The Diverse Impact of Internationalisation on Innovation Inputs and Outputs in the Context of Small Economy of Estonia

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Abstract

The paper outlines the relationship between internationalisation path chosen by firms and their innovation behaviour in Estonia, a small economy in Central and Eastern Europe. Internationalisation of firms is limited to exporting and foreign direct investments. Innovation behaviour of firms is analysed using three waves of Community Innovation Survey data 1998-2000, 2002-2004 and 2004-2006 and covers data about the innovation input and output, innovation barriers as well knowledge sources for innovation used by Estonian firms. In general the results revealed that particularly outward FDI and lesser degree exporting activities seem to facilitate innovativeness. Outward investment influences positively innovativeness, both, in domestic and foreign owned firms groups. In terms of innovation inputs, measured by likelihood of innovation expenditures and their size, foreign firms are more likely to make such expenditures. In terms of innovation outputs, measured by product or process innovations and alternatively by sales of new products per employee, the ownership was initially significant but turned to be insignificant when all other control characteristics were entered into model. Hence the difference between foreign and domestically owned firms groups could be explained by their difference in size, intensity of formal protection, use of customer, competitors and other knowledge sources for innovation. Thus, internationally involved firms and multinationals, both domestic and foreign in origin, are more likely to engage into innovation activities than solely local firms (including domestic non-exporters). We found also positive and significant horizontal spillover effect of FDI on innovation output.

JEL Classification: F10, F23, O30

Keywords: innovation, internationalisation, foreign direct investments, catching-up countries.

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1. Introduction

It is well documented in the literature that foreign owned firms have higher productivity than their domestic counterparts (for literature review see e.g. Arnold and Javorcik 2005); though that can be also due to the foreign owners investing in more productive firms and sectors, the other possibility is the transfer of technology from parents to local subsidiaries. The positive contribution of FDI on home country productivity can occur either through the own-firm effect (increased productivity of firms with foreign owners) or spill-over effects (the increased productivity of non-FDI firms due to the presence of FDI in the same industry – horizontal spillovers – or in downstream or upstream industries). However, as argued by Stiebale and Reize (2005), a better way to estimate the technological performance of foreign owned versus domestic firms would be to study instead of productivity the differences in the innovation input and output indicators, like expenditures on R&D or more broadly on various kinds of innovation activities, sources of information used for innovation, the patterns of innovation cooperation, product and process innovations. Differently, the main reason for the differences in productivity could be differences in knowledge (Criscuolo et al. 2005), thus studying the impact of FDI with production function approach may have little to say what are the specific mechanisms, how knowledge spillovers from foreign to domestic firms occur (Knell and Shrolec 2006). We stress that both home- and host country effects of FDI need to be considered, e.g. we need distinguish also between foreign and domestic multinationals, as knowledge transfer occurs also from the foreign subsidiaries of domestic multinationals to home country (Barba Navaretti and Venables 2004).

From theoretical perspective, the relationship between technology, innovation activities and FDI is ambiguous. Although multinational parents have access to more advanced technologies, they may have incentive to transfer to local firms older technologies; although in many countries foreign firms do a significant percentage of total industrial R&D, in most OECD countries foreign owned firms have lower R&D intensities than domestic firms (OECD 2003), thus it is not taken for granted that FDI enhances innovativeness. Numerous studies have been undertaken on the effects of foreign ownership on various aspects of firms innovative activities in developed countries; a more thorough review of the literature is provided in section two of the article.

There are somewhat less studies on the impact of FDI on innovativeness in developing and catching-up countries. To mention a few, Erdilek (2005) shows in case of Turkey that foreign owned firms had both higher R&D intensity and higher propensity to undertake innovation activities. Srholec (2006) showed that foreign affiliates were less likely to engage in intramural R&D. Knell and Srholec (2006) by studying the impact of foreign ownership on innovation cooperation in Czech Republic found out that foreign-owned firms were more likely to cooperate globally but less likely to cooperate locally. Alvarez (2001) found in case of Chilean manufacturing that exporting was more important determinant of technological innovation than foreign ownership. Almeida and Fernandes (2006) found from a study of a large number of developing countries (43) that majority foreign-owned firms were significantly less likely to engage in innovation than minority foreign-owned firms as the technology transferred to majority foreign owned firms was more mature. Vishwsrao and Bosshardt (2001) found that in India foreign-owned firms were more likely to adopt new technologies than domestic firms. Günther et al. (2009) found for the five Central and Eastern European countries that while majority foreign owned firms were engaged in R&D and innovation, they build less technological linkages with local science institutions limiting the developmental impact of FDI. Thus, in the paper we aim at contributing to the understanding about the role of firm internationalisation in a catching-up country context. These countries are usually further below the technological frontier, lack domestic knowledge base, thus the question is, to which extent FDI can help to overcome these problems.

The aim of this paper is to outline the impact of multinational activities, FDI, and exporting on the innovation inputs and outputs of domestic and foreign-owned firms in Estonia, a small economy in Central and Eastern Europe. The innovation data comes from three waves of Community Innovation Survey (hereinafter CIS) undertaken in all European Union countries in the majority in the same way. We use CIS3 covering 1998-2000, CIS4 (2002-2004) and CIS2006 (2004-2006), as several firms are represented in all 3 surveys, we are able to track the firms' innovative performance over 3 time points. The data is characterised by fairly high response rates. Whereas the innovation survey data includes only rather limited information on firms' global engagement and internationalisation (like exporting activities, belonging to the enterprise group), the innovation survey data was merged with the dataset from the Bank of Estonia on firms that have outward FDI, as well as the Estonian Business Register's firm level financial data for all firms for 1995-2005. The analysis will be mostly centred on the knowledge production function approach, i.e. investigating the determinants of innovation

output variables. In order to account for the selectivity into innovation activities and the endogeneity of innovation expenditures, the estimation of the knowledge production function is preceded with estimating the generalised tobit model for the innovation expenditures. Finally we shall also use the propensity score matching (hereinafter PSM) approach in order to identify the effect of FDI and internationalisation on various innovation inputs and outputs by considering the differences between FDI and non-FDI firms, e.g. it is well observed that multinational firms are larger, foreign owners move into certain sectors et cetera. Thus our contribution to the literatures is that we study the effects of both inward and outward FDI on innovation (as was done also by Criscuolo et al. 2005).

The rest of the paper is structured as follows. The next section reviews the theoretical standpoints on the impact of internationalisation on innovativeness as well the results of the previous empirical studies. The section after that describes the data that we use and the following section introduces our econometric approach to the reader. The 5th section presents the results from descriptive analysis and econometric estimations. The final section concludes, but provides additionally also some policy discussions.

2. Theoretical Background

From the macroeconomic perspective the positive shocks to the innovative activity lead to booms in the short run and to the sustained productivity growth in the long run. There is also evidence that internationally generated knowledge is in the long run indeed an important facilitator of the innovativeness of a country, while large countries have impact on knowledge creation of other countries even in short run (Bottazzi and Peri, 2007)

Fromhold-Eisebith (2007) takes more general perspective on foreign-domestic issue as well by analysing the interconnections between national, regional, and international innovation systems. The main argument is that these levels of innovation systems do not function independently and rely mutually on each others strengths and specific qualities to interact productively. Regional innovation systems build usually upon well-established national innovation systems and wider international linkages can provide significant additional benefits. Although, it has to be said that countries as well as industries differ significantly in their need for connectedness into international flows. System development efforts should take these disparities into account.

The relationship between creative innovations and economic growth of a country depends also on institutions and governance. In connection to FDI policy measures should be oriented towards institutional governance that reduces aggregate country risks. Such measures expand creative innovation and may have significant payoffs. In terms of aggregate country risk efforts to strengthen property rights and judicial independence have considerable positive effects by reducing corruption and expanding economic freedom. These societal changes contribute to the level of creative innovations. (LeBel 2008)

Dashs and Ebersberger (2007) found that membership in multinational enterprise group helps to overcome several innovation obstacles. These include the lack of sufficient financial resources, the lack of technological and market information or various organisational problems. This shows that even when direct impact of foreign ownership on innovation inputs and outputs might be insignificant, the network support derived from ownership relations still matters.

Other comparative study of five countries revealed that, in comparison to domestic firms, the foreign ownership does not render considerably higher levels of innovation inputs, but it is indeed associated with higher levels of innovation outputs and higher labour productivity. The foreign-owned firms showed also more interest in cooperation with host country partners than domestic counterparts. (Dashs et al. 2008).

Baldwin and Gu (2005) show similarly that advantages are likely to be multinational rather than just foreign in nature. They found that Canadian foreign-owned manufacturers belonging to larger multinational enterprise are more productive, more innovative, more technology intensive. Such firms pay also premium wages and use more skilled workers. Authors stress specifically that it is more a matter of being multinational and not just foreign ownership per se.

The study conducted by Griffith et al. (2004) investigated the foreign ownership and productivity relationship in the context of service sector. The findings suggest that foreign-owned multinational service providers proved to be more productive than British own service firms, but the difference was smaller than in the case of manufacturing sector. The study showed also that foreign-owned service firms invest considerably in UK-based R&D. Thus,

general argument is that foreign-ownership, and especially embeddedness into multinational enterprise, facilitates productivity and innovativeness in manufacturing as well as in services.

Rasiah and Kumar (2007) relate technological intensity and R&D activities in Asian electronic firms to the network strength. However, the study indicates that network strength has higher impact on these aspects in local rather than foreign-owned firms. It might be the case that foreign firms benefit more from intra-corporate multinational cooperation (intra-corporate networks), while domestic firms utilise more external networks and their resources. In a recent work of Urem et al. (2008) the specific focus is on propensity and intensity concerning the innovations of high novelty. The empirical results in the developing country context of China suggest that foreign-owned firms do not exhibit a higher propensity of high novelty innovation, but they have higher intensity of such innovations in comparison to domestic firms. Even when foreign-owned firms engage in formal R&D activities in developing host economy, the propensity towards the innovations of high novelty is not significantly different from that of domestic companies.

Liu and Buck (2007) show on the basis of Chinese data that the international technology spillover enhances an innovation performance of domestic firms through various channels. The results indicate that learning from exporting or importing clearly promotes innovation in domestic firms. The R&D activities of multinational firms in host economy help to significantly enhance innovation performance of domestic firms only when latter have sufficient absorptive capacity for benefiting from such spillovers. However, in general it is clearly evident that the innovation performance of high-tech sector in developing economy is jointly determined by international sources of technology spillover and domestic efforts. Tanaka et al. (2007) introduce yet another channel of technology transfers by discussing the issue of international licensing agreements. They found that increased probability of reaching licensing agreement with a predetermined effort promotes innovation in both the long and short run, but an increase in license fee discourages technology transfers and innovation.

The regional networks have been also identified as important contributors to the innovation competence. Even internationally operating firms gain such competences also from participation in regional networks. Thus, the regional networking and international market orientation are not to be seen as contradictory alternatives. There can be considerable

simultaneous gains from both scales of knowledge search – from regional as well as from international. (Gellynck et al. 2007)

Lööf (2009) argues that knowledge spillovers into multinational enterprises via domestic and foreign R&D collaborations take typically place as network phenomenon and not via the partnership process between local firm and single partner. The results show also that the success of R&D collaborations depends on having foreign innovation partners in the network. This study indicates additionally that non-export oriented firms and foreign multinationals who sell to local and regional markets in host economy benefit from such networked collaborations more than others.

The global network configuration for innovations has been analysed by Perks and Jeffery (2006). They conclude that successful configuration is about locating the innovation value in the network and building capabilities and mechanisms for understanding and accessing these values. This is not an easy task, especially for firms that tend to be deeply embedded into their traditional knowledge base and patterns of network relations. (Perks and Jeffery 2006)

Vila and Kuster (2007) studied the relationship between internationalisation decisions and innovations in the context of textile industries. These results indicate that firms with higher levels of international activities, who engage in export agreements or directly manufacture in the overseas market, are often not the most innovative firms in sector. This means that domestic or simply exporting firms can offer superior, more original, and more customer oriented products than firms, which invest considerably or establish international joint ventures. Thus, this work concludes that internationalisation and product/market innovations are independent decisions. However, they also point out that the independence of these decisions might be somewhat specific to textile industry, because even domestic producers have to do product innovations in a seasonal pattern.

When majority of studies focuses on the international influences to innovation activities or performance in a particular country, then Fallah and Lechler (2008) take a global perspective on innovation reach. According to this study in the knowledge economy many firms have to access global technological and market knowledge in order to retain their competitive position. However, the expanding innovation reach should account for the need to preserve the efficiency of organisation. The organisational efficiency represents here an important

limitation and disregarding of it might lead to unfavourable competitive position. Thus, the global reach of innovations should not be maximised but optimised considering the limitations. The relationship between innovation reach and global performance turned out to be non-linear and with a considerable time lag of more than two years. This study implies that internationalisation and innovation can have also well-defined and mutually reinforcing relationship, when innovation itself is seen has international rather than local phenomenon. (Fallah and Lechler 2008)

Castellani and Zanfei (2007a) investigated internationalisation and innovation from intra-industry heterogeneity perspective. The results of this study reveal that level of involvement in foreign activities influences the innovation performance. Firms producing abroad exhibit best innovation performance, while exporters are better off than non-internationalised firms. According to this study multinationals without foreign production operations have higher productivity than exporting firms, but the innovativeness of these two groups does not prove to be significantly different. These results were obtained while controlling for sector, location, firm age, and size. The robust heterogeneity in productivity revealed by this analysis suggests that involvement in international activities is a distinct channel for knowledge transfer and accumulation to be viewed separately from differences in innovative activities.

In another study Castellani and Zanfei (2007b) show that not only foreign-owned multinationals contribute to the innovativeness of a country by transferring intangible assets and through spillovers to local firms. This analysis indicates that headquarters of domestic multinationals are often more productive and more interested in innovating than foreign firms. Although exporting firms benefit in terms of innovation knowledge from their foreign activities, knowledge spillovers to non internationalised firms are directly related to the activities of domestic multinationals. The evidence provided by Grünfeld and Knell (2005) confirms the finding that foreign-ownership itself does not bring along significantly higher knowledge spillovers to local firms, but they conclude also that the international R&D agreements in general are important to host economy.

One of the most comprehensive studies of foreign ownership and innovation activities is offered by Ebersberger et al. (2005). They analyse the impact of foreign ownership on innovation inputs and innovation outputs of Finnish companies. This study outlines the impact of foreign ownership on firm’s participation in the innovation system, on access to

public research funding, and on productivity. Interestingly, the origin of foreign capital is also taken into account in order to provide even more refined comparison between foreign-owned and domestic-owned firms. The results reveal that domestic multinationals are often better off in terms of innovation inputs, collaboration levels, and access to public funding. Nordic-owned firms perform relatively well do, while Anglo-Saxon origin seems to render highest productivity and comparable levels of innovation inputs and outputs to these of domestic-owned firms. However, the impact of Anglo-Saxon origin on innovation activities seems to be dependent on methods of analysis utilised. Despite some evidence about the relevance of foreign ownership, the study concludes that the market strategy of a firm in terms of focusing is stronger determinant of the innovation activities than ownership. (Ebersberger et al. 2005)

The importance of control variables, like firm size, age and other characteristics, is well outlined in studies by Martin Falk and co-authors. The more detailed modelling of the relationship between foreign-ownership and innovation activities revealed that the presumed negative impact does not only find additional proof, but is also stronger than in case of more common regression analysis (Falk and Falk 2006). The more recent comparative evidence from twelve European countries shows that the difference between foreign and domestic firms can indeed be attributed to other firm characteristics than ownership itself. Yet, there are important disparities between countries, because in new EU members foreign ownership has strong and positive impact on the share of market novelties and on the share of new products in turnover. (Falk 2008) Thus, foreign-owned firms can be more innovative, but in global terms this innovation can be seen rather as imitation. Such findings undoubtedly stress the contingent nature of the interplay between foreign-ownership and innovation activities.

Warner (2006) argues on the basis of German evidence that exporters and foreign direct investors are more active also in generating new knowledge than domestically oriented counterparts. He stresses that this difference is not to be attributed to differences in firm size, different industries, or higher enrolment of researches, but to the higher learning from external knowledge sources. Thus, in some respect, these findings oppose to Falk, but one must keep in mind that even seemingly slightly different research focus can reliably explain the variation in findings. The study indicates also that better knowledge base contributes to the higher productivity of internationalised German firms in comparison to national ones.

Johansson et al. (2008) analyse the role of foreign takeovers on performance of large sample of Nordic firms. Their finding suggest that although domestic firms seem to outperform foreign-owned ones in terms of R&D and engagement in innovations, the general value of innovations per unit of expenditure is in these two ownership groups rather similar. This is so when controlling for firm size, human capital and industry sector. The other result is that foreign takeover did not have significant impact on labour productivity. Given the similar rate of innovation input to output conversion and the lack of direct effects on productivity, foreign ownership is seen as neutral or without significant welfare gain or drain to host economy. The empirical contributions are summarised in Appendix 1.

Figure 1 shows the generalised summary of firm types, internationalisation modes and innovation indicators used in empirical construct. These are based on the theoretical considerations and earlier studies. Licensing and franchising contracts will be excluded from empirical study due to their minor usage in Estonian context.

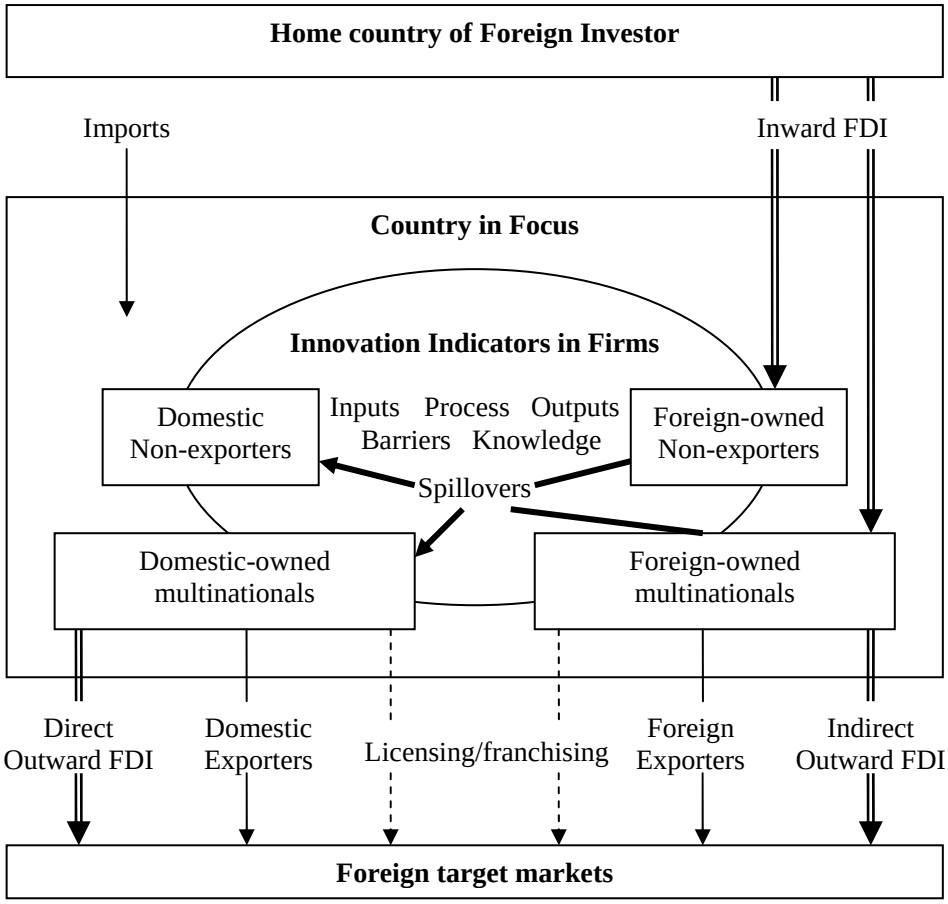

Figure 1 Typology of innovating firms by their internationalisation modes

As we have seen, the wide body of existing empirical evidence reveals somewhat controversial results, which range from adverse impact of foreign ownership on the innovation activities or from their insignificant and neutral nature to the clearly positive impact of firm's foreign ownership and international activities. In following section we offer additional empirical evidence in the context of small developing economy of Estonia.

3. Econometric method

In the empirical analysis we estimate the innovation investment equations and the knowledge production functions in our sample of firms. In general, the model can be described as a multi-step model consisting of several equations. Shortly, the model is based on the framework for estimating the innovation input and output that was firstly developed by Pakes and Griliches (1984) and further developed in Crepon et al. (1998). This so-called CMD model has been used extensively to evaluate the impact of innovation on productivity, but also in the earlier studies on the link between FDI and innovation (e.g. Johansson et al. 2008).

The model that we use can be written down as follows. Let us use $i = 1,\ldots,N$ to index firms. At the 1st step, firms decide whether or not to engage themselves in the innovation activities (that is the selection equation), thereafter a selected group of firms decide on the size of the investment into R&D or more broadly total innovation expenditures. This is specified by the Heckman equation. Equation (1) models the firm's latent (unobserved) propensity to innovate, g_i^*:

(1) $g_i^* = \beta_0 x_{0i} + \varepsilon_{0i}$,

where x_{oi} is a vector of variables that determine this innovation effort, β_0 is the associated coefficient vector, and ε_{0i} is an error term. Let us use g_i to denote the observed indicator variable that equals 1 for firms reporting innovation expenditures and 0 for firms not reporting innovation expenditures. A firm invests in knowledge producing activities, i.e. $g_i = 1$, if $g_i^* > c$, where c is some constant threshold level. Correspondingly, if $g_i^* \le c$, then $g_i = 0$. The term g_i^* represents some decision criterion about whether to engage in innovative activities; e.g., the expected return on investment in research and development (Crépon et al. 2006).

If a firm engages in innovative activities (i.e. if $g_i^* > c$), we can observe the innovation expenditure of firm *i*, denoted as r_i. The variable r_i^* denotes the latent intensity of research for firm *i*. The two variables, r_i and r_i^* are related in the 2nd equation of our model as follows:

$$(2)\ r_i = \begin{cases} r_i^* = \beta_1 x_{1i} + \varepsilon_{1i} \quad if \quad g_i = 1 \\ 0 \quad if \quad g_i = 0 \end{cases}.$$

In equation (2) x_{1i} is a vector of explanatory variables and ε_{1i} an error term. We have used the Heckman model to estimate equations (1) and (2). Equation (2) looks at the size or intensity of the innovation activities (e.g. the amount of innovation expenditure per employee). Instead of R&D expenditure (as used by several other papers) we use total expenditure on innovative activities. The reason for that is the relatively small number of Estonian companies undertaking R&D activities.

The vector x_{0i} includes the following explanatory variables: dummy for foreign firms (FOR_i), firm size measured as the log of number of employees (l_i), a dummy variable for the presence of public funding from any source (pf_i), a dummy variable denoting usage of formal protection (like trademarks, copyright, etc; denoted as p_i); m_i is a dummy variable denoting exposure to international competition (it takes value 1 if the firm's main market is international). The innovation expenditure equation includes also the dummies for public funding, international competition and formal protection, but in addition to these several other variables, but also the following variables. We have included 3 ownership variables: domestic multinationals (domestic firms with outward investments), foreign firms without outward FDI and foreign firms with outward FDI; thus local firms (domestically owned firms without foreign investments) is the reference category. We have also included a set of variable on innovation cooperation (vector c_i), sources of innovation related information for the firm (vector j_i) and vector of dummy variables denoting different obstacles to innovation (o_i). Unlike in several other studies, the variables in vectors c_i, j_i, o_i have not been defined as dummies, but each of them have 4 values, these are 0, 1/3, 2/3, 1; a higher value indicates a greater importance attached to the particular cooperation partner, source of information or innovation obstacle by the responding firm. We think that such specification is more appropriate as it takes into account the whole information provided in the survey. Finally, all

the equation include also 6 industry dummies (vector I_i) for industries aggregation according to the OECD technology levels (high-technology manufacturing, high-medium technology manufacturing, low-medium technology manufacturing, low technology manufacturing, knowledge intensive services, other services). These explanatory variables have been used in earlier studies applying the CDM model and the studies on the linkages between innovation and FDI (Griffith et al. 2006; Lööf et al. 2003). The precise definitions of the variables can also be found in Appendix 2.

Equation (3) is the knowledge or innovation production function relating (potentially unobserved) knowledge (innovation output) to the innovation input and other variables:

(3) $t_i = \alpha_K r_i^* + \beta_2 x_{2i} + \varepsilon_{2i}$.

Here, variable t_i is the innovation output or knowledge proxied both by the product and process innovation indicators (dummy variables) as well as innovation sales per employee, x_{2i} is a vector of explanatory variables, ε_{2i} an error term, which is assumed to be normally distributed with a zero mean and variance σ_2^2, and is also assumed to be independent of error terms ε_{0i} and ε_{1i}. The vector x_{2i} includes the three ownership variables described above, firm size variable (l_i), industry dummies (I_i), protection variable (p_i), a dummy for the presence of public funding from any source (variable pf_i) and a vector of variables for different sources of information j_i To account for the fact that the use of process and product innovation by a firm is highly interdependent, we estimated equation (3) as a bivariate probit model, the dependent variables being respectively the dummy variables for product innovation (P_i) and process innovation (Q_i). Alternatively, we estimated the knowledge production function also in the form, where the dependent variable was the innovation sales per employee; in that case the knowledge production function was estimated with least squares. The latent innovation effort, r_i^*, enters the knowledge production function as an explanatory variable. It is instrumented, i.e. it's predicted value from the 1st step of the equation is used in order to account for both the selectivity and endogeneity of r_i^* in equation (3). The endogeneity comes from the fact that unobservable firm characteristics may increase both the enterprises's innovation effort and its capability to produce technological innovation (Griffith et al. 2006).

In addition to these variables the knowledge production function includes also two other industry-level variables. The share of imports in the level of 2-digit industries measures the competitive pressure on domestic market coming from imports (Bertschek 1995). The foreign market share (hereby measured in terms of employment) measures the indirect impact of FDI on innovativeness. Domestic firms (and also other foreign owned firms) may also benefit from the introduction of new products and processes by the foreign affiliates if due to the public good characteristics of the foreign firms' firm specific assets foreign firms cannot acquire all the benefits of their activities in host country (Caves 1996). The spillover effects may occur either through a diffusion of new technology due to worker mobility between foreign owned and domestic firms, demonstration effects and the increased competition in the product markets increasing the incentives to adopt state-of-the art technology (Blomström and Kokko 2003). Following Vahter and Masso (2007), the foreign market share is measured as follows.

$$(4)\ FOR\_spillover_{ijt} = \frac{\left(\sum_{i\ for\ all\ \ i\in j} Z_{ijt}^{FOR}\right) - Z_{ijt}^{FOR}}{\sum_{i\ for\ all\ \ i\in j} Z_{ijt}}, \quad Z_{ijt}^{FOR} = \begin{cases} Z_{ijt}, \text{ if } FOR_{ijt} = 1 \\ 0 \text{ else.} \end{cases}$$

As we can see, this variable differs from the standard variable, the share of FDI in the corresponding sector, in the sense that that for each FDI firm its own employment has been subtracted from the total industry FDI.

4. Data description and preliminary data analysis

In the study we use the Estonian Community Innovation Survey data from three different waves, these are CIS3 (covering1998-2000), CIS4 (2002-2004) and CIS2006 (2004- 2006). CIS3 data includes 3,161 firms, CIS4 data includes 1,747 firms and CIS2006 data 1,924 firms. The surveys have been conducted by the Statistics Estonia. The response rates in the surveys were rather high, 74% in CIS3 and 78% in CIS4, while the EU average has remained 55% (Terk et al. 2007). Whereas the innovation survey data includes only rather limited information on firms' global engagement and internationalisation (like exporting activities, belonging to the enterprise group), the innovation survey data was merged with the dataset on firms that have outward FDI compiled by the Balance of Payments Department of the from the Bank of Estonia. Secondly, CIS data was also linked with the Estonian Business Register's firm level financial data for all firms for 1995-2006. The descriptive statistics of the variables used either in regression or descriptive analysis can be found in Appendix 2. The main

characteristics of the firms' innovative activities according to CIS have been covered by Kurik et al. (2002) using CIS3 results and by Terk et al. (2007) using CIS4 results.

The next tables provide preliminary descriptive evidence on the relationship between FDI and innovation inputs and outputs according to Estonian CIS data. Table 1 presents the data on innovation expenditures by groups of firms classified by their multinationality status (local firms, domestic and foreign multinationals). Table 1 reveals that similarly to the results of Griffith et al. (2004), domestic multinationals have the highest expenditure on the innovation and R&D, however, differently from their results we have no evidence that foreign owned firms spend more than the solely domestic firms. However, if the category of foreign owned firms is further divided into two groups, foreign owned firms with and without outward investment from Estonia, the differences between the two groups are quite big (the second section in Table 1). Foreign outward investors are the group with highest average expenditures while foreign owned firms, which do not invest outward, are close to purely local firms. One explanation and part of the story is that foreign owned firms (without outward investments) are small and medium sized firms belonging to Scandinavian investors and not big multinationals. Given that, we below use this 4-group classification of the firms instead of the classification used by Griffith et al. (2004). The last section of Table 1 divides firms according to exporting and domestic-foreign ownership. As we can see, here the differences are much smaller and concerning the indicator the groups rank differently. Therefore analysis produces first conclusion, internationalisation matters for the firms' propensity to innovate. Firms engagement with outward investment is related with more active investments into innovation compared with exporting, both, in domestic and foreign owned firms groups.

Table 1 Innovation expenditures: all firms

Breakdown	Group of firms	Total innovation expenditure per employee	R&D expenditure per employee	Innovation expenditure dummy	R&D expenditure dummy
Multinationality status	Local firm	16.64	5.33	0.28	0.17
	Domestically-owned multinationals	29.25	7.48	0.51	0.4
	Foreign-owned multinationals	15.54	5.08	0.38	0.25
Inward and outward investment	Local firms	16.64	5.33	0.28	0.17
	Domestic outward investors	29.25	7.48	0.51	0.4
	Foreign owned firms	14.07	5.1	0.37	0.24
	Foreign outward investors	36.78	4.9	0.57	0.46

Breakdown	Group of firms	Total innovation expenditure per employee	R&D expenditure per employee	Innovation expenditure dummy	R&D expenditure dummy
Ownership and exporting	Domestic non-exporters	14.33	4.23	0.23	0.13
	Domestic exporters	18.32	5.89	0.33	0.21
	Foreign owned non-exporters	16.27	9.67	0.3	0.16
	Foreign owned exporters	15.37	4.74	0.4	0.27
All enterprises	All enterprises	16.8	5.46	0.31	0.19

Table 2 shows the differences in the use of various sources of knowledge for innovation. As we can see, the indirect investors (foreign-owned firms with outward investment) have the highest use of information sources internal to the firm. It supports the importance of intra-firm knowledge transfer mechanisms. Direct investors (domestic outward investing firms) have the highest use of competitors as the source of information. It indicates that those firms do not own strong knowledge base themselves and they could not reap useful information from their internal networks. Instead they try to learn from the competitors in the markets where they have invested. Further analyses of innovation output reveals that direct investors are relatively successful in their innovative behaviour and they demonstrate relatively high productivity level and job creation. Indirect investors have the highest use of conferences as the source of information, while direct investors have the highest use of universities as the source of information. But in general the role of universities as the source of knowledge is very low in all groups of firms. It reflects the weakness of triple helix linkages in Estonian innovation system and more broadly overwhelming networking failure. It has several reasons, which are going beyond the limits of the article (see Varblane et al. 2008).

Table 2 The importance of knowledge flows by different types of firms: inward and outward FDI

Type of firms	Internal	Vertical	Competitor	Conferences	Universities
Domestic owned firms that have not invested abroad	0.53	0.6	0.46	0.53	0.15
Domestic owned firms that have invested abroad (direct investors	0.67	0.67	**0.58**	0.53	**0.24**
Foreign owned firms that have not invested abroad from Estonia	0.72	0.66	0.44	0.57	0.13
Foreign owned firms that have invested abroad from Estonia (indirect investors)	**0.78**	0.64	0.48	**0.64**	0.14
All enterprises	0.59	0.62	0.47	0.54	0.15

Note. Each variable has the 4 values, 0, 1/3, 2/3, 1; higher value indicates a greater importance attached to the particular source of information.

Table 3 shows the differences between different groups of firms in terms of various innovation output indicators. When dividing the firms into local firms, domestic and foreign multinationals, then for all innovation output indicators, the most innovative firms are the domestic multinationals, followed by foreign-owned multinationals. There is not much difference whether to look only on innovations new to firm or new to the market. If we distinguish between domestic and foreign outward investors, both types of outward investors are much more innovative than simply foreign owned firms. When looking also at the exporting status, domestic non-exporters are the least innovative group. Foreign-owned non-exporters are the most innovative in terms of product innovations and foreign-owned exporters are more innovative in terms of process innovations. It may reflect the low valued-added content of Estonian exports. The process innovation is major path to reduce costs and improve competitiveness. Exporting firms have been much weaker launching new products. When comparing imitative (new to the firm) and real (new to the market) innovations, local firms do relatively more innovations being just new to firm. On the other hand, the product innovations undertaken by domestic and foreign multinationals are more often radical. The share in sales of radical innovations is the highest among the domestic multinationals. It is again support to the already earlier obtained result, that outward investment is positively related with the innovativeness of firm. These results are in line with those of Sadowski and Sadowski-Rasters (2008) who also found that though foreign firms had higher frequency of product innovations, there was a smaller difference in radical innovations.

Table 4 shows the importance of different factors hampering innovative activities. In accordance with the previous works innovation barriers are more serious for domestically owned firms compared with foreign owned firms. Internationalisation experience is somewhat reducing the severity of innovation barriers among domestic firms. The biggest difference between foreign and domestic firms occurs by the lack of financing and innovation costs. In case of the “lack of adequate personnel”, differences are much smaller, but are the most acute in case of domestic multinationals. For domestic enterprises it is also more difficult to find cooperation partners, as expected. For local firms the reason “market dominated by established enterprises” is important.

Table 3 Innovation output by different types of firms

Breakdown	Group of firms	Product innovation	Product innovation: new to market	Product innovation: new to firm	Process innovation	Share of sales from new products	Share of sales from products new to market	Share of sales from products new to firm	Organisational innovation
Multinationality status	Local firm	27.3%	13.9%	18.0%	25.7%	7.6%	3.4%	6.3%	40.6%
	Domestically-owned multinationals	51.2%	32.1%	35.7%	48.8%	15.5%	8.3%	8.1%	58.5%
	Foreign-owned multinationals	40.7%	22.5%	24.4%	37.0%	10.6%	5.6%	7.6%	50.3%
Inward and outward investment	Local firms	27.3%	13.9%	18.0%	25.7%	7.6%	3.4%	6.3%	40.6%
	Domestic outward investors	51.2%	32.1%	35.7%	48.8%	15.5%	8.3%	8.1%	58.5%
	Foreign owned firms	39.8%	21.6%	24.0%	35.4%	10.6%	5.6%	7.6%	48.5%
	Foreign outward investors	54.3%	37.0%	30.4%	60.9%	11.4%	5.3%	6.8%	72.0%
Ownership and exporting	Domestic non-exporters	19.1%	9.9%	12.9%	20.7%	6.2%	2.7%	5.3%	31.7%
	Domestic exporters	33.0%	16.9%	21.8%	29.4%	8.4%	3.7%	6.8%	45.2%
	Foreign owned non-exporters	**41.7%**	19.7%	30.3%	25.0%	**14.6%**	**4.6%**	**14.9%**	31.8%
	Foreign owned exporters	40.1%	23.2%	23.7%	**37.6%**	10.1%	5.6%	6.6%	51.2%
All enterprises	All enterprises	30.3%	15.8%	19.6%	28.2%	8.2%	3.8%	6.6%	43.8%

Table 4 Barriers to innovative activities

Breakdown	Group of firms	Lack of appropriate sources of finance	Innovation cost too high	Lack of qualified personnel	Lack of information on technology	Difficulty in finding cooperation partners	Lack of information on markets	Market dominated by established enterprises	Uncertain demand for innovative goods and services	Excessive perceived economic risks	Organisational rigidities	Insufficient flexibility of regulations or standards
Multinationality status	Local firm	0.485	0.411	0.392	0.23	0.227	0.235	0.33	0.283	0.303	0.156	0.211
	Domestically-owned multinationals	0.419	0.433	0.447	0.27	0.264	0.264	0.239	0.264	0.312	0.28	0.161
	Foreign-owned multinationals	0.339	0.346	0.371	0.232	0.188	0.217	0.251	0.27	0.27	0.21	0.18
Inward and outward investment	Local firms	0.485	0.411	0.392	0.23	0.227	0.235	0.33	0.283	0.303	0.156	0.211
	Domestic outward investors	0.419	0.433	0.447	0.27	0.264	0.264	0.239	0.264	0.312	0.28	0.161
	Foreign owned firms	0.345	0.348	0.374	0.235	0.19	0.217	0.255	0.27	0.271	0.203	0.178
	Foreign outward investors	0.222	0.304	0.333	0.2	0.16	0.213	0.2	0.267	0.238	0.333	0.222
Ownership and exporting	Domestic non-exporters	0.497	0.405	0.334	0.177	0.194	0.173	0.295	0.246	0.289	0.135	0.205
	Domestic exporters	0.476	0.42	0.419	0.254	0.244	0.267	0.34	0.3	0.313	0.173	0.214
	Foreign owned non-exporters	0.321	0.311	0.288	0.182	0.167	0.212	0.333	0.227	0.29	0.21	0.148
	Foreign owned exporters	0.343	0.351	0.378	0.241	0.192	0.217	0.243	0.273	0.262	0.206	0.184
All enterprises	All enterprises	0.463	0.401	0.392	0.234	0.222	0.233	0.313	0.281	0.299	0.165	0.207

5. Results of econometric analysis

5.1. Innovation expenditure equation

Table 5 presents the results on simple OLS and probit regressions on the likelihood to undertake innovation expenditures and their size, while Table 6 presents the results of the estimation of Heckman equation. We think that presenting the results of both simple and slightly more sophisticated models could be useful for estimating the robustness of our results.

Table 5 Innovation intensity equation and probit model for non-zero expenditures

Dependent variable	Non-zero innovation expenditure	Non-zero innovation expenditure	Innovation expenditure per employee	Non-zero R&D expenditure	Non-zero R&D expenditure	R&D expenditure per employee
Estimation method	Probit	Probit	OLS	Probit	Probit	OLS
Domestic exporter	-0.336	-0.183	0.210	-0.319	-0.222	0.727
	(-7.81)***	(-3.55)***	(1.63)	(-6.64)***	(-3.87)***	(0.30)
Foreign owned non-exporter	-0.145	-0.050	0.539	-0.278	-0.216	4.819
	(-0.98)	(-0.33)	(1.31)	(-1.62)	(-1.23)	(0.59)
Foreign-owned exporter	0.180	0.156	-0.015	0.183	0.189	-1.411
	(3.24)**	(2.68)**	(-0.12)	(3.09)**	(3.05)**	(-0.52)
International competition		0.198	0.310		0.075	3.013
		(4.20)***	(2.87)**		(1.46)	(1.34)
Formal protection		0.839	-0.159		0.836	12.641
		(15.96)***	(-1.58)		(15.75)***	(4.95)***
Public funding		1.679	0.339		1.211	16.702
		(12.82)***	(2.25)*		(11.76)***	(3.43)***
Constant	-0.421	-0.761	2.337	-0.790	-1.081	1.525
	(-16.36)***	(-18.48)***	(23.37)***	(-28.26)***	(-24.00)***	(0.79)
Observations	1431.000	4908.000	1431.000	4908.000	4908.000	4576.000
Log-likelihood	-2809.358	-2711.324	-2801.066	-2380.550	-2161.232	-25288.040
Pseudo-R^2		0.105		0.015	0.106	
R^2	0.001		0.012			0.010

Table 5 and Table 6 show that foreign firms have significantly higher likelihood to make non-zero innovation expenditures; that result contrasts those of the Johansson et al. (2008). The other determinants of engagement in innovation activities are significant and have expected signs – the probability to have expenditures increases with the presence of public funding, openness to international competition (exporting), formal protection (so that firms investing into innovation can reap the benefits of these investments) and firm size. On the other hand, there is no significant difference in the size of innovation expenditures by firms with different internationalization patterns, though the descriptive tables revealed some differences. It seems

that this impact is captured by other variables, like the use of different sources of innovation and the hampering factors – as we saw, foreign firms used more intensively the sources within the firm (group), while were much less subject to various hampering factors.

Table 6 Innovation expenditure equation

Variables	Engagement in innovative activities (0/1)		Innovation investment intensity	
	Coef.	St.err.	Coef.	St.err.
Foreign firm	0.053**	(0.020)		
Domestic multinational			-0.013	(0.075)
Foreign firm without outward FDI			0.011	(0.038)
Foreign firm with outward FDI			0.176	(0.098)
International competition	0.062***	(0.016)	0.225***	(0.047)
Formal protection	0.284***	(0.022)	0.568***	(0.068)
Public funding	0.581***	(0.033)	1.541***	(0.152)
Log number of employees	0.069***	(0.006)		
Innovation cooperation				
Other enterprises within the group			-0.018	(0.043)
Competitors			0.052	(0.044)
Customers			0.041	(0.048)
Suppliers			-0.001	(0.045)
Sources of information				
Sources within the firm or group			0.109*	(0.043)
Competitors			0.035	(0.042)
Customers			-0.027	(0.042)
Suppliers			0.150***	(0.038)
Obstacles to innovation				
Lack of appropriate sources of finance			-0.132**	(0.041)
Innovation cost too high			0.047	(0.041)
Lack of qualified personnel			-0.004	(0.043)
Lack of information on technology			0.005	(0.053)
Lack of information on markets			0.034	(0.047)
Rho			.713	.047
Observations	4422		1364	
Log-likelihood			-4908.5	

Notes. * significant at 10% level; ** significant at 5% level; *** significant at 1% level. Reported are the marginal effects for the probability of engagement in innovative activities and the expected value of innovation investment. Industry dummies have been included in regression equations.

Foreign owned exporters have a higher propensity to make non-zero innovation expenditure, but there is no effect on the size of the R&D expenditure. Among the four groups of firms domestic exporters have the lowest probability to undertake either R&D expenditures or innovation expenditures. It supports again the finding that export is dominated by labour intensive production, which does not require significant investments into R&D. For non-exporting firms the probability seems not to depend on the ownership (domestic or foreign).

Concerning the other determinants of the innovation investment, similarly to probability to have innovation investment, formal protection, public funding and international competition are all positive and significant. Innovation investment is increased with more intensive knowledge flows within firms and suppliers, while reduced due to the lack of appropriate sources of finance. These results are mostly in line with the earlier studies, like Masso and Vahter (2009) and Knell (2009).

5.2. Innovation output equation

The various tables below present the results for estimation of the knowledge production function. Table 7 presents the results for equations where the innovation output variable is either product or process innovation dummy variable, while Table 8 presents the results where the output indicators is sales from new products per employee. Earlier econometric studies have used both product and process innovation dummies (e.g. Grifitth et al. 2006) and innovation sales (e.g. Lööf et al. 2003) as innovation output variables. We did not use patents as output measure due to the low patenting activity of Estonian firms (that can be generalised more or less to the other CEE countries as well).

In the equation for all output measures, the export dummy increases the innovation output in most specifications. Relative to the reference category "Local firms", all three other groups have a significantly higher innovation output for all three output measures; the coefficients are larger for domestic multinationals and foreign multinationals with outward investments. However, once we include other variables to the equation, the ownership variables do not remain significant anymore; that result contradicts e.g. the ones by Criscuolo et al. (2005). It might indicate that the differences between these groups are quite well captured by their different expenditures and knowledge flows.

In addition to the discussed "own-firm" effect of FDI the FDI may also impact firm performance and behaviour (including innovativeness) more indirectly through spillover effects, through the presence of FDI in other firms in the same industry (horizontal spillovers), upstream or downstream industries (vertical spillovers). Hereby the horizontal spillover effects are captured by the employment share of other FDI owned enterprises in the 2-digit industry. So far only a small number of studies have studied the impact of FDI spillover effects on innovation output, among which both Bertschek (1995) and Blind and Jungmittag (2006) found in case of Germany the market share of foreign-owned firms to

increase the propensity to innovate. As both Table 7 and Table 8 show, the impact is positive and significant in almost all estimations, thus the presence of FDI in the industry indeed increases innovativeness, e.g. either due to stronger competitive pressure or the knowledge flows from FDI firms to other firms either due to the flows of people, demonstration effects et cetera, that are not nullified du to the business-stealing effect. That result is encouraging as quite often it is difficult to find robust evidence on the presence of FDI spillover effects in productivity regressions. The size of the impact is comparable to the own-firm impact.

Table 7 Estimates of the knowledge production function for the process and product innovations with bivariate probit model

Variables	Pr(Product innovation=1)			Pr(Process innovation=1)		
	(1)	(2)	(3)	(1)	(2)	(3)
Export dummy	0.138***	0.075**	0.071*	0.101***	-0.052	-0.056*
	(0.014)	(0.027)	(0.028)	(0.013)	(0.027)	(0.028)
Domestic multinational	0.195***	0.036	0.031	0.199***	0.057	0.040
	(0.052)	(0.060)	(0.060)	(0.052)	(0.062)	(0.062)
Foreign firm without outward FDI	0.066***	-0.021	-0.045	0.057**	-0.044	-0.041
	(0.019)	(0.028)	(0.030)	(0.019)	(0.030)	(0.031)
Foreign firm with outward FDI	0.201**	-0.034	-0.028	0.309***	0.132	0.139
	(0.077)	(0.092)	(0.091)	(0.076)	(0.086)	(0.084)
Foreign market share in 2-digit industry	0.264***	0.268***	0.232**	0.091*	-0.126	-0.104
	(0.046)	(0.074)	(0.075)	(0.046)	(0.071)	(0.072)
Import share in 2-digit industry	-0.024*	-0.017	-0.015	-0.011	0.014	0.010
	(0.009)	(0.013)	(0.013)	(0.008)	(0.015)	(0.014)
Innovation expenditure (pred.)		0.075***	0.038		0.145***	0.075**
		(0.018)	(0.022)		(0.020)	(0.024)
Formal protection			0.115***			-0.032
			(0.025)			(0.030)
Log number of employees			-0.013			0.039***
			(0.009)			(0.010)
Sources within firm or group			0.072*			0.028
			(0.035)			(0.038)
Competitors			0.032			0.011
			(0.036)			(0.037)
Customers			0.216***			-0.106**
			(0.034)			(0.036)
Suppliers			-0.136***			0.268***
			(0.032)			(0.034)
Observations	4905	1815	1814	4905	1815	1814
Log-likelihood	-4886.8	-2039.1	-1947.1	-4886.8	-2039.1	-1947.1

The other variables in the equations have expected signs. Customers are important sources of information for product innovation and competitors for process innovation. Also sources within the firm are significant in all specifications. Given the lower intensity of how universities are used, it is not surprising that this variable is significant in the regressions. Innovation expenditure (predicted from Heckman equation) is in all specifications statistically significant. The protection of innovation through formal methods is more important for

product than process innovation that could be explained by the fact that protection using formal methods is more often applied to product than process innovation. Firm size has an insignificant impact on product and a positive impact on the probability of process innovation, thus only in the case of process innovation is the Schumpeterian hypothesis confirmed, possible explanation being that most product innovations are probably rather incremental, and thus, do not require large expenditures on R&D that only large firms can afford. On the other hand process innovations in the large scale firms may produce significant positive results and improve competitiveness of firms.

Table 8 Estimates of the knowledge production function for the innovation output (sales from new products) per employee

Variables	(1)	(2)	(3)
Export dummy	146.686***	-11.060	79.497***
	(25.338)	(30.143)	(26.717)
Domestic multinational	248.874***	61.228	68.094
	(75.705)	(76.394)	(60.041)
Foreign firm without outward FDI	101.440***	20.111	-4.314
	(30.774)	(33.045)	(27.249)
Foreign firm with outward FDI	254.774**	24.061	33.365
	(103.602)	(104.367)	(81.779)
Foreign market share in 2-digit industry	432.006***	301.468***	128.321*
	(85.164)	(92.822)	(75.787)
Import share in 2-digit industry	-64.303***	-54.412***	-57.472***
	(15.736)	(15.754)	(13.104)
Innovation expenditure (pred.)		73.437***	48.394**
		(20.101)	(21.400)
Formal protection			3.190
			(25.895)
Log number of employees			-26.734***
			(9.034)
Sources within firm or group			107.569***
			(35.107)
Customers			138.450***
			(32.874)
Suppliers			-61.196**
			(30.927)
Competitors			45.712
			(33.675)
Universities			-45.237
			(43.863)
Observations	5101	5101	1789
Log likelihood	-9763.246	-9763.246	-8687.534

6. Conclusions

It might seem straightforward that internationalisation and especially foreign ownership should enhance knowledge base, productivity and innovations. The numerous earlier studies reveal very diverse results. Some works find that domestic firms are clearly more innovative

and, thus, foreign ownership has rather adverse impact on innovation activities. Other authors call for fine-tuned modelling, because when other important firm characteristics are included, ownership and foreignness issues can prove to be insignificant. There are also several contributions (including macro level studies), which show that foreign ownership and international activities in general have positive impact on innovations.

Our study investigated the issue in the context of small economy of Estonia. The Community Innovation Surveys (CIS) provide a useful body of data for this purpose. In order to investigate the wider internationalisation context (exporting and non-exporting, outward FDI etc), these data were interlinked with data from targeted survey and from Estonian Business Register. The preliminary analysis of dataset revealed that domestic multinationals have highest expenditures on innovation and R&D. However, foreign-owned outward investors exhibit even higher expenditure levels. Such firms tend to rely heavily on intra-firm knowledge sources, while domestic outward investors use competitors as knowledge sources. In a single country context foreign firms have much less knowledge contacts with universities than domestic counterparts. It might indicate their relatively low embeddedness into local systems. Foreign-owned firms are less restricted by various barriers to innovations than domestic companies.

The preliminary view on innovation outputs indicated that domestic multinationals are most innovative. Engagement in outward FDI and in exporting activities facilitates the innovations in both domestic-owned and foreign-owned firms. Unlike foreign firms, which introduce innovations new to the market, local firms limit themselves often to imitative activities that are new to the firm. Foreign exporters exhibit higher levels of process innovations and foreign non-exporters product innovations. This might imply the process optimising and cost oriented nature of exports from such firms.

The more sophisticated econometric modelling reveals that foreign-owned firms have higher likelihood to make innovation expenditures. The probability of such expenditures increases with availability of public funding, with firm’s openness to international competition, with better formal protection, and firm size. Although preliminary analysis revealed that ownership might have some impact on size of such expenditures per employee, the probit modelling did not reveal statistically significant results. From foreign firms exporters have highest

propensity to make innovation expenditures. The alternative Heckman equation gave similar results about the impact of funding and international operations.

The estimation of knowledge production function for innovation outputs shows that exporting has significant positive impact in most configurations. The local firms have lowest coefficients in comparison to other groups, while domestic and foreign multinationals who engage into outward FDI have higher impact coefficients. However, when all other control variables are introduced into model ownership becomes insignificant. More importantly modelling revealed positive and significant spillover effects from FDI. Firm size had significant positive effect only on process innovation.

To generalise, we can say that despite the insignificance of ownership in comparison to other characteristics there are important positive spillover effects on innovation from FDI. Thus, in terms of innovation expenditures as inputs and product or process innovations as outputs internationalisation by exporting, FDI and multinational aspirations has all in all more positive than neutral or negative impact. The interesting finding specific to small country context relates to the fact that outward openness (outward FDI) and spillovers seem to reinforce the relationship.

The study has some important limitations. First of all the intricate nature of direct and indirect influences makes it difficult to find the appropriate set of variables to be included in models. There might be other organisational characteristics of importance, which are currently left out due to limitations of available data. Secondly, the survey data has some problems in terms of interpretational qualities of respondents. The revealed responses might not always reflect the true and detailed understanding of the issue. This inherently influences also the modelling outcomes. Despite that the results represent our best effort to coherently use the joint potential of various datasets in order to derive detailed picture which has also potential for generalisations.

The theoretical implications from these results point to the importance of outward openness in comparison to non-exporting non-investing closeness of subject firm. The diverse impact of foreign support seems to be significantly influenced by this transmitting nodal status versus the dead-end nature. The other theoretical refining concerns the direct ownership influences and indirect spillovers. Both these subjects have already found considerable research interest,

but more interconnected approaches are called for to identify positive spillovers where direct impact might be non-existent.

The managers can benefit from this study by tapping into wider range of knowledge sources via diverse and active involvement in exporting and investing activities. Often they fail to realise that initiation of international activities can also serve as an important learning opportunity in becoming more innovative.

The policy implications suggest that government policies as well as triple helix cooperation should be oriented not only towards attracting foreign interest, but also towards building opportunities for more extensive regional and international business networking by exporting and outward FDI. The multidirectional openness of business environment seems to be the key for harnessing the full potential of internationalisation from the perspective of innovations. The spillovers from inward-outward foreign firm are also likely to exceed those from non-exporting foreign interest.

The future research should be aimed at the further refinement of model configurations in terms of ownership, exporting, and other variables to be included into analysis. At present studies tend to be too limited in terms of incorporating more indirect influences. The theory development should offer more refined explanations for revealed contradictory influences on firm, industry, and country levels. There is multitude of empirical work done in the field, but theory building seems to lag behind.

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Appendix 1 Overview of selected studies on the impact of internationalization on innovation

Appendix 2. Definitions and summary statistics of variables used in descriptive tables and regression analysis

Variable name	Variable definition	Mean	Std. Dev.
Foreign firm	Dummy; 1 if foreign owners have the majority in the firm	0.16	0.37
Local firms	Dummy; 1 if domestically owned firm and without outward FDI	0.68	0.47
Domestic outward investors	Dummy; 1 if domestically owned firm with outward FDI	0.01	0.12
Foreign firm without outward FDI	Dummy; 1 if foreign owned without outward FDI	0.12	0.33
Foreign outward investors	Dummy; 1 if foreign owned firm with outward FDI	0.01	0.09
Export dummy	Dummy, 1 if firm has positive exports	0.61	0.49
Foreign market share in 2-digit industry	Employment in foreign firms divided with total employment	0.22	0.15
Import share in 2-digit industry	Imports divided with the sum of sales of local firms and imports	0.36	1.19
Log number of employees	Natural log of the number of employees	3.21	1.19
Product innovation	Dummy, 1 if firm reports having introduced new or significantly improved product	0.18	0.38
Process innovation	Dummy, 1 if firm reports having introduced new or significantly improved production process	0.17	0.37
Sales from new products per employee	Sales from new products per employee, in '000 kroons	30.71	208.36
Innovation expenditure	Total innovation expenditure per employee (in logs)	2.55	1.72
Innovation expenditure dummy a)	1 if firm reports positive expenditure on innovation	0.16	0.36
International competition	Dummy, 1 if the firm's most important market is international market.	0.45	0.50
Formal protection	Dummy, 1 if firm uses registration of design patterns, trademarks, copyright to protect inventions or innovations	0.08	0.27
Public funding	Dummy, 1 if firm received public funding for innovation projects	0.02	0.13
Other enterprises within the group	'4 values, 0, 1/3, 2/3, 1; higher value indicates greater importance	0.03	0.18
Suppliers	'4 values, 0, 1/3, 2/3, 1; higher value indicates greater importance	0.05	0.23
Customers	'4 values, 0, 1/3, 2/3, 1; higher value indicates greater importance	0.05	0.22
Competitors	'4 values, 0, 1/3, 2/3, 1; higher value indicates greater importance	0.03	0.18
Sources within the firm or other firms within the group	'4 values, 0, 1/3, 2/3, 1; higher value indicates greater importance	0.52	0.34
Competitors	'4 values, 0, 1/3, 2/3, 1; higher value indicates greater importance	0.40	0.35

Variable name	Variable definition	Mean	Std. Dev.
Customers	'4 values, 0, 1/3, 2/3, 1; higher value indicates greater importance	0.55	0.37
Supplier	'4 values, 0, 1/3, 2/3, 1; higher value indicates greater importance	0.53	0.38
Lack of appropriate sources of finance	'4 values, 0, 1/3, 2/3, 1; higher value indicates greater importance	0.43	0.41
Innovation cost too high	'4 values, 0, 1/3, 2/3, 1; higher value indicates greater importance	0.40	0.41
Lack of qualified personnel	'4 values, 0, 1/3, 2/3, 1; higher value indicates greater importance	0.33	0.37
Lack of information on technology	'4 values, 0, 1/3, 2/3, 1; higher value indicates greater importance	0.23	0.30
Lack of information on markets	'4 values, 0, 1/3, 2/3, 1; higher value indicates greater importance	0.24	0.31