing and administrative costs. The panel data allows to track the performance of the firms before and after they became foreign owned, and authors confirm that impact goes from ownership to efficiency and not vice versa (Kairys & Urba, 2005).

Our paper significantly differs from the existing firm-level studies about Latvia. Firstly, we employ bigger dataset, which contains information for 906 companies (Kairys and Urba (2005) analyze 265 companies; Sumrova and Dijokas (2000) analyze 214). Secondly, we take into account many different sectors of the economy, while Kairys and Urba (2005) perform analysis only for food, textile producing and wood processing industries; Sumrova and Dijokas (2000) concentrate on manufacturing and construction (Sumrova & Dijokas, 2000; Kairys & Urba, 2005). Thirdly, our paper is different in terms of time scope. Another important difference is that we endeavor to define how foreign ownership affects productivity through innovations. Finally, due to the fact that we have only cross-sectional data, we apply different econometric techniques.

3. Hypotheses

Based on the empirical evidence from the literature as well as theoretical foundation we formulate the hypotheses that we want to test in our study. Our main hypothesis is as follows.

Hypothesis1: Foreign ownership positively affects productivity in Latvian small enterprises

As we specifically want to test how foreign ownership affects productivity through the channel of innovation we formulate our next hypotheses.

Hypothesis 2: Foreign ownership positively affects productivity through the channel of innovations.

Next, we want to see whether country of origin of the foreign owner has any effect on productivity.

Hypothesis 3: Country of foreign owner matters for the productivity in Latvian small enterprises

Due to the evidence that US enterprises have superior performance we formulate our sub - hypothesis:

Hypothesis 3a: US ownership positively affects productivity in Latvian small enterprises

Based on the reason that technology gap may also be large between Latvia and Nordic/Western Europe, we formulate two more hypotheses:

Hypothesis 3b: Western Europe ownership positively affects productivity in Latvian small enterprises

Hypothesis 3c: Nordic Europe ownership positively affects productivity in Latvian small enterprises

Motivated by the literature which often states the importance of multinationality, we state our last hypothesis:

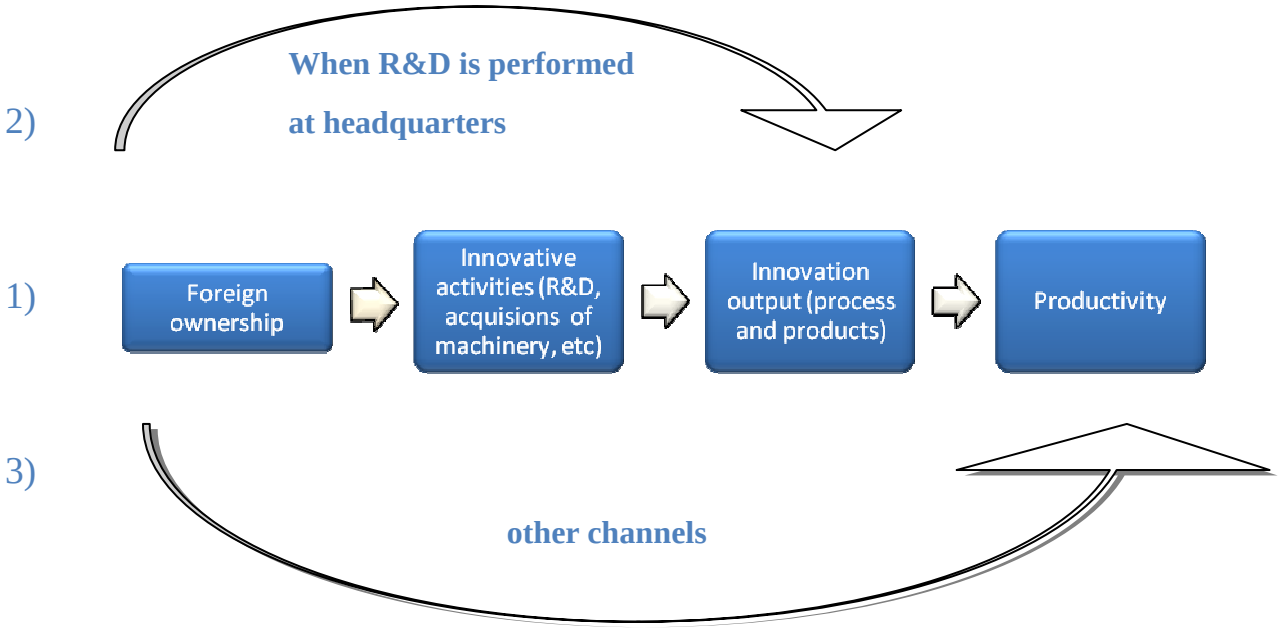
Hypothesis4: Multinationality positively affects productivity in Latvian small enterprises

The hypothesized relationship between four main variables of interest (foreign ownership, innovation input, innovation output and productivity) can be seen in the following diagram. Foreign owners may affect productivity in three following ways:

1) Foreign owners may initiate R&D in Latvia, which will lead to the production of new or improved products/processes. As a result, innovation output will improve productivity of affiliates in Latvia.
2) Foreign owners may decide to leave R&D and related innovation processes in the home country and then they will transfer ready products/processes to affiliates in Latvia, which again can improve productivity.

3) Foreign owners affect productivity through channels other than innovation.

Figure1. Effect of foreign ownership on innovation



Source: Composed by the authors

4. Data

We base our study on the data acquired from the Survey of Innovative Business in Latvia (hereinafter SIBiL)[1]. SIBil is an extensive dataset which to a large extent reflects Eurostat's Community Innovation Survey (CIS). CIS is carried out in all countries belonging to the European Union, and also in Norway and Iceland. SIBiL comprises same questions and industries as included in 4th wave of CIS; however it also has a few features that distinguish it from the latter. For example, in addition to the questions about process and product innovations, it also asks information about owners (gender, age, nationality, level of education, field of education, experience, stake etc). Other feature is that questions are asked directly to owner-managers during face to face interviews, performed by the professional surveying company– Latvian Facts. If some questions were not clear to respondents, trained interviewers helped them out. Therefore, potentially data in SIBiL is more accurate than in mail based CIS. Moreover, large difference between SIBiL and CIS lies in the samples the

[1] We are highly grateful to Vyacheslav Dombrovsky, the initiator and organizer of the SIBiL, for providing the dataset for our thesis.

surveys are based on. CIS does not include firms, where the number of employees is less than 10 (Allen, 2007) while focus of SIBiL is small enterprises where there are less than 50 employees. Thus, SIBiL adds to what we can learn from CIS by including small firms with less than 10 employees. The sample also embodies a moderate number of companies from "high- tech industries" (Dombrovsky, 2009).

Additionally, the information obtained from the survey is complemented with the financial data from the Latvian Business Register Lursoft. Information about foreign owners is also acquired from Lursoft. The sample contains operating firms with less than 50 employees in 2006 and firms that were registered in 2007. The dataset contains accounting data for the year 2007. The questions in the survey concerned information about the companies' innovations in 2005-2007. The dataset covers 1254 small firms in Latvia.

Original dataset was created using stratified sampling technique. The target population included companies with less than 50 employees and obliged to provide financial statements to business register. Based on industry and firm size it was then divided into 40 strata, and random sampling techniques within each stratum were performed (Dombrovsky, 2009).

Data is cross-sectional; all observations are for year 2007. In this work, authors limit original dataset from 1254 to 906 companies. Several criteria for exclusion of the firm from the sample were applied. Firstly, authors dropped out firms, which did not report values of the variables which are used in the study. For example, if company does not report sales, it is clearly impossible to calculate productivity; therefore such observation is left out. Secondly, discretionary decision, based on knowledge and common sense of authors, to delete outliers was made. For example, sales of three companies were at least two times larger than sales of all the rest, some companies had no fixed assets, etc, which significantly deviated from the rest of the data.

Finally, firms, reporting ambiguous values were excluded; for example, if to the question "Did you perform product innovations in the last three years?", firm answered "do not know", it is not clear how such observation should be treated. Another example is that we exclude observations where foreign country owner is Cyprus or Virgin Islands. These countries are known as tax heavens, and ultimate owners of companies registered there are not known.

We discuss characteristics of the residual firms in the descriptive statistics section.

5. Methodology and Econometric model

In this paper, the main focus is to test whether foreign ownership matters for productivity. We are also interested to examine whether foreign ownership affects productivity through the channels of R&D and innovation. In the first stage of analysis we simply report descriptive statistics and try to see whether foreign and domestic companies have different levels of productivity and innovations. This helps to understand the distribution of data; however, to get the better understanding of the relationship, regression analyses should be performed.

Firstly, the authors perform a few simple OLS regressions, where effects of R&D, innovation and foreign ownership on productivity are tested, with all of the independent variables being exogenous. OLS method is one of the most simplistic and common procedures among academics to test whatsoever effects on productivity, and in our case these are foreign ownership and innovation. The serious limitation of such approach, however, is that R&D most likely has impact on productivity not directly, but via innovation products and processes (Crépon, Duguet & Mairesse, 1998). Additionally, R&D might be endogenous, i.e. it might be affected by other variables, e.g. foreign ownership.

Therefore, next, the authors apply CDM model, which is widely considered to be the most reliable model for finding the relationship between R&D, innovation and productivity.

OLS

In this paper authors apply an extended Cobb-Douglas production function, with R&D (as a proxy for innovation) being one of the input variables, and perform simple OLS regression, which has the following view:

$$Prod_i = \beta_0 + \beta_1 R\&D_i + \beta_2 Foreign50_i + \beta_k Control_{ki} + \varepsilon_i \quad , \qquad (1)$$

where $Prod_i$ stands for labor productivity, expressed as a natural log of sales divided by number of employees; $R\&D_i$ is dummy indicating whether firm performed intramural R&D in 2005 – 2007; *Foreign* is equal to 1 if controlling shareholder comes from abroad and $Control_k$ is a set of control variables which are usually used in production function such as size (natural logarithm of the number of employees), age, amount of capital expressed in terms of natural logarithm of fixed assets, dummy for international competition, industry dummies. We use number of employees as a proxy for both human input and size, and fixed assets as a proxy for capital. The best measurement of human input is the number of worked hours, however, when this information is not available, number of employees can be used (Congressional Budget Office, 2005). Size is an important variable to include, because large

firms can affect productivity due to economies of scale. Dummy for the international competition equals 1 when a firm had more than 50% of its sales in the foreign market. Firms facing international competition may be more productive when they have to meet tough competition abroad. Age is also an important variable; however, its effect on productivity might be ambiguous. On the one hand, older firms might possess more experience or well-tried methods resulting in better productivity. On the other hand, younger firms might better adjust to different condition, quickly change and as a result be more productive.

As it was discussed before, it is not innovation input, but rather innovation output that influences firm's productivity (Crépon, Duguet & Mairesse, 1998). Therefore, we also apply two other regressions, one is where R&D is replaced for dummies indicating whether firm reports product and process innovation, and the other is where latter dummies are simply added to the equation (1) :

$$Prod_i = \beta_0 + \beta_1 Product\_Innov_i + \beta_1 Process\_Innov_i + \beta_2 Foreign50_i + \beta_k Control_{ki} + \varepsilon_i \quad (2)$$

$$Prod_i = \beta_0 + \beta_1 R\&D_i + \beta_1 Product\_Innov_i + \beta_1 Process\_Innov_i \beta_2 + Foreign50_i + \beta_k Control_{ki} + \varepsilon_i \quad (3)$$

The problem with equation (2), however, is that it does not provide any measures for effect of R&D on productivity and innovation. Equation (3) also does not solve the problem as most likely innovations are affected by R&D. Also product and process innovations in both equations are likely to be highly interdependent.

CDM model

In recent years much of the academic work focused on applying CDM model, which was first developed by Crepon, Duguet and Mairesse (1998). In contrast to OLS, it allows to track implicitly the impact of R&D through innovation on productivity. Additionally, this approach helps to deal with selectivity and simultaneity biases, the potential sources of unreliable results in previous empirical research on the subject.

Selectivity bias is likely to exist in studies where econometric analysis is limited only to using the firms which are engaged in R&D or innovation activities (Crépon, Duguet & Mairesse, 1998). Therefore such sample cannot be considered as randomly drawn and thus does not represent the whole population. CDM model solves this problem by introducing a selection equation, which explains how firms decide whether to engage in innovation activities or not (Crépon, Duguet & Mairesse, 1998). Another potential problem of previous studies is simultaneity bias. Innovation literature suggests that links between R&D,

innovation and productivity are more complicated than just to be studied in terms of single equation, and that system of equations should be applied (Pakes & Griliches; 1980). However, when simultaneous equations are performed, it is highly likely that some explanatory variables which are treated as exogenous (especially R&D), might be actually endogenous, that is correlated with an error term. In CDM model, endogeneity of both innovation input and output is taken into account, and appropriate econometric techniques are introduced to resolve the issue of simultaneity (Crepon, Duguet & Mairesse, 1998)

Standard structure of CDM model can be expressed as a three-step model consisting of four equations. Two of them are related to R&D, specifically, equations help to answer the question whether or not firms decide to perform research and development and then what will be the level of investment. To estimate both and correct for potential selectivity bias, Heckman selection technique is employed. Afterwards, equation of knowledge production function, which links R&D to innovation output, is applied. Finally, Cobb-Douglas production function, linking innovation and productivity, is performed. Allowing arbitrary correlations among the error terms in all equations, and with R&D being endogenous in innovation equation, while innovation output being endogenous in productivity equation, CDM model is based on the system of simultaneous equations, e.g. in original version asymptotic least squares (ALS) method was applied (Crepon, Duguet & Mairesse, 1998).

In this study, however, authors do not go in line with original CDM model, but mainly follow slightly modified version of CDM, initially introduced by Griffith, Huergo, Mairesse and Peters (2005) and then replicated in various other works, e.g. Hall, Lotti and Mairesse (2009), Masso and Vahter (2008). The rationale for applying modification is discussed further, and now we describe each step of the model in detail.

Innovation decision

In the first stage, in order to understand, what determines firm's decision to perform innovation activities and to what extent company will invest in them, authors apply Heckman selection model. In contrast to other papers where standard full maximum likelihood or two-stage Heckman selection model is used, we apply Probit model with selection, due to the fact that our dependent variables in both equations are dummies. The reason for choosing dummy variable instead of expenditures on R&D, is that impermissibly small amount of firms in the sample reported these expenditures, thus, using the latter measure would not allow us to draw any reliable implications. Therefore, in outcome equation, we use dummy indicating whether a firm was performing continuous R&D in years 2005-2007 instead of R&D expenditure

variable. We believe dummy for continuous R&D is a reliable alternative to R&D expenditures and allows differentiating between firms which spend much on R&D and those who engage in R&D activities only occasionally. Selection equation has the following form:

$$g_i = \begin{cases} 1 \text{ if } g_i^* = \beta_0^0 + \Sigma_n \beta_n^0 X_{ni}^0 + \varepsilon_{0i} > \hat{c} \\ 0 \text{ if } g_i^* = \beta_0^0 + \Sigma_n \beta_n^0 X_{ni}^0 + \varepsilon_{0i} \leq \hat{c} \end{cases} \quad (4)$$

Selection equation (eq.4) shows what influences companies' decision to innovate. g_i is an observable dummy variable equal to 1 when firms perform innovation activities, and equal to 0 otherwise. g_i^* stands for latent decision variable, measuring propensity to innovate. Firm *i* decides to engage in innovation activities only when g_i^* is larger than some constant threshold $\hat{c}$. X_{ni} is a set of variables explaining innovation decision, ε_{0i} is an error term.

$$k_i = k_i^* = \beta_0^1 + \Sigma_m \beta_m^1 X_{mi}^1 + \varepsilon_{1i} \text{ if } g_i = 1 \quad (5)$$

In outcome equation (eq. 5), k_i^* represents unobserved innovation input, which is equal to actual value of continuous R&D variable k_i when g_i = 1, and equal to 0 otherwise. X_{mi} is a set of explanatory variables, ε_{1i} is an error term.

Knowledge production function

The knowledge equation has the following view:

$$t_i = \beta_0^2 + \beta_k k_i^* + \Sigma_l \beta_l^2 X_{li}^2 + \varepsilon_{2i} \quad (6)$$

In knowledge production function equation, contrary to original CDM, we apply all firms for the analysis. The reason for that is that potentially some of the firms are not reporting innovation effort, even though such effort inside these companies may exist (e.g. workers' discretionary decision to improve processes, they are working on). But below a certain threshold company will not collect and report such data (Griffith, Huergo, Mairesse & Peters, 2005). To account for this problem as well as for selection bias, predicted value of unobserved innovation input (k_i^*), which comes from equation (5) is included into equation (6).

As a measure of innovation output (t_i) we apply two dummies indicating whether firm performed product or process innovations. These variables are argued to be better proxies for

knowledge output for small firms in transition economies than patents that were initially used by Crepon, Mairesse and Duguet. The reason is that patents do not reflect all innovation output, especially in developing economies, where use of patents is very low (Masso & Vahter, 2008). Indeed only 50 out of 906 firms (5.5%) in the sample applied for patents. Both product and process innovations are highly correlated. If we assume that firm characteristics influencing those two variables are the same, bivariate probit econometric technique for knowledge production function is applied. Moreover, afterwards, in order to check the robustness of the results, two separate univariate probit models with the same variables are also introduced.

Productivity equation

In production function equation (7), t_i is endogenous variable, which stands for predicted values of product and process innovations, q_i stands for productivity, X_{ji}^{3} is set of explanatory variables and ε_{3i} is an error term.

$$q_i = \beta_0^{3} + \beta_t t_i + \Sigma_j \beta_j^{3} X_{ji}^{3} + \varepsilon_{3i} \quad (7)$$

Model specifications

Authors implement the described above model to a sample of small firms constituting SIBil database. Specific variables, which are applied in each of the four equations (4)-(7), are chosen in line with previous studies of CDM, where these variables have proven to be important (for example, Griffith, Huergo, Mairesse & Peters, 2005; Masso & Vahter, 2008). Table 9 in Appendix C shows which variables we have chosen to use in different regressions. However, while performing regressions, authors decided to drop some of those variables from the outcome equation, as they do not improve regression, have no influence on the variable of interest and their exclusion does not change coefficients and significance of other variables too. The initial selection and outcome equations are presented in Appendix C, Table 11. Shorter specification is in Appendix C, Table 12 a. One can see that dropping some of the variables (such as competitors or universities as sources of information) from the outcome equation indeed does not change anything.

Also one should note that as we do not limit our study only to innovative firms in knowledge and productivity equations, we can apply only variables which are observed for all firms in these regressions. Various questions in the questionnaire are answered only by

innovative firms, and observations with non-innovative firms have missing values in these questions.

The choice of variables for each equation is presented in Appendix C, Table9. In the selection equation, dependent variable is “innovative firm”, this is dummy variable which equals to 1 if firm is engaged in innovation activities in years 2005-2007, and equal to 0 otherwise. The set of explanatory variables include: size of the company, which is proxied by natural logarithm of number of employees; age, expressed in years from the registration date; share of export sales; formal protection, dummy variable, marking whether firm used copyrights, trademarks or industry design to protect inventions in years 2005-2007; vector of variables, depicting factors which served as obstacles to innovation; vector of industry dummies; and finally, dummy variable of primary interest in this work, indicating whether firm is foreign or domestic owned (specifically, authors consider firm to be foreign owned if foreigner is the controlling shareholder). Larger firms may have bigger probability to involve in innovation activities due to economies of scale, more ways to obtain financing and opportunity to divide fixed costs by a larger amount of sales. The positive relationship between size and innovations is usually named as Schumpeterian hypothesis (Cohen, Levin, Mowery & Peters, 1987). We also use share of export sales as a control variable due to the fact that firms selling abroad may need to be especially innovative in order to compete on the foreign market. The effect of age may again be ambiguous: older firms may have more knowledge and networks that are helpful in innovation, but on the other hand, they might be reluctant to innovate, because they have already well-established clientele and operating processes. Obtained patents and copyrights might have negative effect on innovativeness of a firm because the firms’ products and processes are already protected from competitors and there might be no more need to involve in further innovation. However, those firms that have obtained formal protection once may also innovate more, because they feel more confident that competitors will not follow them and innovation will be beneficial. The detailed definitions of variables and short names from STATA are presented in the Appendix A , Tables 1a- 1f.

In the outcome equation, dependant variable is equal to 1 if firm performs R&D activities in years 2005-2007 on continuous basis. Explanatory variables, excluding size and obstacles to innovation are the same as in the selection equation. Mentioned above variables are excluded, as we find them to affect only the selection equation, and by dropping them it would allow us dealing with issues of identification. Problem of identification happens when the same variables are used in outcome equation as in selection equation and it can cause

imprecise estimates, large standard errors and high multicollinearity in outcome equation (Selection equation, n.d.). However, new variables are also added. These are: vector of dummy variables equal to 1 when information, related to innovation and obtained from different sources, such as enterprise, customers, consultants and government is of high importance; two demand pull dummy variables, showing whether environmental aspects and regulation and standards were important for innovations in years 2005-2007; dummy variables, indicating whether company co-operated with different partners (customers, government etc) on any of its innovation activities in years 2005-2007 and dummy, indicating whether company received state or EU financing for its innovations. Public funding gives additional financing and thus might be favorable for innovations. Different information sources and cooperation partners might also help companies to innovate.

In equation (6), as it was mentioned before, dummies for product and process innovations are used as proxy for innovation output. Specifically, they are equal to 1 if firm introduced new or significantly improved products or processes in years 2005-2007. Explanatory variables include predicted innovation input from equation (5), size, age, formal protection, international competition, industry dummies and foreign ownership.

In productivity equation, log of sales per employee as a proxy for labor productivity serves as independent variable. Explanatory variables include predicted product and process innovations, natural logarithm of physical capital (gross book value of fixed assets) per employee, size, age, international competition, foreign ownership and industry dummies.

6. Descriptive statistics

This section of the paper is meant to acquaint the reader with the data and make preliminary conclusions on the differences between domestic and foreign controlled firms.

Table 2 in Appendix B exhibits the distribution of our final sample. It also shows how innovative are firms with different owner characteristics. We consider firm to be innovative if it engages at least in one of the innovative activities, such as intramural R&D, extramural R&D, acquisition of machinery or equipment, or acquisition knowledge from other enterprises or organizations.

Our sample contains 815 domestically controlled and 91 companies, where foreigners hold the majority stake. It is interesting to notice that proportion of companies engaged in innovation activities is bigger for foreign controlled firms: 80.22% of foreign companies and 66.87% of domestic companies perform R&D, acquisitions of machinery or other innovative

activities. 123 companies in our sample have at least one foreign owner and almost 79% of them are innovative (Appendix B, Table 2).

Next in line with the empirical literature we also divide all companies into four groups: domestic multinationals, domestic uninationals, foreign controlled multinationals and foreign controlled uninationals. Again it should be noted that authors of similar studies assume that all foreign controlled companies are multinationals. However, we cannot make this assumption. Among foreign controlled companies in our sample, 49 answered that they operate only in Latvia and 41 agreed that they belong to a multinational group. Domestic multinationals are very poorly presented. There are only 6 domestic companies that have affiliates abroad and 5 of them state to perform innovative activities. Unfortunately, such a small sample of domestic multinationals will not allow us to make reliable conclusions about importance of domestic multinationals. Speaking about innovativeness of MNE's, the highest proportion of innovative firms can be observed among foreign multinationals, then domestic multinationals follow (Appendix B, Table 2). This goes in line with empirical literature where it is stated that multionationality rather than foreign ownership matters for innovation (Baldwin & Gu, 2005; Doms & Jensen, 1998), but again we should bear in mind that there are only 6 domestic multinationals in the sample. Moreover, multinationals may seem to be more innovative due to big size. Regression analysis will help to control for other characteristics.

In the next step we looked at the country of origin of foreign owner. We combined countries into several groups (Appendix B, Table 7): CIS (24 observations), CEE (26 observations), Western Europe (32 observations), Nordic Europe (27 observations), the USA as a separate group (12 observations), and other countries (2 observations). We find that 85% of Nordic companies and 81% of CEE companies perform innovative activities. A bit smaller portion of other foreign companies are innovative (75% of CIS, 78% of Western European, 75% of US reported some innovative activities). The smallest number of innovative firms is among group of "other" countries (Cuba, Israel), but there are only two companies in this group (Appendix B, Table 3).

Further, we compare foreign and domestic firms according to the means of different variables that are later used in the regressions. Table 4 in Appendix B shows that foreign firms are on average more innovative, they perform continuous R&D more frequently, introduce bigger number of innovative products and processes and are in general more productive. The differences are significant (t-tests are presented in Appendix B, Table 5). This goes in line with our hypotheses. We also find that foreign owned firm have statistically

bigger turnover, are younger, have more employees. There are also more likely to export than domestic firms (Appendix B, Table 5). However, one should remember that this is pure comparison of means which neglects biases and does not account for other factors that affect performance. The real effect of foreign ownership will be seen only after performing regression analysis.

Next we would like to see which sources of information foreign and domestic enterprises considered important for innovation activities. 60% of foreign companies and 46% of domestic find information within enterprise or the group to be highly important for the innovative activities. Customers, suppliers and competitors were also central for the big number of companies, both domestic and foreign. Other sources such as new employees, conferences and exhibitions, scientific journals, professional associations are reported to be of high importance for about of 40% of foreign and domestic enterprises. Rather small number of firms stated that information from family and friends, consultants and R&D institutes, universities or public research institutes contributed to the introduction of innovative activities or success of current activities (Appendix B, Table 4).

It is also interesting to see who are the cooperation partners of the companies in our sample. Both foreign and domestic firms often cooperate with suppliers, customers, competitors and enterprises within the group. The cooperation partners of foreign enterprises are usually located in Latvia or in other European countries. Domestic companies have partners mainly in Latvia (Appendix B, Table 4).

Further, we look at different obstacles that could prevent companies from performing innovative activities. Lack of qualified personnel was frequently named by foreign and domestic firms as an important barrier. Market conditions were often critical as well. For example, about a half of domestic and foreign companies reported that market domination by established enterprises was a reason not to innovate. Cost factors such as lack of funds or high innovation costs were among other significant obstacles impeding innovations and it is interesting to notice that they seem to be more important for domestic rather than foreign enterprises. This goes in line with empirical literature that states that foreign firms have better access to finance sources, because they can obtain finance in several countries (Oulton, 1998). There are also more domestic than foreign companies that lack cooperation partners (Appendix B, Table 4).

Another remarkable fact is that bigger proportion of foreign companies applied for formal protection, i.e. acquired patents, registered a trademark or claimed a copyright, as compared to domestic ones. This matches with the view that patenting is not so common in

developing countries (Masso & Vahter, 2008). What is more, almost 30% of foreign controlled companies and only 8% of domestic companies had the majority of sales abroad (Appendix B, Table 4). As we have already mentioned above, one explanation is that foreign investors choose Latvia only due to its low labor costs, and orient produced products to foreign markets (Vahter, 2004).

Finally, we look at representation of different industries in the sample in order to have better understanding of our dataset (Appendix B, Table 6). Industries are classified according to NACE revision 1. Following industries are the most represented in our sample: the wholesale, retail trade and repair of vehicles (130 companies), manufacture of food, clothing, wood, paper, furniture (110 companies); architecture, engineering and technical testing (87 companies). Other industries are represented by smaller number of enterprises. We also report what fraction of companies in different industries is controlled by a foreign owner. Approximately one fourth of financial, insurance and real estate service companies are foreign. Another industry which seems to attract many foreign investors is manufacturing of electrical and other machinery (17.65% of them are foreign controlled). Other industries are represented by a smaller number of foreign owners. Some sectors of the economy, such as agriculture, fishing, mining, quarrying, manufacture of pharmaceuticals, R&D are represented only by domestic enterprises (Appendix B, Table 6).

Before proceeding to the regression analysis, we also have to look at the correlation matrix in order to make sure that there is no threat of multicollinearity (Appendix B, Table 8). Rather big correlation has been found between dummy for internal sources of information and dummy for innovative firm (0.53), dummy for market sources of information and dummy for innovative firm (0.56), market source of information and process innovation (0.57), internal sources of information and market sources of information (0.6). A rule of thumb is that one should be cautious when correlation is more than 0.75. We do not have such values in our correlation matrix, so the used variables are not multicollinear.

Now when we have an idea of the distribution of companies in the sample we can move further to the regression analysis and testing hypotheses.

7. Results

OLS regressions

At first we perform OLS regressions, corresponding to equations (1) – (3) in methodology part. The results we obtain in these regressions should provide only general idea

about the links, present among Latvian small firms. Only after CDM model is performed, we can argue about reliability of these findings.

In equation (1) impact of foreign ownership, R&D, capital intensity and other variables on productivity is tested (Appendix C, Table 10, regression (1)). As it can be seen from Table 10, foreign ownership had economically large and statistically significant (t-statistics = 4.87) effect on productivity. According to the results, foreign controlled firms are predicted to be 60.5% more productive than domestic ones, other variables being constant. By any standards, this is very impressive figure. Another interesting and relatively surprising finding is that firms, which implemented R&D activities at least in some of the years 2005-2007, seem to have no advantage in terms of productivity, compared to firms with no R&D activities. Speaking about other control variables, findings are pretty much in line with what theory predicts. Larger, more capital intensive and younger firms are all expected to be more productive than others. Increase in fixed assets per employee by 10% would be associated with 2.2% growth in productivity of the firm. The same gain of 2% is also attributed to 10% increase in size of the firm, when latter is measured by the number of employees. These results prove the fact, that productivity is a positive function of capital and that companies tend to experience increasing returns to scale. What concerns different industries, then one can note that companies whose business is wholesale and retail are more productive than those dealing with other services. This can be explained by bigger demand for everyday consumption products that are sold by retail companies. Unexpected sign of the coefficient appears for the companies whose main profile is research and development. The regression results suggest that such companies are less productive than those providing other services. R&D services need many employees, e.g. people with different profiles- engineers, designers, while, the sales of such companies might be modest due to the fact that the culture of innovations in Lativa is underdeveloped (Eurostat, 2010) and thus demand for such services might be small (Appendix C, Table 10).

Adjusted R squared equals to 0.30, which means that approximately 30% of variation can be explained by the variables.

In equation (2) where dummies, indicating whether company has introduced product and/or process innovation are used instead of discrete variable for R&D (Appendix C, Table 10, regression (2)). Authors obtain very similar results to those in equation (1). Size of coefficients, their significance and adjusted R-squared do not change almost at all. As in the case with R&D, coefficients for product and process innovations are both very insignificant and low. Due to their interdependence, we also apply F-statistics to test joint hypothesis that

product and process innovations are equal to zero. F-statistics is equal to 1.44, indicating that hypothesis cannot be rejected. Therefore, even taken together none of the innovation output variables has impact on productivity.

In equation (3), where both R&D and product and process innovations are used, once again coefficients for all the variables are in line with the ones, obtained in (1) and (2). R&D, product and process innovations are all insignificant. F-statistics shows that even jointly these variables have no influence on productivity (Appendix C, Table 10).

Based on OLS regressions, we can expect that foreign ownership significantly matters for productivity. At the same time looks like that latter is not affected by innovation output and R&D in Latvian small enterprises. To determine whether these propositions are really true, we proceed with the application of CDM model.

CDM model

Equations (4) – (7) in methodology part correspond to stages of CDM model.

Innovation decision

For description of the results we have chosen a shorter specification of the model (Appendix C, Tables 12 a –d). As we have already mentioned, firstly, we included very many variables into innovation input equation (we followed Masso and Vahter (2008) as well as Griffith, Huergo, Mairesse and Peters (2005) (Appendix C, Table 11). However, after we have dropped some of the variables that were insignificant, the significance of other variables did not change. Thus, in the next steps (innovation output and labor productivity equations), we used the results obtained in the shorter specifications of selection and outcome equation.

We start the description of the results with selection equation, determining which factors affect firm's decision to engage in innovation activities (Appendix C, Table 12 a, regression 6). Foreign ownership has positive and at 5% significant impact, which indicates that probability of the firm to be innovative increases if owner of the firm comes from abroad. Likely explanation is that foreign owned companies decide to engage in R&D and in other innovation activities in order to be able to adjust their assets to local market conditions (Kuemmerle, 1999; Le Bas, 2007), or as it is likely to be in the case of foreign MNEs, if they find Latvia to be a cheaper place for performing innovation activities on the part of the whole company there (Appendix C, Table 12 a, regression 6).

Though no generalization about the size of the coefficient can be made in probit model, if we take average foreign owned firm in manufacturing industry (NACE C10-18, 31) probability of it to perform innovation activities is 65%. At the same time if such firm will be

domestic owned probability will be only 50%. Thus, in this specific case, foreign owned firm is 15% more likely to make innovation effort, other variables held constant at means. This example make authors suggest that impact of foreign ownership should be quite significant in other cases as well.

Firm size also has positive impact on a firm's decision to innovate (Appendix C, Table 12 a, regression 6). This finding is consistent with Schumpeterian hypothesis that larger firms tend to innovate more. It is argued that such firms have economies of scale for R&D, can obtain financing for innovative projects at more comfortable terms and returns associated with R&D are higher, because fixed costs related to innovation can be spread over larger volume of sales (Cohen, Levin, Mowery & Peters, 1987).

Adverse and significant at 5% effect of age on the dependant variable can be explained by the fact, that mature firms are less flexible to changes and it takes them slower to adopt to new conditions. Therefore, older firms are less likely to decide to make innovation effort, than their younger counterparts.

Speaking about obstacles to innovation, we find logical predictions that probability of the firm to engage in innovative activities decreases: if company lacks finances from sources outside enterprise; it has difficulties in finding cooperation partner; it has no need for innovation either due to previous innovations or due to lack of demand for them. However, surprisingly, we also find positive impact on the decision to engage in innovative activities if innovation costs are too high or company has unqualified personal. Possible explanation why firms finding high innovation costs as an obstacle are still more likely to decide to perform innovation activities, is that benefits, innovation will bring for these firms still offset the costs related to it, even though these costs are high and problematic. Speaking about unqualified personal, firms that find latter as a problem to innovation may decide to innovate because this would allow raising skills of its workers, and in the future make it possible to undertake more serious innovations. There are trainings and other innovative processes that can upgrade the expertise of subordinates.

Industry dummies in this regression were compared with manufacture of pharmaceuticals. We find that firms operating in R&D industry, manufacture of computers, electronics and optical equipment, telecommunications, computer programming have higher probability to make innovation effort as compared to manufacturers of pharma products.

Outcome equation

In regression (7) only firms that come from regression (6) and decide to innovate are analyzed.

Foreign ownership is significant at 5% level in determining whether firm performs R&D on continuous basis. Its effect is positive, and explanation for such impact is similar to the one provided in the selection equation (Appendix C, Table 12a, regression7).

Firms that have formal protection such as copyrights etc also have higher probability to engage in continuous R&D activities. This happens due to the fact that being protected, companies feel more confident in performing R&D, because their innovations most likely will be protected from imitation by the competitors. Thus, benefits from continuous R&D will be higher for such firms, than for those, which do not have any formal protection. Different information sources that supplied information for new innovative activities were also added to the regression. All sources, which include information from within the enterprise, clients, consultants and government, are considered to have positive and significant influence on probability to engage in continuous R&D activities, if management believes that these sources are of high importance for the firms. These findings are in line with previous research, specifically with Masso and Vahter (2008).

Both regulatory requirements and environmental issues seem to have no impact whatsoever on firm's decision to engage in continuous R&D activities. If we consider influence of cooperation partners, only consultants positively influence probability of firm to perform continuous R&D activities. The fact that all other cooperation partners are insignificant is not surprising. For example, Masso and Vahter (2008) find for neighboring Estonia that cooperation partners have no influence on R&D activities (Masso & Vahter, 2008).

What concerns industry dummies, which were compared with manufacturers of pharmaceuticals, we find that R&D services have higher probability to engage in continuous R&D activities.

Knowledge Production Function

To investigate impact of innovation input on innovation output knowledge production function, corresponding to equation (6) in methodology is applied. To control for possible correlation between product and process innovation, bivariate probit model is used. Regression tests hypothesis, that there exists link between company's engagement in continuous R&D activities and what innovative output it then obtains. We see that predicted probability to engage in continuous R&D is extremely significant (z-value is 8.32 for product

innovation and 11.03 for process innovation) for either probability to introduce new or significantly improved products and for probability to introduce process innovations (Appendix C, table 12 b, regressions 8 and 9).

Foreign ownership in both cases is insignificant, meaning that it influences innovation output not directly, but only through R&D and probably other innovation activities. Therefore, foreign owners in Latvia are more likely to do innovations only because the probability of their engagement in R&D and other innovation activities is higher. However, no effect of innovation on foreign ownership aside of it is found (Appendix C, table 12 b, regressions 8 and 9).

As to other similarities between independent variables in their effect on product and process innovations, we see that size is also significant and positively related to innovation output (Appendix C, table 12 b, regressions 8 and 9). This finding once again proves that Schumpeterian hypothesis works in Latvian small firms. International competition in both regressions is not significant.

Speaking about age, results indicate that while it has no impact on product innovation, it negatively influences probability of innovative process output (Appendix C, table 12 b, regressions 8 and 9). Possible explanation is that mature firms do not differ from younger ones in the sense that they still understand the necessity to introduce new or innovative products, if they want to stay in business, because customers all the time change their preferences. However, in terms of process innovations, mature firms are more reluctant to change ongoing processes inside the firm and prefer to leave things as they are, being less flexible in that sense.

Another interesting finding is that formal protection also being insignificant for product innovation, has strong negative impact on process innovation (Appendix C, table 12 b, regressions 8 and 9). It is not the result, which is usually obtained in other works and which would be expected, so we can only speculate about it. Potentially, it might happen due to the fact that those firms which were able to obtain protection for their production and services, on average did not see need to improve their processes and therefore their probability to introduce process innovation was lower compared to other firms.

What concerns different sectors of the economy, we find that manufacture of food, clothes, furniture, computers, electronics; construction firms; computer programming and related services; financial, insurance and real estate firms are more engaged in product innovations as compared to the industry classified as “other services and activities”.

Additionally as a robustness check we perform two univariate probit regressions, where effects on each of the dependent variables of knowledge production function are tested separately. As it can be seen from Appendix C, Table 12c, results are almost completely the same as in bivariate probit, only coefficients and z-values slightly change, while significance of all variables remains constant. Thus, these regressions add support to our main findings.

Productivity equation

After obtaining values for predicted product and process innovations, we test their effect on productivity (Appendix C, Table 12 d, regression 12). Results indicate that neither product nor process innovations had any impact on labor productivity. It means that in Latvian small companies innovation does not lead these firms to becoming more productive. F-statistics also provides p-value equal to 0.84; therefore even jointly innovations do not impact productivity. Such finding is quite unexpected, and authors can only hypothesize why no link between innovation and productivity in Latvian small enterprises exists. One explanation why new products and processes did not increase sales per employee is that such products simply replaced other existing products, whose business cycle was coming to an end and to produce such goods company had to introduce new processes within the firm. Alternatively new products may have only increased variety of products offered, but it did not have any effect on sales per employee (Masso & Vahter, 2008). Anyway, evidence suggests that firms are motivated to introduce innovative products and processes due to reasons other than productivity.

Actually, due to insignificance of innovation effects on productivity, results obtained in productivity equation of CDM model are very similar to those in OLS regressions. Being foreign owner is associated with 62% increase in productivity (Appendix C, Table 12 d, regression 12). Such significant impact indicates that foreign owners bring different unobservable advantages other than innovation to Latvian firms. Main reason is that Latvia is still rather undeveloped and foreigners might bring different practices in management, corporate governance etc. which can raise productivity, and which are not practiced by domestically owned companies. Later in this paper we also show results of the same regression, but dividing foreigners into groups according to their geographical origin. That would allow providing more specific explanations to why foreign ownership matters.

Analyzing other variables, all results are in line with what economic theory predicts. 1% growth in capital per employee would increase productivity by 0.22%. This finding is logical as higher availability of capital would allow other things equal to produce more

output. Positive influence of size denotes that larger firms experience increasing returns to sale. 1% increase in size would raise productivity by 0.2% (Appendix C, Table 12 d, regression 12).

Age is negatively related to sales per employee, and the rationale for that is the same as was discussed before – mature firms are less flexible to adjust to market conditions and their methods of conducting business might be outdated. Therefore older firms are less productive than their younger counterparts.

What concerns industry dummies, we find that wholesale and retail trade are more productive than industry, which is classified in our dataset as "other services and activities". Research and development firms are, however, less productive, and this can again be explained by low demand for the R&D services and big number of sophisticated labor force that is needed for such a firm.

The discussion above indicates that "hypothesis 1" is correct, foreign ownership indeed matters for productivity for Latvian SMEs. However, we reject "hypothesis 2", foreign ownership influences productivity through channels other than R&D and innovations. Among these channels can be good networks of foreign owners, which help to facilitate operations. Foreign owners may also bring better strategic solutions and management know-how (Aitken & Harrison, 1999; OECD, 2002). Moreover, foreign owned companies may have wider access to financing (Oulton, 1998). Another explanation for the absence of the relationship between innovation and productivity is the time lag. It might be that higher probability to innovate will result in better productivity later. And though now foreign owners bring higher productivity through other channels, after some time their superior innovativeness might also cause enhancement of productivity. However, due to the fact that we do not have panel data, we cannot check that. Now we will investigate foreign owners and their impact in more detail.

In the output equation of CDM model and in productivity OLS regressions foreign owners were analyzed from the perspective that they are controlling shareholders in the company. Thus, such owners have voting power to make decisions, which are completely in line with their interests and are not affected by domestic shareholders. Now we would like to transform regression (12) and look what effect on productivity would be in the case when foreign owners are minorities. Regression (13) in Table 12d, Appendix C shows, that in contrast to controlling foreign shareholders, foreign minorities do not lead their firms to higher productivity compared to purely domestic enterprises. Therefore, minorities do not have enough power and influence on decisions within the firm, so that it would be possible to

increase productivity. Coefficients of other controlling variables almost do not change and significance levels remain the same.

Next, we proceed with our analysis by dividing foreign shareholders according to the country of their origin (Appendix C, Table 12d, regression (14). These countries are further grouped according to their geographical location. Countries are grouped in six regions: Commonwealth of Independent States (CIS), Nordic Europe, Western Europe, Central and Eastern Europe (CEE), USA and other. The results we obtain are quite predictable and in line with our hypothesis.

USA and CEE based owners have the largest impact on productivity. Firms, owned by these countries' representatives are 82% and 83% respectively more productive than domestic ones (Appendix C, Table 12d, regression (14)). USA is one of the most advanced countries in the world, and as it was already mentioned in literature review, owners from this country tend to bring various advantages both technological and non-technological to firms in various parts of the world. Latvia in this sense is not an exception. Speaking about CEE (basically, about other Baltic states), these countries have similar economic background as Latvia, thus owners coming from there should have an advantage compared to other foreign owners in terms of understanding business specifics and market conditions in Latvia. It is likely that owner from CEE, having implemented successful (highly productive and profitable) business concept in their home country see Latvia as an opportunity for expansion, on conditions that such concept in latter country still does not exist or competition is weak. Thus after entering Latvian market, these CEE owned companies tend to be much more productive than domestic counterparts.

Influence of Western European and Nordic European countries on productivity is not as high as in the previous case but is still substantial (Appendix C, Table 12d, regression (14)). Western European companies are predicted to be 45% more productive and Nordic European companies 47% more productive than domestic small enterprises. Coefficient for Western European owners is significant at 1% and for Nordic European owners it is significant at 10%. Positive effect of both regions as in case with USA can be explained by massive differences in terms of development of these countries compared to Latvia. Therefore, owners of latter countries bring many advantages, which positively influence productivity and do not exist in domestic companies, about how to organize business.

However, results indicate that companies owned by CIS region representatives have no advantage in terms of productivity when compared to domestic ones (Appendix C, Table 12d, regression (14)). This finding is not surprising taking into account that both Russia and

Belorussia are less advanced in terms of GDP per capita and GDP per person employed (Conference Board Total Economy Database, 2010) Therefore, owners from these countries do not possess any technological or other advantages, which would be able to yield higher productivity of their firms compared to domestic owned enterprises. Nevertheless, such owners can still bring some management know-how, methods different from those applied in Latvian owned enterprises, better strategies or they may have better opportunities to get financing, and that explains why such owners do not have negative impact on productivity. Based on the regression results we accept "hypothesis 3" and corresponding sub hypotheses, which were declared in the preceding sections of the paper.

Another relationship we are interested in is whether multinationality matters for productivity. According to the theory of multinational enterprises, firms decide to extend their operations to a foreign market if they have some superior assets that would allow them to succeed abroad and overcome the costs of entering new market (Dunning, 1974; Dunning, 1993; Caves; 1996). Thus, foreign multinationals may show higher productivity than foreign uninational companies. And indeed, our regression results indicate such relationship to be true. As it can be seen from regression (15) (Appendix C, Table 12d) while foreign uninationals are only 39% more productive than domestic owned companies, for MNEs this number is substantially higher and equal to 91%. Thus, MNEs are also 52% more productive than foreign uninationals. Consequently, we can conclude that foreign MNEs in Latvia possess substantial advantages compared to both domestic owned and foreign uninational owned small companies. The finding is also in line with our "hypothesis 4".

The regressions have adjusted R-squared of around 0.30, which is very similar to R-squared in other studies using CDM model (Masso & Vahter, 2008; Griffith, Huergo, Mairesse & Peters, 2006)

Study limitations

In this section authors would like to outline limitations and potential biases of the study. First issue which should be addressed is causality. It may be so, that foreign owned firms are more productive not because their owners bring various benefits and advantages, but due to the fact that they initially choose more productive firms as their acquisition target. Unfortunately, our data is cross-sectional and there is no way we can test whether past productivity affected foreign owners' decision to acquire the firm. However, we believe that reverse causality does not exist. When we test influence of different regions on productivity, we see that CIS region has no impact on the latter. Such result is in line with economic theory

and with what common sense suggests us, taking into account history of the region. At the same time hardly we can explain such results by the fact that owners from these countries are worse in analyzing which firms are more productive at the time of acquisition. The same can be also said when comparing MNEs and uninationals. Foreign multinationals should not be better at identifying more productive companies as compared to foreign uninationals, which concentrate only on Latvia. The problem of reverse causality could be solved if the data would be panel and we would have information on the changes in ownership. Then we could find, for example, whether a firm, which became foreign, improved its productivity or became more innovative. Another idea is to use instrumental variables. In the first stage one could regress productivity on innovation and other control variables and in the second stage regress innovation on instrumental variables. However, there can be other endogenous variables apart from innovation, and thus the method is also not perfect. Another possible solution is to use Heckman-type two-step procedure, where probability to become foreign could be regressed on productivity in the first stage, and in the second stage when the inverse Mill's ratio is included, productivity is regressed on it and other control variables. This method was used by Vahter (2004) in his paper about foreign ownership and productivity in Estonia. However, due to the fact that we use multi-step CDM model and also apply Heckman selection, adding additional stages would make the model too complicated.

Another problem is that Omitted Variable Bias might exist. We have chosen the set of variables for our regressions in line with studies of Masso and Vahter (2008) and Griffith, Huergo, Mairesse and Peters (2005). However, we are also aware that due to data limitations we did not manage to include some of the variables that were significant in other papers on productivity. Among these variables are: human capital measured by proportion of highly educated employees (Lööf, Ebersberger & Oksanen, 2006) or engineers as a proportion of employees (Crepon, Duguet & Mairesse, 1998 ; Lööf & Heshimati, 2002), materials per employee (Vahter, 2004), investment per employee (Lööf, Ebersberger & Oksanen, 2005; Hall, Lotti & Mairesse, 2009). Nevertheless, mentioned above variables are unlikely to be significantly correlated with the variables we use and especially with foreign ownership. The fact that many studies also did not use these variables supports our opinion.

8. Conclusion

The aim of this study was to investigate the relationship between foreign ownership and productivity in small Latvian companies. Authors suggested that this link might not be

direct, but go through the channel of innovation. For that reason, CDM model, which is widely considered to be the most efficient in investigating impact of innovation on productivity, was applied. Moreover, it is unlikely, that all foreign owners influence Latvian small companies in the same manner. Differences might exist between controlling and non-controlling owners, owners coming from different geographical regions and whether domestic company is owner's affiliate or not.

Findings indicate that indeed companies that are foreign controlled are more productive than their domestic counterparts. Furthermore, this difference is substantially large and equal to 60% for average foreign owned firm. Based on that, authors conclude that FDI to Latvia is highly beneficial, and being still one of the least developed countries in EU, Latvia definitely should attempt to attract more foreign investment, as it is one of the factors to improve productivity.

Speaking about innovation, authors find that foreign ownership positively influences probability to engage in R&D activities, and by that foreign owned firms are likely to be more innovative. This finding should be considered as another benefit, which foreign owners bring to the Latvian environment. Nevertheless, evidence shows that such benefit is not relevant for production output of the firms as there is no link between innovation and productivity exists.

Finally, hypothesizing, that foreign owners cannot be treated unilaterally, authors find that if former are minority shareholders, their power within the company is not enough to influence productivity in a positive way. Another result is that there are differences in effect on productivity of owners coming from various regions. USA and CEE owners have highest influence on production output; they are followed by Western and Nordic European shareholders, whose impact is also positive and significant. At the same time owners coming from the CIS do not possess any advantage compared to domestic companies. In the end, authors also find that affiliates of foreign MNEs are as twice productive as foreign uninationals and 90% more than domestic owned firms.

All these findings indicate that FDI coming into Latvia positively affects productivity, at least in the case of small firms. With productivity growth being the major driver for economic growth, efforts should be made to attract FDI and increase foreign investment into the country. Especially, such efforts should be directed towards foreign multinational companies, which come primarily from USA, CEE or at least from Western or Nordic Europe. With more foreign owners being represented in Latvian economy, country has high chance to prosper in the future.

Practical suggestions

Our study can be used by the Ministry of Foreign Affairs of the Republic of Latvia for the formulation of Latvia's foreign policies. As there is evidence of positive influence of foreign ownership on productivity, then even bigger emphasis could be put on the promotion of Latvia as an attractive investment target. Latvia can be interesting for investors due to the fact that firstly, it is an EU country. This automatically generates some confidence and a good image. Secondly, it has quite educated labor force. Thirdly, Latvia has a very good location – it is a neighbor of Russia, it is close to Nordic and Western Europe.

Maybe some bonuses could be offered to foreign investors in terms of aid or special tax treatment. Though we found that companies owned by investors originating from CIS countries do not bring benefits in terms of productivity, it is not worth to discriminate between different investors. However, funds related to promotion of Latvia should be mostly targeted at potential investors from the USA, CEE countries, Nordic and Western Europe. The Investment and Development Agency of Latvia could put special effort in attraction of foreign multinationals to Latvia, as their effect on productivity is higher as compared to firms owned by foreigners but operating only in Latvia.

We also have found that foreign owned companies are more innovative than Latvian companies. This suggests that the Latvian government could find additional ways to encourage innovativeness of Latvian entrepreneurs.

Though we have spotted positive effect of FDI on innovations and productivity, one should remember that foreign ownership can have negative impact on other aspects of the economy. For example, foreign companies can drive local companies out of the competition and be a great obstacle to local entrepreneurs. Moreover, foreign owners often drive wages up, which is stressful for local competitors, whose productivity is lagging. This can all lead to "dual economy" – prospering foreign companies and unsuccessful local firms (Dudáš, n.d.).

Suggestions for further research

As currently we have only cross-sectional data for year 2007, when the second round of the SIBiL survey is held, one could make a deeper analysis and compare relationships between ownership, innovation and productivity in different years. This would allow making stronger and more detailed inferences about these relationships in Latvia.

It can also be possible to add variables and test horizontal productivity spillovers of FDI to domestic companies. A few cross-industry analyses have been performed for Latvia on this topic, and a cross-firm study could contribute to the existing literature.

Different owner characteristics can be added to test whether human capital of owners has any effect on productivity.

Another idea is to make cross-country comparison between Latvia, Lithuania and Estonia to see whether foreign ownership has different impact on productivity in these countries.

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Appendices

Appendix A – Presentation of variables

Table 1 a

Definitions of dependent variables

Variable	STATA	Dummy/ continuous	Definition
Dependent variables			
Productivity	productivity	continuous	equals natural logarithm of sales over number of employees
Product innovation	product_innov	dummy	equals 1 if a company introduced new or significantly improved goods or services in 2005 -2007, equals 0 otherwise
Process innovation	process_innov	dummy	equals 1 if a company introduced new or significantly improved methods of producing goods or services; or new or significantly improved logistics, delivery, or distribution methods for inputs, goods or services; or new or significantly improved supporting activities for processes, such as maintenance systems or operations for purchasing, accounting or computing in 2005 -2007, equals 0 otherwise
The probability of the firm to perform R&D on a continuous basis	continuous_RD	dummy	equals 1 if a company performs intramural R&D on continuous basis; equals 0 otherwise
The probability of the firm to be innovative	innov_firm	dummy	equals 1 if during 2005-2007 the company engaged in intramural R&D; performed it occasionally or continuously; or engaged in extramural R&D; or engaged in acquisition of machinery, equipment and software to produce new or significantly improved products and processes; or acquired external knowledge such as purchasing or licensing of patents and non-patented inventions, know-how and other types of knowledge from other enterprises and organizations; equals 0 otherwise

Note: Complied by the authors with reference to SIBiL questionnaire.

Table 1 b

Definitions of foreign ownership variables

Variable	STATA	Dummy/ continuous	Definition
Foreign ownership variables			
Foreign controlled company	frgn50	dummy	equals 1 if foreign owners has share of more than 50%, equals 0 otherwise
At least one foreign owner	frgn	dummy	equals 1 if there is at least one foreign owner in the company; equals 0 if there are no foreign owners
Foreign owner is minority	frgn_minor	dummy	equals 1 if foreign owners constitute minority in the company; equals 0 otherwise
CIS	CIS	dummy	equals 1 if foreign owner comes from CIS country; equals 0 otherwise
Western Europe	West_EU	dummy	equals 1 if foreign owner comes from Western Europe; equals 0 otherwise
Nordic Europe	Nordic_EU	dummy	equals 1 if foreign owner comes from Nordic Europe; equals 0 otherwise
CEE	CEE	dummy	equals 1 if foreign owner comes from CEE country; equals 0 otherwise
USA	USA	dummy	equals 1 if foreign owner comes from the USA; equals 0 otherwise
other region	other	dummy	equals 1 if foreign owner comes from a country not belonging to the groups: CEE, CIS, Western Europe, Nordic Europe and not belonging to the USA; equals 0 otherwise
Interaction term between frgn50 and MNE	frgn50_MNE	dummy	equals to the product of dummies frgn50 and MNE

Note: Complied by the authors with reference to SIBiL questionnaire.

Table 1c

Definitions of variables of obstacles

Variable	STATA	Dummy/ continuous	Definition
Factors hampering innovation			
Lack of funds	lack_funds	dummy	equals 1 if owner considers lack of funds within enterprise or a group to be a factor of high or medium importance in hampering innovation activities or projects or influencing the decision not to innovate in 2005-2007; equals 0 otherwise
Lack of finance	lack_finance	dummy	equals 1 if owner considers lack of finance from sources outside the enterprise to be a factor of high or medium importance in hampering innovation activities or projects or influencing the decision not to innovate in 2005-2007; equals 0 otherwise
Too high innovation costs	lack_cost	dummy	equals 1 if owner considers too high innovation costs to be a factor of high or medium importance in hampering innovation activities or projects or influencing the decision not to innovate in 2005-2007; equals 0 otherwise
Cost factors	*cost_obst*	*dummy*	*equals 1 if at least one of the three above variables is equal to 1; equals 0 otherwise*
Lack of qualified personnel	unqual_pers	dummy	equals 1 if owner considers lack of qualified personnel to be a factor of high or medium importance in hampering innovation activities or projects or influencing the decision not to innovate in 2005-2007; equals 0 otherwise
Lack of information on technology	lack_info	dummy	equals 1 if owner considers lack of information on technology to be a factor of high or medium importance in hampering innovation activities or projects or influencing the decision not to innovate in 2005-2007; equals 0 otherwise
Lack of information on markets	lack_infomarket	dummy	equals 1 if owner considers lack of information on markets to be a factor of high or medium importance in hampering innovation activities or projects or influencing the decision not to innovate in 2005-2007; equals 0 otherwise
Difficulty in finding cooperation partners for innovation	dif_coop	dummy	equals 1 if owner considers difficulty in finding cooperation partners to be a factor of high or medium importance in hampering innovation activities or projects or influencing the decision not to innovate in 2005-2007; equals 0 otherwise
Knowledge factors	*knowl_obst*	*dummy*	*equals 1 if at least one of the above four variables is equal to 1; equals 0 otherwise*

Table 1 c (continued)

Variable	STATA	Dummy/ continuous	Definition
Market dominated by established enterprises	mark_dom	dummy	equals 1 if owner considers market dominated by established enterprises to be a factor of high or medium importance in hampering innovation activities or projects or influencing the decision not to innovate in 2005-2007; equals 0 otherwise
Uncertain demand for innovation goods or services	unc_dem	dummy	equals 1 if owner considers uncertain demand for innovation goods or services to be a factor of high or medium importance in hampering innovation activities or projects or influencing the decision not to innovate in 2005-2007; equals 0 otherwise
Market factors	*market_obst*	*dummy*	*equals 1 if at least one of the above two variables is equal to 1; equals 0 otherwise*
No need due to prior innovations	prior_innov	dummy	equals 1 if owner considers no need due to prior innovations to be a factor of high or medium importance in hampering innovation activities or projects or influencing the decision not to innovate in 2005-2007; equals 0 otherwise
No need because of no demand for innovations	no_need	dummy	equals 1 if owner considers no need due to no demand for innovations to be a factor of high or medium importance in hampering innovation activities or projects or influencing the decision not to innovate in 2005-2007; equals 0 otherwise
Reasons not to innovate	*Reasons_notinnov*	*dummy*	*equals 1 if at least one of the above two variables is equal to 1; equals 0 otherwise*

Note: Complied by the authors with reference to SIBiL questionnaire.

Table 1d

Definitions of variables of sources of information

Variable	STATA	Dummy/ continuous	Definition
Sources of information			
Family as a source of innovations	info_family	dummy	equals 1 if owner considers family as an important information source to the innovation activities of the enterprise in 2005 - 2007; equals 0 otherwise
Information source within enterprise or enterprise group	info_enteprise	dummy	equals 1 if owner considers information source within enterprise or enterprise group to be of high importance to the innovation activities of the enterprise in 2005 - 2007; equals 0 otherwise
Internal sources	*Int_sources*	*dummy*	*equals one if at least one of the above two variables is equal to 1, equals 0 otherwise*
Client or customer as an innovation source	info_client	dummy	equals 1 if owner considers client or customer to be an information source of high importance to the innovation activities of the enterprise in 2005 - 2007; equals 0 otherwise
Supplier as source of information	info_supplier	dummy	equals 1 if owner considers supplier to be an information source of high importance to the innovation activities of the enterprise in 2005 - 2007; equals 0 otherwise
Competitor as a source of information	info_competitor	dummy	equals 1 if owner considers competitor to be an information source of high importance to the innovation activities of the enterprise in 2005 - 2007; equals 0 otherwise
Consultant, commercial lab or private R&D industry as a source of information	info_consutltant	dummy	equals 1 if owner considers consultants, commercial labs or private R&D institutes to be an information source of high importance to the innovation activities of the enterprise in 2005 - 2007; equals 0 otherwise
Market sources	*market_source*	*dummy*	*equals one if at least one of the above four variables is equal to 1, equals 0 otherwise*
Government as a source of information	info_gov	dummy	equals 1 if owner considers government to be an information source of high importance to the innovation activities of the enterprise in 2005 - 2007; equals 0 otherwise
University as a source of information	info_univ	dummy	equals 1 if owner considers university to be an information source of high importance to the innovation activities of the enterprise in 2005 - 2007; equals 0 otherwise
Institutional sources	*institut_source*	*dummy*	*equals one if at least one of the above two variables is equal to 1, equals 0 otherwise*

Note: Complied by the authors with reference to SIBiL questionnaire.

Table 1e

Definitions of cooperation variables

Variable	STATA	Dummy/ continuous	Definition
Cooperation partners			
Cooperation with other enterprises within group	coop_enterprise	dummy	equals 1 if a company cooperated with other enterprises within group on any innovation activities during 2005 - 2007; equals 0 otherwise
Cooperation with suppliers	coop_supplier	dummy	equals 1 if a company cooperated with suppliers on any innovation activities during 2005 - 2007; equals 0 otherwise
Cooperation with clients or customers	coop_client	dummy	equals 1 if a company cooperated with clients or customers on any innovation activities during 2005 - 2007; equals 0 otherwise
Cooperation with competitors	coop_competitor	dummy	equals 1 if a company cooperated with competitors on any innovation activities during 2005 - 2007; equals 0 otherwise
Cooperation with consultants	coop_consultant	dummy	equals 1 if a company cooperated with consultants, commercial labs or private R&D institutes during 2005 - 2007; equals 0 otherwise
Cooperation with government	coop_gov	dummy	equals 1 if a company cooperated with government or public research institutes any innovation activities during 2005 - 2007; equals 0 otherwise

Note: Complied by the authors with reference to SIBiL questionnaire.

Table 1f

Definitions of other variables

Variable	STATA	Dummy/ continuous	Definition
Other variables			
R&D	RD	dummy	equals 1 if a company engaged in intramural R&D in 2005 -2007, equals 0 otherwise
Predicted innovation input	predicted_innovation_input	continuous	predicted from step 2 (innovation input equation) in multiple production function
Predicted product innovation	predicted_product	continuous	predicted from step 3 (innovation output equation) in multiple production function
Predicted process innovation	predicted_process	continuous	predicted from step 3 (innovation output equation) in multiple production function
Capital	fixed_assets	continuous	equals the natural logarithm of fixed assets over the number of employees
Public funding	public_funding	dummy	equals 1 if a company obtained external financing that was used to significant extent to support the development of product/service innovations from state programs, EU programs or partnerships; equals 0 otherwise
International competition	inter_competition	dummy	equals 1 if more than 50% of sales during the last three years were in the foreign market, equals 0 otherwise
Age	age	continuous	equals the number of years of operation since the year of registration
Formal protection	formal_protection	dummy	equals 1 if during 2005-2007 registered an industrial design; or registered a trademark; or claimed a copyright; equals 0 otherwise
Regulations	regulatory	dummy	equals 1 if owner considers the meeting of regulatory requirements to be an important effect of products or processes introduced in 2005 - 2007; equals 0 otherwise
Environment	environment	dummy	equals 1 if owner considers reduced environmental impacts or improved health safety to be an important effect of products or processes introduced in 2005 - 2007; equals 0 otherwise
Size, labor input	ln_empl	continuous	equals natural logarithm of the number of employees
Export intensity	sales_exp	continuous	exports as a share of total sales in 2007
Industry dummies	naceid1 - naceid21	dummy	equals 1 if a company belongs to this industry, equals 0 otherwise

Note: Complied by the authors with reference to SIBiL questionnaire.

Appendix B – Descriptive Statistics

Table 2

Sample Distribution

	Observations	Innovative Firm	Percent of innovative firms
Domestically controlled	815	545	66,87%
Foreign controlled	91	73	80,22%
No foreign owner	783	521	66,54%
At least one foreign owner	123	97	78,86%
Domestic multinationals	6	5	83,33%
Domestic uninationals	804	536	66,67%
Foreign multinationals	41	36	87,80%
Foreign uninationals	49	36	73,47%

Note: STATA output

Table 3

Origin of foreign owner

	Observations	Innovative Firm	Percent of innovative
CIS	24	18	75,00%
Western Europe	32	25	78,13%
Nordic Europe	27	23	85,19%
USA	12	9	75,00%
CEE	26	21	80,77%
Other	2	1	50,00%

Note: STATA output

Table 4

Mean comparison between foreign controlled and domestic companies (the whole sample)

	Foreign	Domestic
Innovative Firm (dummy)	0.8022	0.6687
Continuous R&D (dummy)	0.3956	0.281
Product innovations(dummy)	0.7033	0.5178
Process innovations(dummy)	0.7253	0.6344
Productivity (ln)	10.526	9.5697
Fixed assets	460763.6	125401
Sales	1037586	385611.3
Age	7.362637	9.645399
Employees	17.92308	12.53129
Exports (Dummy)	0.5055	0.2785
Source of information (dummies)		
Internal		
Family or friends	0.0879	0.1067
Within your enterprise or group	0.6044	0.4589
Market source		
Suppliers of equipment, components	0.3846	0.3227
Customers	0.4066	0.384
Competitors	0.2857	0.2233
Consultants, R&D institutes	0.0659	0.0601
Institutional Sources	0.011	0.0466
Other Sources	0.4066	0.3853
Cooperation (dummy)	0.4615	0.3607
Type of cooperation partner (dummies)		
Enterprises within group	0.3077	0.1693
Suppliers of equipment, components	0.3626	0.292
Customers	0.3077	0.2552
Competitors	0.3187	0.2307
Consultants, R&D institutes	0.1209	0.1288
Universities	0.0659	0.0933
Government or public research institutes	0.011	0.0528
Cooperation in Latvia	0.4066	0.3472
Cooperation in Europe	0.1868	0.0663
Cooperation in USA	0.022	0.0098
Cooperation in other countries	0	0.0258

Note: STATA output

Table 4 (continued)

Mean comparison between foreign controlled and domestic companies (the whole sample)

	Foreign	Domestic
Obstacles to innovations (dummies)		
Cost factors		
Lack of funds	0.4066	0.5644
Lack of finance	0.2308	0.4319
High innovation costs	0.5385	0.6307
Knowledge factors		
Lack of qualified personnel	0.5824	0.5215
Lack of information on technology	0.0879	0.1546
Lack of information on markets	0.1758	0.1951
Lack of cooperation partners	0.2308	0.3018
Market factors		
Market dominated by established enterprises	0.5055	0.4994
Uncertain demand for innovative goods/services	0.3077	0.2773
Reasons not to innovate		
No need due to prior innovations	0.1868	0.1276
No demand for innovations	0.2527	0.1804
Environment (dummy)	0.4066	0.3914
Regulations (dummy)	0.5714	0.5006
Formal protection (dummy)	0.1758	0.1129
International competition (dummy)	0.2857	0.0822
Public financing (dummy)	0.1209	0.0429

Note: STATA output

Table 5

T-tests

	Innovative firm		Continuous R&D (dummy)		Product Innovation		Process Innovation		Productivity	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Domestically controlled	0.6687	0.0165	0.281	0.0158	0.5178	0.0175	0.6344	0.0169	9.57	0.0392
Foreign controlled	0.8022	0.042	0.3956	0.0515	0.7033	0.0482	0.7253	0.0471	10.5266	0.1151
	t-statistics		t-statistics		t-statistics		t-statistics		t-statistics	
Domestic-Foreign	-2.9589***		-2.1267**		-3.6205***		-1.8188*		-7.8684***	

	Fixed assets		Sales		Age		Employees		Export (dummy)	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Domestically controlled	125401	13249.14	385611.3	31317.89	9.6454	0.15038	12.5313	0.4531	0.2785	0.0157
Foreign controlled	460763.6	261637.1	1037586	158124.7	7.362637	0.3986	17.9231	1.7113	0.5055	0.0527
	t-statistics		t-statistics		t-statistics		t-statistics		t-statistics	
Domestic-Foreign	-1.2801		-4.0446***		5.3587***		-3.0458***		-4.1271***	

Note: STATA output. *, **, *** denote significance at the 10, 5, 1 percent level, respectively.

Table 6

Distribution of companies according to industries

NACE	Description of the industry	Total number of companies	Number of foreign controlled companies	% of foreign controlled companies
A&B	Agriculture, forestry, fishing, mining, quarrying	22	0	0,00%
C 10 -18, 31	Manufacture of food, clothing, wood, paper, furniture etc	110	6	5,45%
C 19, 20, 22-25	Manufacture of fuels, chemicals, plastics, metals etc	49	6	12,24%
C21	Manufacture of pharmaceuticals	4	0	0,00%
C26	Manufacture of computers, electronics and optical equipment	15	2	13,33%
C27 - C28	Manufacture of electrical and other machinery	17	3	17,65%
C29 - C30	Manufacture of vehicles	12	2	16,67%
C32	Manufacture not elsewhere classified	30	4	13,33%
C33	Repair, maintenance, installation of machinery	56	2	3,57%
D&E	Electricity, gas, air and water supply	48	2	4,17%
F	Construction	27	1	3,70%
G	Wholesale and retail trade; repair of motor vehicles	130	21	16,15%
H	Transportation and storage	47	5	10,64%
J58 - 60, 63	Information services, publishing, TV, radio etc	20	2	10,00%
J61	Telecommunication	57	7	12,28%
J62	Computer programming and related services	56	5	8,93%
K&L	Financial, insurance, real estate services	45	12	26,67%
M69, 70, 73-75	Professional, scientific and technical activities	21	2	9,52%
M71	Architecture, engineering, technical testing	87	6	6,90%
M72	R&D	18	0	0,00%
I, N, O, P, Q, R, S, T, U	Other services and activities	35	3	8,57%

Note: STATA output

Table 7

Country of foreign owner

	Observations	Innovative firms	Percentage of innovative firms
USA	12	9	75,00%
CIS			
Belorussia	1	1	100,00%
Russia	23	17	73,91%
Western Europe			
Italy	5	4	80,00%
Great Britain	6	5	83,33%
France	1	0	0,00%
Germany	14	11	78,57%
Switzerland	2	2	100,00%
Belgium	0	0	0
The Netherlands	4	3	75,00%
Nordic Europe			
Island	1	1	100,00%
Denmark	4	4	100,00%
Sweden	10	8	80,00%
Finland	8	8	100,00%
Norway	4	2	50,00%
CEE			
Estonia	12	12	100,00%
Lithuania	11	6	54,55%
Poland	2	2	100,00%
Bulgaria	1	1	100,00%
Other			
Israel	1	1	100,00%
Cuba	1	0	0,00%

Note: STATA output

Table 8

Correlation matrix

	Productivity	Innov_firm	Contin_RD	Prod_innov	Proc_innov	Size	Age	Fix_assets	frgn50	Public_fund	Int_compet
Productivity	1.0000										
Innov_firm	0.1267	1.0000									
Contin_RD	0.0530	0.4389	1.0000								
Prod_innov	0.1203	0.5252	0.3690	1.0000							
Proc_Iinnov	0.0871	0.7340	0.3975	0.3986	1.0000						
Size	0.2454	0.1069	0.0353	0.1112	0.0843	1.0000					
Age	-0.1251	-0.0834	-0.0391	-0.0516	-0.0770	0.1216	1.0000				
Fix_assets	0.3715	0.0523	0.0221	0.0462	0.0244	0.1970	-0.0298	1.0000			
frgn50	0.2496	0.0862	0.0757	0.1118	0.0571	0.1244	-0.1597	0.0463	1.0000		
Public_fund	0.0076	0.1255	0.1387	0.1243	0.1512	0.0871	-0.0622	0.0454	0.1067	1.0000	
Intern_compet	0.0939	0.0122	0.0304	0.0519	0.0012	0.0742	-0.0243	0.0170	0.2016	0.1206	1.0000
Cooperation	0.1167	0.4505	0.3703	0.3563	0.4284	0.0123	-0.1057	0.0499	0.0627	0.1347	0.0340
Cost_obst	-0.1437	0.0718	-0.0248	0.0465	0.0943	-0.0112	-0.0376	-0.0476	-0.0897	0.0141	-0.0927
Knowl_obst	-0.0217	0.0765	-0.0574	0.0644	0.0488	0.0562	-0.0516	-0.0233	0.0216	0.0995	0.0121
Market_obst	0.0043	0.0648	-0.0001	-0.0014	0.0746	-0.0186	-0.0623	0.0229	0.0132	0.0111	-0.0842
Reasons_notinnov	0.0139	-0.2146	-0.1746	-0.0670	-0.2010	0.0234	0.0356	0.0001	0.0438	0.0227	0.0053
Int_sources	0.1149	0.5288	0.3772	0.3848	0.4867	0.0523	-0.0611	0.0352	0.0853	0.1364	0.0264
Market_source	0.1011	0.5648	0.3774	0.4162	0.5667	0.0648	-0.0431	-0.0012	0.0522	0.0935	0.0364
Institut_source	-0.0431	0.1331	0.1984	0.1208	0.1352	-0.0094	0.0187	-0.0251	-0.0528	0.0500	0.0179
Other source	0.0427	0.4310	0.2158	0.3349	0.3980	0.1146	0.0342	0.0603	0.0132	0.1567	0.0595
Formal_prot	0.0446	0.0829	0.1678	0.1644	0.0463	0.0899	-0.0111	0.0244	0.0584	0.1477	0.0776

Table 8 (continued)

Correlation Matrix

	Cooperation	Cost_obst	Knowl_obst	Market_obst	Reasons_notnnov	Int_source	Market_source	Institut_source	Other_source	Formal_prot
Cooperation	1.0000									
Cost_obst	0.0485	1.0000								
Knowl_obst	0.0408	0.2965	1.0000							
Market_obst	0.0484	0.2686	0.2949	1.0000						
Reasons_notinnov	-0.2023	-0.0293	0.0823	0.1387	1.0000					
Int_sources	0.3524	0.0428	-0.0759	0.0199	-0.2808	1.0000				
Market_source	0.4372	0.0378	-0.0022	0.0769	-0.2495	0.6041	1.0000			
Institut_source	0.1974	-0.0200	0.0329	-0.0421	-0.0049	0.0867	0.0986	1.0000		
Other source	0.2900	-0.0135	0.0766	0.0307	-0.0819	0.3343	0.3877	0.1662	1.0000	
Formal_prot	0.1407	-0.0175	0.0236	0.0126	0.0081	0.0498	0.0338	0.0730	0.0990	1.000

Notes: As we have very many variables, we show the correlation only between the main variables. Different sources of information and obstacles are grouped.

Appendix C – Regression results

Table 9

The choice of variables for CDM model

STATA	OLS equation	Selection equation	Innovation input (outcome) equation	Innovation output equation	Productivity equation
Dependent variables					
productivity	dependent				dependent
product_innov	x			dependent	
process_innov	x			dependent	
continuous_RD			dependent		
innov_firm		dependent			
Foreign ownership variables					
frgn50	x	x	x	x	x
frgn					x
frgn_minor					x
CIS					x
West_EU					x
Nordic_EU					x
CEE					x
USA					x
other					x
frgn50_MNE					x
Other variables					
RD	x				
predicted_innovation_input				x	
predicted_product					x
predicted_process					x
ln_empl	x	x		x	x
public_funding			x		
sales_exp		x	x		
inter_competition	x			x	x
age	x	x	x	x	x
formal_protection		x	x	x	
regulatory			x		
environment			x		
fixed_assets	x				x
naceid1 - naceid21	x	x	x	x	x

Table 9 (continued)

The choice of variables for the CDM model (continued)

STATA	OLS equation	Selection equation	Innovation input (outcome) equation	Innovation output equation	Productivity equation
Obstacles to innovations					
lack_funds		x			
lack_finance		x			
lack_cost		x			
unqual_pers		x			
lack_info		x			
lack_infomarket		x			
dif_coop		x			
mark_dom		x			
unc_dem		x			
prior_innov		x			
Sources of information					
info_family			x		
info_competitor			x		
info_enteprise			x		
info_client			x		
info_consutltant			x		
info_gov			x		
info_univ			x		
Cooperation partners					
coop_enterprise			x		
coop_supplier			x		
coop_client			x		
coop_competitor			x		
coop_consultant			x		
coop_gov			x		

Note: here we show what variables are chosen for the initial regressions. After we perform the initial regression, we delete some of the variables from the Innovation Input equation. We drop selected variables which are insignificant and which do not change the significance of other variables after being dropped.

Table 10

OLS regressions

Dependent Variable:	Productivity		
Regression	(1)	(2)	(3)
RD	0.0405 (0.0665)	-	-0.0135 (0.0744)
Product_innov	-	0,0924 (0.0745)	0,0941 (0.0753)
Process_innov	-	0,0472 (0.0763)	0,053 -0,0824
fixed_assets	0.2208 *** (0.0229)	0.2189*** (0.0229)	0.219*** (0.0231)
frgn50	0.6043*** (0.124)	0.5916*** (0.1226)	0.592*** (0.1229)
ln_empl	0.2144*** (0.0413)	0.2092*** (0.0414)	0.209*** (0.0414)
inter_competition	0.1733 (0.1432)	0.1701 -0.1439	0,017 -0.144
age	-0.0283*** (0.0077)	-0.0277 *** (0.0077)	-0.0277*** -0.0077
Industry dummies	Yes	Yes	Yes
const	7.5418 *** (0.2859)	7.505*** -0.2892	7.5056*** -0.2893
Regression summary statistics			
R^2adj	0.2966	0.2979	0.2972
SER	0.967	0.9661	0.9666
F-test (product innov=0, process_inov=0)		1.44 (0.2373)	
F-test (product innov=0, process_inov=0, RD=0)			0.97 (0.4059)
n	906	906	906

Note: Robust standard errors are reported in brackets under coefficients. *, **, *** denote significance at the 10, 5, 1 percent level, respectively. P-values are given in brackets under F-statistics.

Table 11

Selection equation when all variables are used

Step 1 Probit model with selection Selection equation (all variables)		
Dependent variable: The probability of the firm to innovate (innov_firm)		
Regression	(4)	
	Coefficient	SE
Frgn50	0.4103**	0.1861
Sales_exp	0,0011	0.0019
Ln_empl	0.1922***	0.0494
Age	-0.0227**	0.0114
Formal_protection	0,1154	0.1734
Lack_funds	0,0257	0.1277
Lack_finance	-0.2775**	0.1227
Lack_cost	0.3758***	0.1145
Unqual_pers	0.2864***	0.1066
Lack_info	0,1329	0.1599
Lack_infomarket	0,1115	0.1433
Dif_coop	-0.2377*	0.1201
Mark_dom	0,1602	0.1052
Unc_dem	0,0105	0.1206
Prior_innov	-0.253*	0.1491
No_need	-0.5821***	0.1336
Industry dummy	Yes	
Const	-0.0229	0.2802

Table 11 (continued)

Innovation input equation when all variables are used

Step 2		
Probit model with selection		
Innovation input equation (All variables)		
Dependent variable: continuous_RD		
Regression	(5)	
	Coefficient	SE
Frgn50	0.3804**	0,1882
Age	0,0105	0,0139
Formal_protection	0.6729***	0,1894
Sales_exp	-0,0012	0,0022
Info_family	-0,1451	0,1666
Info_enterprise	0.3376**	0,1355
Info_client	0.4618***	0,1332
Info_competitor	0	0,1374
Info_consultant	0.5201**	0,2282
Info_gov	0,5382	0,4197
Info_univ	0,3972	0,3399
Regulatory	-0.3105*	0,1734
Environment	0,0742	0,158
Coop_enterprise	-0,0249	0,1741
Cooper_supplier	0,2214	0,1729
Coop_client	0,1419	0,202
Coop_consultant	0.6856***	0,2056
Coop_competitor	-0,1012	0,181
Coop_univ	0,0933	0,2556
Coop_gov	-0.2714	0,3053
Public_funding	0,1212	0,233
Industry dummy	Yes	
Const	-1.2876***	0,3944
Regression statistics		
Rho	0,4991	0,3063
Uncensored Observations	618	
Log - likelihood	-807,2419	

Note: Robust standard errors are reported next to coefficients. *, **, ***denote significance at the 10, 5, 1 percent level, respectively. Rho is the correlation between errors in two equations. In Step 2 we use all cooperation and all information dummies.

Table 12a

Multistep Production Function – Selection equation

Step 1		
Probit model with selection		
Selection equation		
Dependent variable: The probability of the firm to innovate (innov_firm)		
Regression	(6)	
	Coefficient	SE
Frgn50	0.4071**	0.1862
Sales_exp	0,0011	0.0019
Ln_empl	0.1917***	0.0495
Age	-0.0227**	0.0114
Formal_protection	0.1166	0.1736
Lack_funds	0.027	0.1283
Lack_finance	-0.2793**	0.123
Lack_cost	0.3743***	0.1152
Unqual_pers	0.2859***	0.107
Lack_info	0.1332	0.1606
Lack_infomarket	0.1105	0.1437
Dif_coop	-0.2383*	0.1205
Mark_dom	0.1584	0.1056
Unc_dem	0.0149	0.1214
Prior_innov	-0.2545*	0.1494
No_need	-0.5835***	0.1345
Industry dummy	Yes	
Const	0.0739	0.6509

Table 12 a (continued)

Multiple production function – innovation input equation

Step 2 Probit model with selection Innovation input equation		
Dependent variable: continuous_RD		
Regression	(7)	
	Coefficient	SE
Frgn50	0.3744**	0,1897
Age	0,0117	0,0139
Formal_protection	0.6872***	0,1885
Sales_exp	-0,0009	0,0022
Info_enterprise	0.3138**	0,1321
Info_client	0.44***	0,127
Info_consultant	0.5015**	0,221
Info_gov	0.7301*	0,3863
Regulatory	-0.2738	0,1697
Environment	0,0471	0,1576
Coop_enterprise	-0,0038	0,1709
Coop_client	0,226	0,1644
Coop_consultant	0.761***	0,1989
Coop_gov	-0.249	0,2662
Public_funding	0,1137	0,2337
Industry dummy	Yes	
Const	-1.2741***	0,3943
Regression statistics		
Rho	0,4473	0,3158
Uncensored Observations	618	
Log - likelihood	-809,5335	

Note: Robust standard errors are reported next to coefficients. *, **, ***denote significance at the 10, 5, 1 percent level, respectively. Rho is the correlation between errors in two equations. This regression does not include some of the variables that were insignificant in equation (5), the results are still the same.

Table 12 b

Multiple production function – Innovation output equation (bivariate probit)

Step 3				
Bivariate probit regression				
Innovation output equation or Knowledge production function				
Dependant variable:	Product Innovation		Process Innovation	
Regression	(8)		(9)	
	Coefficient	SE	Coefficient	SE
Predicted_cont_RD	2.3443***	0.2821	4.3476***	0.3965
frgn50	0.1121	0.1683	-0.2684	0.1812
age	-0.0123	0.0108	-0.0274**	0.0115
ln_empl	0.1285***	0.0473	0.14***	0.0504
formal_protection	-0.075	0.1814	-0.9512***	0.202
intern_competition	0.0529	0.1576	-0.1625	0.1652
Industry dummy	Yes		Yes	
const	-1.0187***	0.2783	-1.14***	0.2951
Regression statistics				
Rho	0.4750***		0.0518	
Observations	906			
Log - likelihood	-970.4284			

Note: Robust standard errors are reported next to coefficients. *, **, ***denote significance at the 10, 5, 1 percent level, respectively. Rho is the correlation between errors in two equations

Table 12 c

Multiple production function – innovation output equation (univariate probit)

Step 3 Univariate probit regressions Innovation output equation or Knowledge production function				
Dependant variable:	Product Innovation		Process Innovation	
Regression	(10)		(11)	
	Coefficient	SE	Coefficient	SE
Predicted_cont_RD	2.3726***	0.2852	4.5662***	0.4177
frgn50	0.1234	0.1688	-0.2945	0.1821
age	-0.0121	0.0108	-0.0282**	0.0116
ln_empl	0.1264***	0.0473	0.1311***	0.0506
formal_protection	-0.0826	0.1824	-1.004***	0.2052
intern_competition	0.0521	0.1584	-0.1621	0.1656
Industry dummy	Yes		Yes	
const	-1.001***	0.2786	-1.1795***	0.2977
Regression statistics				
Pseudo R-squared	0.1453		0.2042	
Observations	906		906	
Log - likelihood	-532.5655		-469,6515	

Note: Robust standard errors are reported next to coefficients. *, **, ***denote significance at the 10, 5, 1 percent level, respectively.

Table 12 d

Multiple production function – Productivity equation

Step 4 Linear regression Productivity equation								
Dependent variable: productivity								
Regression	(12)		(13)		(14)		(15)	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
Predicted_product	-0.3058	0.5538	-0.3185	0.5502	-0.1046	0.522	-0.2831	0.5587
Predicted_process	0.4339	0.4525	0.438	0.451	0.2902	0.43	0.3972	0.4556
Fixed_assets	0.2212***	0.0228	0.2217***	0,0229	0.2223***	0.0228	0.2271***	0.0224
frgn50	0.6186***	0.134	0.6236***	0.1346			0.3947***	0.1521
frgn_minority			0.0725	0.1764				
CIS					-0.0513	0.2189		
West_EU					0.4547***	0.1721		
Nordic_EU					0.4757*	0.2654		
CEE					0.8159***	0.2269		
USA					0.8334***	0.192		
other					-0.0963	0.4075		
frgn50_MNE (interaction term)							0.51694**	0.2312
ln_empl	0.21***	0.0421	0.21***	0,0422	0.1986***	0,0427	0.1987***	0.0447
inter_competition	0.195	0.1436	0.1917	0.1457	0.1767	0.1465	0.1772	0.1451
age	-0.0263***	0,0078	-0.0264***	0,0078	-0.0279***	0,0077	-0.026***	0.0078
industry dummy	Yes		Yes		Yes		Yes	
const	7.4426***	0,304	7.4423***	0,3042	7.4648***	0,3062	7.419***	0.303
Regression summary statistics								
Radj	0.297		0.2963		0.2974		0.2765	
F-test (predicted_product=0, predicted_process=0)	0.84 (0.4308)		0.82 (0.4412)		0.77 (0.4634)		0.69 (0.5)	
SER	0.9667		0.9672		0.9665		0.9645	
n	906		906		906		906	

Note: Robust standard errors are reported in brackets under coefficients. *, **, *** denote significance at the 10, 5, 1 percent level, respectively. P-values are given in brackets under F-statistics.