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Abstract

This paper investigates the effects of both inward and outward foreign direct investment (FDI) on productivity in manufacturing and services sectors. The main novelty is the analysis of the spillover effects of outward FDI that may occur outside the investing firms on the rest of the home country. Our results based on panel data from Estonia do not indicate much spillover effects of outward or inward FDI that are robust to different specifications of the estimated model. There is substantial heterogeneity in the findings on spillovers across different specifications of the model or sector studied.

Keywords: foreign direct investment, spillovers, home country effects, productivity

JEL Code: F10, F21, F23

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Non-technical summary

An increasing number of studies have engaged in the analysis of the effects of foreign direct investments (FDI) on productivity in the host country of the investment. Both direct effects to the subsidiary (own-firm effects) and spillover effects to the domestic enterprises in the host economy have been quite thoroughly addressed. If compared to the analysis of the effects of inward FDI (i.e. the host country effects), the home country effects of FDI have been researched to lesser extent. Still, this issue has (also historically) provoked significant interest for the policy makers in advanced countries. Outward FDI has been blamed often (very often with no reason) for adverse effects on home economy, incl. for example the argument of exporting jobs. The studies that discuss the effects of FDI in its home country focus their analysis overwhelmingly on the effects on the investing firm (on its employment, output, exports, productivity).

The aim of this paper is to study the effects of both inward and outward foreign direct investment (FDI) on productivity. The main novelty is the analysis of the spillover effects of outward FDI that may occur outside the investing firms on the rest of the home country. The effects are addressed both for the manufacturing and services sectors. In our paper we employ a rich enterprise-level panel dataset of all the Estonian firms (up to approx. 41,000 firms per year) during 1995 to 2002 from the Estonian Business Register. We combine this database with the unique dataset from the Department of Balance of Payments of Bank of Estonia on the firms with outward FDI. To our best knowledge there have so far been no studies based on enterprise-level panel data analysing the spillovers of outward FDI in the production function estimation framework.

We find that engaging in outward FDI or receiving inward FDI is positively related to the productivity of the parent firm in Estonia or the subsidiary in Estonia. We do not find evidence of positive spillovers via outward or inward FDI that is robust to the specification of the model or does not depend on the sector being studied. The results on spillover effects vary according to different specifications of the spillover variable, being either not statistically significant or, in some cases, positive. The lack of robust statistical evidence about the spillover effects via outward FDI based on our data does not mean that there are no positive effects at all. The effects of FDI are certainly quite diverse for different host or home countries, different sectors and in different time periods, and are most likely to depend on the type of FDI.

1. Introduction

An increasing number of studies have engaged in analysis of the effects of foreign direct investment (FDI) on productivity in the host country of the investment. Both direct effects (also known as "own-firm effects") on a subsidiary of a multinational enterprise (MNE) and spillover effects on domestic enterprises in the host economy have been quite thoroughly addressed in the literature. There is a general consensus that FDI improves the productivity of the firms that receive it, although part of the effect can be attributed to FDI selecting better firms (Bellak 2004). However, papers studying spillover effects from FDI in the host country show a multitude of different results (Görg and Strobl 2001, Smarzynska Javorcik 2004).

Compared to the analysis of the effects of inward FDI (i.e. host country effects), the home country effects of FDI have been researched to lesser extent. Still, this issue has provoked significant interest among the policy makers in advanced countries. Outward FDI has often been (very often with no reason) blamed for adverse effects on the home economy, including, for example, the argument about exporting jobs. The studies that discuss the effects of FDI in the home country[1] focus their analysis overwhelmingly on the effects on the investing parent firm[2] (on its employment, output, exports and productivity). In their recent publication, Barba Navaretti and Venables (2004) stress that so far the spillovers of FDI in the home country of the investor are mostly left out of the analysis and there is a need to fill this gap in research.

The aim of this paper is to study and compare the spillover effects of both inward and outward FDI on the productivity of firms. The main novelty is the analysis of the spillover effects of outward foreign direct investment that may occur outside the investing firms on the rest of the home country. Additionally, we concentrate on the effects both in the manufacturing and the

[1] I.e. the source country of FDI.
[2] Examples, among others, include Lipsey (2002), Criscuolo and Martin (2003).

services sector. Most of the former studies (except e.g. Griffith et al. 2004 on UK) consider the effects of FDI in the manufacturing sector.

We use a rich enterprise-level panel dataset of the population of all Estonian firms (up to approx. 41,000 firms per year) from the Estonian Business Register from the period 1995 to 2002. Estonia has been a transition economy that has witnessed rapid economic reforms and growth and has attracted substantial amounts of inward FDI per capita. Moreover, the outward FDI from the Central and Eastern European (CEE) countries in general and from Estonia in particular to its neighbouring countries has risen significantly in recent years. Estonia ranked first in 2001–2003 among the CEE countries by the ratio of its outward FDI to the total capital formation (UNCTAD: WIR 2004). Thus there is reason to expect, in addition to inward FDI spillovers, that some spillovers occur from firms that have undertaken outward FDI.

Our finding about the direct effect of FDI is that both receiving FDI into the firm and making outward FDI is associated with the higher productivity of the firm. at the same time, significant self-selection effects are also found among firms.

However, we do not find much evidence of positive horizontal spillovers via outward or inward FDI that is robust to the specification of the model. The results vary according to the different specifications, being either not statistically significant or, in some cases, positive.

This paper is structured in the following way: Section 2 provides an overview of relevant literature related to the "own-firm" and spillover effects of both inward and outward FDI. Section 3 describes the methodology used in the paper. Section 4 gives a short overview of outward and inward FDI in Estonia. Section 5 describes data and provides descriptive statistics based on enterprise level panel data. The results of our econometric analysis are presented in Section 6. Section 7 concludes.

2. Home and Host Country Effects of FDI

It is well known from the theory of host country effects of FDI that in order for FDI to occur, the multinational enterprise (MNE) must have some firm specific advantages compared to the enterprises in the host economy (Caves 1996, Markusen 2002, Dunning 1988). These firm specific advantages may result in technology transfer from the parent firm to its affiliate in the host country of investment and related spillover effects[3] in the host economy. There are many articles, both theoretical and empirical, studying this issue (Blomström and Kokko 2003, Görg and Strobl 2001, Bellak 2004).

If foreign firms introduce new products and/or processes in their affiliates in a host country, domestic firms (and in fact also other foreign owned firms) may benefit from a faster diffusion of new technology through worker mobility between foreign owned and other local firms, demonstration effects and through increased incentives to adopt state-of-the art technology in domestic firms due to increased competition in the product market (Blomström and Kokko 2003). Spillovers are said to take place as MNEs, due to the public good characteristics of their firm specific assets, cannot reap all the benefits of their activities in a foreign location (Caves 1996).

Generally, we can in the same manner as with host country effects[4], divide the home country effects into two parts. The first is the so-called "own-firm effect" – the effect of making outward FDI on the performance characteristics of the home firm of the MNE. The second part is the

[3] Spillover effects – in the context of home country effects; these are effects from the presence/proximity of multinational enterprises that have invested abroad upon other local enterprises (that have not invested abroad) in the home country. In the context of host country effects of FDI, FDI spillovers measure how the presence of firms with foreign owners in the country affects other firms in this host country.

4 For earlier studies on productivity related host country effects in Estonia see e.g. Sinani and Meyer (2004), Damijan and Knell (2005) or Vahter (2005).

various external effects. These are *horizontal* or *vertical spillover effects*[5] from the presence of multinational firms on the performance of other local firms and other MNEs active in the home economy.

The theoretical predictions about the effects of doing outward FDI on the performance of the investing firm and on other firms in the home country of investment via potential spillover effects are, however, not so clear cut as in the case of inward FDI.

At first, there is certainly a self-selection effect into doing FDI (or alternatively there is one into receiving it). A recent and increasingly popular model of exporting and FDI by Helpman, Melitz and Yeaple (2004), that assumes heterogeneous firms, predicts that the least productive firms sell only to the domestic market, that relatively more productive firms export, and that the most productive firms engage in outward FDI. One reason why firms that engage in outward FDI have higher productivity is the need to be able to cover sunk costs related to FDI. Only "good" firms are able to do that.

Apart from the self-selection effect, there are some reasons why opening a foreign affiliate may affect positively the productivity of the MNE in its home country. These may be:

- opening of new channel of international sourcing of technological, managerial, host country conditions/market related knowledge;
- the exploitation of firm level scale economies;
- possible change in composition of production inputs, i.e. specialization effect – taking advantage of international division of labour within a MNE.

The first of these, the knowledge transfer effect, may also be translated into positive spillover effects on other national firms in the home economy of the investor. The transferred knowledge

5 Horizontal spillovers are the effects of FDI on other firms in the same sector (to the competitors), vertical spillovers are the effects on suppliers and clients of the firm that has FDI.

may concern technology[6], marketing, foreign market related information, information that will also make it easier for other firms to become multinational, etc.

The channels of effects of outward FDI on productivity of other firms (i.e. the spillovers) in the home country of investment are arguably similar to these of inward FDI. These are mostly the demonstration effect and worker mobility effect. In general, we can expect these spillover effects from presence of other MNEs to be positive (unless, for example, there is some adverse effect on former suppliers in the home economy due to switching to new suppliers from the host economy). One important relevant assumption from the previous literature on host country spillovers is that the magnitude of host country spillovers may depend a lot on the absorptive capacity of firms in the host or home country[7] (Cohen and Levinthal 1989). This is likely to be the case also for home country spillover effects. Thus the external effects of FDI may in fact be larger for firms that are themselves foreign affiliates or for firms that have invested abroad themselves, as these firms have more international experience and may due to that be more able to absorb potential benefits via spillovers.

So far the empirical literature on home country effects has focused mainly on the effects on the investing firm (see e.g. Lipsey 2002). There are, however, some empirical papers that could be considered as studies of spillover effects. The most recent one is a parallel work to this paper by Castellani and Zanfei (2006) "Multinational firms, Innovation and Productivity" where in the 6th chapter they find that domestic multinationals have a positive impact on non-internationalised domestic firms (Castellani and Zanfei 2006).

[6] In the case of Estonia, technology related know-how from outward investment is probably not very important, as the technological level of the main host countries of Estonian FDI, Latvia and Lithuania, is not significantly different from Estonia. We would, in this context, rather expect spillovers in the form of improved host market related know-how (e.g. the knowledge about local customers).

7 It is possible that the amount of positive effects of outward FDI in the home economy may increase as the home country's economy grows and the absorptive/learning capacity of national firms grows as well. A sufficient level of

Other former studies, however, concentrate on examining a part of the spillover effects of outward FDI by analysing patent citation data (e.g. Globerman et al. 2000). The previous patent citations in the patent acquisition processes of MNEs and other local enterprises are compared in these papers, and based on this information some conclusions on external effects are made. Unfortunately, these studies tend to look at a small number of firms – they consider firms that have patents. Thus a sizeable share of the potential spillover effects may potentially be left out of the analysis as only some knowledge can be patented. In addition, this approach cannot be used in our particular case here for Estonia due to the very low patenting activity among local firms in this country. Contrary to the spillovers of inward FDI, there is so far a lack of broader empirical studies about the spillover effects of FDI in the home country context[8].

3. Methodology

We estimate a Cobb-Douglas type production function in order to find out the effects of outward FDI (esp. the externalities) on TFP and compare these results with the effects of inward FDI. In order to check for the robustness of our findings we have employed both the two-step estimation framework (with separate TFP estimation in the first phase) and the augmented production function approach. At first we estimate the augmented Cobb-Douglas production function in logs with measures of the presence of either inward or outward FDI at firm level and sector level included is:

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absorptive capacity among national firms may be a necessary condition for benefiting from possible positive spillovers from outward FDI in Estonia and in the home countries in general (see e.g. Cohen and Levinthal 1989).

[8] One recent exception is a paper by Bitzer and Görg (2005). They investigate the productivity effects of both inward and outward FDI. However, they do not use enterprise level data, but instead use country and sector level data from OECD countries. They find, on average, a negative correlation between a country's stock of outward FDI and productivity. However, this is the average effect. Also, a positive relationship is found for several OECD countries in their article. Their results underline that the effects of FDI depend a lot on the characteristics of the home (or host) countries of investment.

$$
\begin{aligned}
(1)\quad & y_{ijt} = \beta_0 + \beta_1 k_{ijt} + \beta_2 l_{ijt} + \beta_3 m_{ijt} + \beta_4 X_{ijt} + \\
& \beta_5 OUTFDI\_firm_{ijt} + \beta_6 OUTFDI\_spillover_{ijt-1} + \\
& + \beta_7 OUTFDI\_firm_{ijt-1} \cdot OUTFDI\_spillover_{ijt-1} + \\
& + \alpha_j + \alpha_t + \varepsilon_{ijt}
\end{aligned}
$$

where:

$$
OUTFDI\_spillover_{ijt} = \frac{\left(\sum_{i \text{ for all } i \in j} Assets_{ijt}^{OUTFDI} \right) - Assets_{ijt}^{OUTFDI}}{\sum_{i \text{ for all } i \in j} Assets_{ijt}},
$$

$$
Assets_{ijt}^{OUTFDI} = \begin{cases} Assets_{ijt}, \text{ if } OUTFDI\_firm_{ijt} = 1 \\ 0 \text{ else.} \end{cases}
$$

Here the log of the output (y) for firm i in industry j at time t is regressed on logs of inputs like capital (k), labour (l), intermediate inputs (m), a vector of possible other control variables X_{ijt} and two measures of the presence of multinationals. $OUTFDI\_firm_{ijt}$ is an MNE status dummy that is equal to 1 if a firm has subsidiaries abroad at time t; otherwise it is equal to 0. Variable $OUTFDI\_spillover_{ijt}$ captures horizontal spillovers of outward FDI to those firms that are in the same sector in the home economy as the MNE. In order to test the robustness of the results to the specification of the spillover variable we have used three different versions of it – either based on the assets, sales or number of employees of the firm. The only difference between these spillover measures is the base variable. If we take the assets of the firm as a base variable, then the spillover variable is measured for different sectors in the form of the ratio: the assets of the *home firms of MNE* (with each outward FDI firm's own assets subtracted) to the sum of all firms' assets in the sector. Including its interaction variable with $OUTFDI\_firm_{ijt}$ into our econometric

estimation allows us to study the spillover effects to other home firms of MNEs in the economy[9] separately from national firms.

The reason for including lagged values of spillover variables in the analysis is that it may take time for the spillovers from inward or outward FDI to take effect. One might even expect to find more and positive spillovers in the longer time horizon.

Also, sector specific control variables, such as sector dummies and Herfindahl index, are included in order to take account of industry specific productivity differences and the fact that MNEs may originate from sectors with relatively high productivity. Additionally, the five region dummies are also included. We will estimate the equation both in levels and in differenced form. Differencing will remove fixed firm-specific unobservable effects, that may otherwise bias the results.

The specification for estimating the effects of inward FDI is similar to the one above. The difference is that instead of the MNE status dummy we use a dummy variable that is equal to 1 if the firm has received inward FDI, otherwise it is 0. Another difference is that instead of the outward FDI related variable $OUTFDI\_spillover_{ijt}$, we use a similar variable, $INFDI\_spillover_{ijt}$, for capturing the intra-industry spillovers of inward FDI. $INFDI\_spillover_{ijt}$ represents the share of foreign owned firms in a sector, measured by the ratio: the sum of the assets of the foreign owned enterprises in a sector (with each foreign owned firms' own assets subtracted) to the sum of the assets of all firms in the sector.[10] Sectors and spillover variables are defined at either the NACE[11] double-digit or three-digit level.

[9] This effect is given by the sum of β_6 and β_7.

[10] There is a caveat in estimating the model as specified in this section, if the variable $INFDI\_spillover_{ijt}$, instead of being defined as in this paper, were defined as simply the ratio of the sum of foreign owned firm's assets to the sum of total assets of the sector (or if $OUTFDI\_spillover_{ijt}$ were defined as the ratio of the sum of all MNE's assets in home country firms to the sum of total assets of the sector). In that arguably inferior case, there might be difficulties in separating the "own-firm" and spillover effects wholly from each other. This would particularly be a problem for the sectors with a small number of firms and one or a small number of foreign owned firms (or firms with outward

As a robustness check on the results from estimating TFP effects via the augmented production function (i.e. in one step), we follow a two-step approach. At first, we estimate the TFP as a residual from the logarithmic form of the Cobb-Douglas production function by using the Levinsohn-Petrin (2003) procedure, accounting for endogeneity of inputs and allowing different coefficients of logs of capital and labour in the production function for different sectors (at NACE 2-digit level):

$$(2)\quad v_{it} = \beta_0 + \beta_1 k_{it} + \beta_2 l_{it} + \omega_{it} + \eta_{it},$$

where v denotes the log of value added, ω_{it} is the productivity component of the error term that is allowed to be correlated with the input choices, and η_t is an error term that is uncorrelated with input choices. The Levinsohn-Petrin semi-parametric estimation method (see also Appendix) estimates this equation with materials as a proxy for accounting for ω_i. The TFP is calculated from the estimated equations as follows:

$$(3)\quad TFP_{it} = \exp(v_{it} - \hat{\beta}_1 k_{it} - \hat{\beta}_2 l_{it})$$

In the second step, we regress the log of TFP (denotes as *tfp*) on a FDI dummy, spillover variable(s) and other control variables (these include Herfindahl index and the size of the firm):

$$(4)\quad \begin{aligned} tfp_{it} &= \beta_3 X_{ijt} + \beta_4 OUTFDI\_firm_{ijt} + \beta_5 OUTFDI\_spillover_{ijt-1} + \\ &+ \beta_6 OUTFDI\_firm_{ijt-1} \cdot OUTFDI\_spillover_{ijt-1} + \alpha_j + \alpha_t + \varepsilon_{it} \end{aligned}$$

This equation is, similarly to the case of augmented production function, estimated both at levels and differences.

FDI) making up large proportion of that sector, or in the case of one very large foreign owned firm entering the sector. Naturally, this new sector level FDI penetration variable has different values for different firms, not only for different sectors. This ought to improve the results by establishing a more clear difference between the "own-firm" and spillover effects in the analysis.

An example: assume there are only three firms, two MNEs (A and B) and one national firm (C). The sum of assets in this sector is 100, A has 50 of it, B 30 and C has 20. The spillover variables value for firm A should be 30/100 as

As mentioned before, one important concern is the selection bias due to better enterprises being acquired by foreign firms or better enterprises making outward FDI. We try to examine this question briefly here by including one additional independent variable into the regression analysis of total factor productivity. This is the dummy variable that, depending on the framework, indicates either the future targets of foreign acquisition during the two years before the ownership change ($INFDI\_change_{ijt}$) or future home plants of multinationals ($OUTFDI\_change_{ijt}$) during the two years before engaging in outward FDI[12]. As we do not have much confidence in the applicability of conventional measures of vertical spillovers in our context, we look at the "horizontal" ones[13]. Notice, however, that at the 2-digit NACE level of aggregation of sectors, we are in fact including a lot of vertical relationships between firms (i.e. at 3-digit or more detailed level) in our measure of spillovers. The 3-digit level spillover measure is in fact more "horizontal".

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it can receive spillovers only from firm B; for firm B it is 50/100 as it can receive spillovers only from firm A and for C it is 80/100 as it can receive spillovers from both A and B.

[11] *Nomenclature générale des activités économiques dans les Communautés européennes, NACE.*

[12] For example, if the firm makes outward FDI for the first time in 2001, the corresponding dummy variable would take the value of 1 for 1999 and 2000. Smarzynska Javorcik and Arnold (2005) have taken similar steps with regard to inward FDI analysis. They found, based on Indonesian data, a positive effect from being a future target of inward FDI on the productivity of a firm

[13] The 2-digit level division of sectors has often been used by different authors in the empirical literature on vertical spillovers of inward FDI. A well-known example is the article by Smarzynska Javorcik (2004). However, such a small number of sectors (in manufacturing industry in the case of 2-digit level division about 14 sectors) may not be enough to study this type of spillovers in the correct way. Arguably, most of the spillovers may take place within each of these 2-digit individual sectors – that is, more inside the wood processing industry than, for example, between the wood processing and chemical industries.

Unfortunately, for many countries (including Estonia) more detailed input-output tables are not available. Also, most often these tables are available for only one year in the time series of the panel. Hence, the researcher actually assumes that the proportion of the output of one sector provided to another stays the same over the years in the study. This may not be a very plausible assumption (especially for transition countries), if the time dimension of the panel that is used is larger than just a couple of years.

4. Estonian Outward and Inward FDI

Estonia has been a transition economy that has implemented radical economic reforms, witnessed rapid economic growth and is known for attracting substantial amounts of inward FDI per capita. The ratio of inward FDI stock to GDP reached 77.6 per cent in 2003 (UNCTAD 2004). By its ratio of inward FDI stock to GDP (and by per capita stock of FDI) Estonia is ranked ahead of other attractive locations for FDI in the CEE region. The corresponding figure for the CEE region on average was 23.7 per cent; even this is a rather high figure internationally. Unlike in many other CEE countries, there are no special incentives provided for foreign investors in Estonia, domestic and foreign investors are treated equally. The attractive features of Estonia for foreign investors have been its geographical proximity to Sweden and Finland, relatively low costs of production and since year 2000 a special tax regime with zero corporate income tax on reinvested earnings.

Moreover, in recent years, outward FDI from Central and Eastern European (CEE) countries in general and from Estonia in particular to its neighbouring CEE countries has also risen significantly. In 2001–2003, Estonia ranked first among CEE countries on the basis of its ratio of outward FDI to total capital formation (UNCTAD: WIR 2004). This shows why Estonia can be a suitable case for studying the home country effects of FDI. Surveys addressing the motivation of outward investors in Estonia have indicated that the most important tend to be the market related motives (Varblane et al. 2001).

5. Data and Descriptive Statistics

We use yearly balance sheet and income statement data for the population of Estonian firms from the Business Register of Estonia for the period 1995–2002 and we have information on up

to 41,000 firms per year. This data includes information indicating whether each firm has foreign (majority) ownership or not. In order to study the effects of outward FDI, we have linked this panel data with a unique dataset on firms with outward FDI in Estonia compiled by the Balance of Payments Department of the Eesti Pank. Our panel data allows us to assess the effects of FDI on total factor productivity both in the manufacturing (NACE 2-digit code between 15 and 37) and services sectors (NACE 2-digit code between 50 and 74). It needs to be mentioned, however, that the commercial banks and construction firms had to be excluded from the analysis of the services sector.

We measure capital as the sum of tangible and intangible fixed assets minus goodwill. The share of firms with a) inward FDI or b) outward FDI in the number of firms in our panel has grown during the period 1995–2002 (see Table 1). The number of firms making outward FDI from Estonia is still significantly smaller than that of firms that have received FDI themselves. This has also been the case in other transition economies in Central and Eastern Europe and corresponds well to the predictions of the investment development path framework by Narula and Dunning (1996), where countries in the lower levels of economic development at first attract inward FDI and then later, as the economy grows and firms accumulate more knowledge and more means to cover sunk costs related to outward FDI, local firms also start investing abroad. At first, these firms start investing in adjacent markets that are relatively well known due to former, pre-entry trade relations, cultural proximity, similar business culture, etc. The number of firms in Estonian manufacturing and services sectors that have invested abroad from Estonia increased from 46 in 1995 to 274 in 2002 (see Table 1). The services sector clearly dominates in such investments. The majority of Estonian outward FDI (about 70 per cent of the stock of

outward FDI as of 31 December 2004) has gone to the other two Baltic countries – Latvia and Lithuania.

The share of intermediated outward FDI in total outward FDI is quite high: in the manufacturing industry the share of foreign owned firms in the total number of firms with outward FDI was 33.9 per cent, the corresponding figure for the services sector was lower at 28 per cent.

The calculations based on our panel of the population of Estonian enterprises show (see Table 2) that foreign owned firms, and especially the firms engaging in outward FDI, are on average larger than the rest. The share of home plants of MNEs in the total number of firms is around or less than 1 per cent. However, their share on the basis of employment or labour costs or sales is much larger.

One can often find extreme values for observations due to, for example, measurement errors in a firm level panel data like ours. We have controlled for the outliers by excluding these observations from the calculations where labour productivity (calculated either as the ratio of sales to employment or the ratio of value added to employment) fell below the 1st percentile or above the 99th percentile of all observations.

The descriptive statistics in Table 3 confirm that the highest level of productivity (incl. TFP), wages and capital intensity in the manufacturing industry can be found in foreign owned firms that have themselves invested abroad from Estonia. The second group on the basis of productivity (both by labour productivity calculated as sales per employee or value added per employee and by log of TFP; see Table 3) is domestic owned firms that have invested abroad themselves. Foreign owned firms that have not invested abroad from Estonia rank third. The lowest level of productivity can be found in domestic owned firms that have not invested abroad from Estonia. All the top three ranking groups have much higher labour productivity than the

domestic owned firms operating only at the national level. However, our data indicates that in the course of time, the differences between the average productivity levels of the four groups have somewhat decreased.

6. Econometric Analysis of the Effects of FDI on Total Factor Productivity

We have estimated the equations (2) and (5) both at levels and differences for the period 1996 to 2002. The results of estimating equation (2) in levels are included in Table 4. The results from estimating equation (5) in levels with log of TFP as dependent variable are included in Tables 5 and 6. The differenced equation (2) is presented in Table 7, the differenced equation (5) is presented in Table 8. The framework (in levels and differences) based on equation (5) has its advantages over estimation of equation (2) as it accounts for the endogeneity of production inputs and allows for heterogeneity in terms of the coefficients of the production function in different industries. This may be reflected in the results of the spillover effects of FDI.

Our estimation results (see Tables 4 to 6) confirm that foreign majority owned firms have higher TFP than domestic owned firms and also that firms with outward FDI have higher productivity than national firms. We also find that firms in manufacturing and services sectors that receive inward FDI during the next two years or engage in outward FDI during the next two years have higher TFP than the rest (as indicated by the variable *INFDI_change* or *OUTFDI_change* respectively). This indicates that MNEs choose good firms as their acquisition targets and that the firms with higher than average productivity invest abroad. This last finding implies that we find here empirical support for some of the predictions of the Helpman-Melitz-Yeaple (2004) theory, namely that firms with above average productivity are able to engage in outward FDI. The TFP premium of firms that have FDI, as indicated by the coefficient of the FDI dummy, is

significantly larger than the TFP premium two years before FDI. This suggests that both inward and outward FDI are likely to have a positive effect on the TFP of the firm.

Year and location dummies are significant in all specifications, also indicating, for example, that the TFP of firms outside Northern Estonia is significantly lower than inside that region.

The findings on spillovers of inward and outward FDI (as in Tables 4-8) are considerably less straightforward than the results on "own-firm" effects/direct effects. Different specifications indeed give rather different results based on Estonian panel data as the signs of the spillover variables differ depending on the model or the variable or the definition of the sectors used.

We have started from the augmented production function estimated in levels with sales based spillover variables and 2-digit sector classification (Table 4). Note that here we start from the rather simplistic assumption of similar capital, labour and intermediate input coefficients for different sub-sectors. In succeeding Tables 5, 6 and 8 we will later on relax this assumption. Also, the spillovers are defined here very broadly – at 2 digit level, thus incorporating probably also some vertical spillover effects, for example, between 3-digit level sectors inside each of the 2-digit level sector.

These findings based on augmented production function estimation in levels from Table 4 for the manufacturing and services sector were that the coefficients of spillover variables for outward or inward FDI proved to be insignificant, but the coefficient of the interaction variable $INFDI\_firm_{ijt} \cdot INFDI\_spillover_{ijt}$ (indicating inward FDI spillovers to other foreign affiliates) proved to be positive and significant in both sectors studied. Thus this finding seemed at first glance to indicate a positive lagged productivity spillover effect to other foreign owned firms, but no such spillover effect to the domestic owned firms in Estonia. In the case of outward FDI,

no lagged spillover effect either to firms that had not invested outside Estonia or those that had invested outside Estonia was found in this framework.

The results from the Levinsohn-Petrin approach based framework (and levels estimation) are given in Tables 5 and 6. Technology used by firms can in these specifications differ across sub-sectors of manufacturing or services, the coefficients of inputs are allowed to vary for each individual sector. In addition to that, in these tables and the following ones, a significantly more detailed view of spillover effects is employed than in Table 4 – we define spillovers at 3-digit NACE sectors. The results from table 5 and 6, based on this approach, are different from these of Table 4. The similarity with Table 4 is a seemingly positive spillover effect of inward FDI on other foreign affiliates in the host country of investment. However, now there appears also a positive spillover effect of inward FDI on domestic owned firms in the services sector. That finding occurs in both Table 5, where direct and spillover effects are estimated together, and in Table 6 where direct effects (columns 1 to 3) and spillover effects (columns 4 to 6) are estimated separately.

If we include both direct and spillover effects into the same regression, a positive effect of outward FDI on other MNEs in both manufacturing and services tended to occur based on the specification presented in Table 5. However, in Table 6 these spillover variables of outward FDI are only significant for the services sector. Column 6 in Table 6 includes the estimation of both inward and outward FDI spillovers in the same framework, indicating positive coefficient for outward FDI spillover variable in services sector.

These findings are based on estimating equations (2) and (5) in levels, however, a model in differences could indeed be preferred to the estimation in levels. Table 7 presents the results from the model (2) estimated in first differences. These estimation results are different from their

level counterpart in Table 4 and also from the results in Tables 5 and 6. The only significant positive spillover variable is the interaction term denoting spillovers from inward FDI to other foreign affiliates.

The specification of equation (5) in differences yields, as in the case of levels equations, results that are different from estimating augmented production function in differences. In fact a more positive (however still ambiguous) picture emerges about horizontal spillovers of outward FDI. The specification in Table 8 accounted for endogeneity of inputs in the first stage of the estimation process. The finding that stays the same in this framework if compared to the corresponding levels equation case for estimating equation (5) is only the positive effect of inward FDI on other foreign affiliates TFP in services sector (see column 1 in Table 8). However, this finding is not robust to the choice of length of time differences. The use of longer time differences gives more emphasis to more persistent changes in FDI penetration and reduces noise in the data (for application of longer time differencing in inward FDI spillover analysis see, for example, Smarzynska Javorcik, 2004). If a longer time difference – either second or third difference is used, then there appear no significant coefficients for spillover variables in that column for services sector. For manufacturing sector these results on inward FDI spillovers are also varying by the choice of time difference. There appear no significant coefficients in column 1 for manufacturing in Table 8 in case the first and second difference framework is used. However, a small significant effect is found if the 3rd difference is employed.

The robust finding from this table is that of positive significant effect of the presence of MNEs on other firms (both national firms and MNEs) in the same sub-sector inside the services sector. This finding is on the other hand in contradiction with the results from the level equations where substantially less effects of outward FDI and several positive significant effects of inward FDI

were found. However, we would rely more on these results from first (and second and third) difference estimation of equation (5) than the levels estimation. These results regarding potential positive evidence from the presence of firms with outward FDI seem to be robust to the choice of shorter or longer time differences.

Our analysis has outlined the multitude of difficulties in the analysis of spillover effects of inward and outward FDI in the production function framework. These varying findings stress the need for many cautious robustness checks of the results regarding spillover effects. Accounting for endogeneity of production inputs and allowing for greater heterogeneity of production technologies via using Levinsohn-Petrin method has yielded significantly different outcomes from the augmented production function case where both these issues are treated in a simplistic way. Augmented production function was assuming homogeneity of technology of firms and did not account for endogeneity of inputs.

In addition to that, the choice of the spillover variable may affect the results (2-digit vs 3-digit level variable, spillover variables as calculated based on assets, employees or sales of firms), the use of the sales-based measure may be less beneficial than the others as the sales numbers of MNEs and foreign affiliates may be distorted by the transfer pricing activities of these companies. There is a clear need to differentiate between potential receivers of spillovers, as other foreign affiliates (in the inward FDI spillovers case) or other MNEs (in the outward FDI spillovers case) might benefit more from knowledge externalities than the local firms with less international experience. Finally, the robustness checks that in addition to the levels equation estimation look also at both longer and shorter time differences may yield important further (and sometimes different) information about the existence and strength of spillovers.

In conclusion, the findings about spillover effects of outward FDI depend on which estimation framework has been used. We prefer more the estimation framework where one accounts for endogeneity of inputs and heterogeneity of coefficients of inputs like capital and labour across sub-sectors, at the same time estimating the relationships not only in levels but in longer and shorter time differences to check their robustness. Thus more emphasis could be put on the results from Table 8, that follow both of these issues. These results indeed show also more positive external effects via outward FDI.

7. Conclusions

In this paper we have examined the productivity spillovers of FDI from both the host and home country perspective. The main contribution of this paper to the literature is addressing the so far largely discarded topic of spillover effects from outward FDI to the rest of firms in the home country of the investor.

Our results show that both inward and outward FDI are positively related to the productivity of the firm receiving FDI or the firm doing FDI ("own-firm effect"). There exists also a significant self-selection effect for firms receiving FDI (both in the manufacturing and services sectors) or for enterprises undertaking outward FDI in the sense that firms with higher productivity attract inward FDI or are more likely to engage in outward FDI. This corresponds well to the implications of the recent model created by Helpman, Melitz and Yeaple (2004).

However, the results on the spillover effects from inward and outward FDI are quite diverse for different specifications of the model or the spillover variable. In our most preferred specification, that accounts for endogeneity of inputs, allows for heterogeneity of technology across sectors and looks at effects in shorter and longer time differences, also some positive external effects of

outward FDI were found. However, these very mixed results show that much caution is needed when interpreting the coefficients of spillover variables and especially when considering the policy implications about special incentives to FDI or generalizing the results for other countries. Different assumptions about the specification of the relationship between FDI and TFP of firms may lead to significantly different results.

The scarcity of robust statistical evidence about the spillover effects via outward FDI based on our data does not mean that there are no positive effects at all. The effects of FDI are certainly quite diverse for different host or home countries, different sectors and in different time periods, and are most likely to depend on the type of FDI. Favourable effects from the proximity of some types of multinationals are likely to occur for some groups of firms with high absorptive capacities.

In the future, better availability of input-output tables could potentially shed more light to the analysis of vertical spillovers of FDI. However, different detailed input-output table for different years of the panel are probably needed for the analysis of vertical spillovers, the use of only one input-output table and thus the assumption that these input-output relations do not change much in time is very often not likely to be a viable one.

References

1. Aitken, B. J., and A. E. Harrison (1999). Do Domestic Firms Benefit from Direct Foreign Investment? Evidence from Venezuela. *The American Economic Review* 89 (3): 605–618.
2. Barba Navaretti, G., and A. J. Venables with Barry, F.G., Ekholm, K., Falzoni, A. M., Haaland, J. I., Midelfart, K. H. and A. Turrini (2004). *Multinational firms in the world economy*. Princeton University Press.
3. Bellak, C. (2004). How Domestic and Foreign Firms Differ and Why Does it Matter? *Journal of Economic Surveys* 18 (4): 483–514.
4. Bitzer, J., and H. Görg (2005). The impact of FDI on industry performance. Economics Working Paper Archive at WUSTL, International Trade No. 0505003.
5. Blomström, M., and A. Kokko (2003). Human Capital and Inward FDI. *Stockholm School of Economics Working Paper* No 167. Stockholm School of Economics, Stockholm, Sweden.
6. Blomström, M. and A. Kokko (1996). The Impact of Foreign Investment on Host Countries: A Review of the Empirical Evidence. *World Bank Policy Research Working Paper* No 1745. World Bank, Washington, USA.
7. Castellani, D. and Zanfei, A. (2006*). Multinational Firms, Innovation and Productivity*. Edward Elgar.
8. Caves, R. (1996). *Multinational enterprise and economic analysis*. New York: Cambridge University Press.
9. Cohen, W. and D. Levinthal (1989). Innovation and learning: The two faces of R&D. *Economic Journal* 99 (397): 569–596.

10. Criscuolo, C. and R. Martin (2003). Multinationals, foreign ownership and US productivity leadership: Evidence from the UK. Royal Economic Society Annual Conference 2003 from Royal Economic Society, Working Paper No 50.
11. Damijan, J. P. and M. Knell (2005). How Important Is Trade and Foreign Ownership in Closing the Technology Gap? Evidence from Estonia and Slovenia". *Review of World Economics* 141 (2): 271–295.
12. Dunning, J. H. (1988). The Eclectic Paradigm of International Production: a Restatement and Some Possible Extensions. *Journal of International Business Studies* 19 (1): 1–31.
13. Dunning, J.H. and R. Narula (1996). The investment development path revisited: some emerging issues. In J.H. Dunning and R. Narula (eds.), *Foreign direct investment and governments*. London: Routledge.
14. Globerman, S., Kokko, A. and F. Sjöholm (2000). International Technology Diffusion: Evidence from Swedish Patent Data. *Kyklos* 53 (1): 17–38.
15. Griffith, R. (2004). Foreign Ownership and Productivity: New Evidence from the Service Sector and the R&D Lab. *Oxford Review of Economic Policy* 20 (3): 440–456.
16. Görg, H. and E. Strobl (2001). Multinational Companies and Productivity Spillovers: A Meta-Analysis. *The Economic Journal* 111 (475): 723–39.
17. Helpman, E., Melitz, M. J. and S. R. Yeaple (2004). Export versus FDI with Heterogeneous Firms. *The American Economic Review* 94 (1): 300–316.
18. Levinsohn, J. and A. Petrin (2003). Estimating Production Functions Using Inputs to Control for Unobservables. *Review of Economic Studies* 70 (2): 317–341.
19. Lipsey, R. E. (2002). Home and Host Country Effects of FDI. NBER Working Paper No 9293. National Bureau of Economic Research, Cambridge, Mass.

20. Markusen, J. (2002). Multinational Firms and the Theory of International Trade. Cambridge: MIT Press.
21. Olley, S. G. and A. Pakes (1996). The Dynamics of Productivity in the Telecommunications Equipment Industry. *Econometrica* 64 (6): 1263–1297.
22. Sinani, E. and K. Meyer (2004). Spillovers of technology transfer from FDI: the case of Estonia. *Journal of Comparative Economics* 32 (3): 445–466.
23. Smarzynska Javorcik, B. (2004). Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers through Backward Linkages. *The American Economic Review* 94 (3): 605–627.
24. Smarzynska Javorcik, B. and J. M. Arnold (2005). Gifted Kids or Pushy Parents? Foreign Acquisitions and Plant Performance in Indonesia. CEPR Discussion Paper No 5065. Centre for Economic Policy Research, London, United Kingdom.
25. Vahter, P. (2005). "Which Firms Benefit More from Inward Foreign Direct Investments? Bank of Estonia Working Paper No 2005-11. Bank of Estonia, Tallinn, Estonia.
26. Varblane, U. (2001). Analysis of the Results of Survey Foreign Investor 2000. Mimeo, Enterprise Estonia.
27. Varblane, U., Roolaht, T., Reiljan, E. and R. Jüriado (2001). Estonian Outward Foreign Direct Investments. University of Tartu Economics & Business Administration Working Paper No 9. University of Tartu, Tartu, Estonia
28. World Investment Report 2004. (2003). New York and Geneva: United Nations, UNCTAD.

Table 1. Number of firms in the dataset (by sector, by presence of foreign investor and outward FDI)

Presence of Inward FDI	Presence of Outward FDI	Sector	1995	1998	2002
No	No	Services	10,949	21,077	25,883
Yes	No	Services	473	1183	1990
No	Yes	Services	28	73	159
Yes	Yes	Services	4	29	62
No	No	Manufacturing	2676	4215	4433
Yes	No	Manufacturing	151	369	480
No	Yes	Manufacturing	10	21	35
Yes	Yes	Manufacturing	4	13	18

Source: own calculations, Estonian enterprise level panel data 1995–2002.

Table 2. Share of firms with inward or outward FDI in the Estonian economy in 2002

Inward FDI	Sector	Firms	Employees	Labour cost	Value added	Assets
No	Services	92.7	88.23	81.95	82.25	81.36
Yes	Services	7.3	11.77	18.05	17.75	18.64
No	Manufacturing	89.97	68.25	59.87	57.86	53.13
Yes	Manufacturing	10.03	31.75	40.13	42.14	46.87

Outward FDI	Sector	Firms	Employees	Labour cost	Value added	Assets
No	Services	99.21	94.74	93.19	93.07	75.69
Yes	Services	0.79	5.26	6.81	6.93	24.31
No	Manufacturing	98.93	91.94	91.78	89.95	85.56
Yes	Manufacturing	1.07	8.06	8.22	10.05	14.44

Source: own calculations based on panel data of Estonian firms 1995–2002.

Table 3. Average labour productivity, capital intensity, wages (‘000 EUR) and log of TFP in 2002 for different groups of firms

Inward FDI	Outward FDI	Sector	Wage	K/L	Log(TFP)	Y/L	VA/L
No	No	Services	2 (4)	11.1 (4)	9.6 (4)	25.2 (4)	7.2 (4)
Yes	No	Services	5.2 (3)	17.9 (3)	10.5 (3)	53.6 (3)	14.9 (3)
No	Yes	Services	5.9 (2)	63.6 (1)	11 (2)	65.9 (2)	19.3 (2)
Yes	Yes	Services	7.3 (1)	31.9 (2)	11.1 (1)	80.7 (1)	23 (1)
No	No	Manuf.	2.4 (4)	3.5 (4)	9.3 (4)	18.7 (4)	6.3 (4)
Yes	No	Manuf.	4.5 (3)	12.2 (3)	9.8 (3)	34.3 (3)	10.9 (3)
No	Yes	Manuf.	5.3 (2)	10.5 (2)	10.1 (2)	46.6 (2)	14.2 (2)
Yes	Yes	Manuf.	5.8 (1)	14.8 (1)	10.6 (1)	66.5 (1)	23.4 (1)

Note: The number in the parenthesis is the respective group’s rank among the four groups in the particular indicator. VA/L – value added per employee; K/L – capital intensity, Y/L – sales per employee. Since 1999, the Estonian kroon (EEK) has been begged to euro (EUR) at the fixed rate of 1EUR=15.6466 EEK. Until 1999 the Estonian kroon was fixed to the DEM at the exchange rate 1EEK=8DEM).

Source: own calculations based on panel data of Estonian firms 1995–2002.

Table 4. Effect of inward and outward FDI on TFP in Estonia, augmented production function with spillovers defined at NACE 2-digit level

	Inward FDI		Outward FDI	
	Manufacturing	Services	Manufacturing	Services
	RE model	RE model	RE model	RE model
k	0.0970***	0.1062***	0.1002***	0.1080***
	(29.43)	(59.60)	(30.30)	(60.50)
l	0.3451***	0.3656***	0.3465***	0.3644***
	(59.15)	(100.82)	(59.03)	(100.06)
m	0.5463***	0.5175***	0.5468***	0.5183***
	(156.23)	(274.15)	(155.40)	(273.86)
Herfindahl index	0.0788	-0.0758	0.0624	-0.1049
	(0.57)	(0.32)	(0.45)	(0.44)
INFDI_firm	0.1610***	0.1744***		
	(9.14)	(13.16)		
INFDI_change	0.0924***	0.1192***		
	(3.70)	(6.80)		
OUTFDI_firm			0.1160***	0.1534***
			(2.58)	(5.09)
OUTFDI_change			0.0771***	0.0800***
			(2.76)	(4.23)
$(INFDI\_spillover)_{t-1}$ (based on sales)	-0.0541	-0.0582		
	(1.48)	(1.13)		
$(INFDI\_firm \cdot INFDI\_spillover)_{t-1}$ (based on sales)	0.0901**	0.1557**		
	(1.96)	(2.57)		
$(OUTFDI\_spillover)_{t-1}$ (based on sales)			-0.0325	-0.0454
			(0.62)	(0.91)
$(OUTFDI\_firm \cdot OUTFDI\_spillover)_{t-1}$ (based on sales)			0.0720	-0.1738
			(0.26)	(0.56)
Sector dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Location dummies	Yes	Yes	Yes	Yes
Constant	5.2639***	5.4714***	5.2830***	5.4493***
	(20.68)	(175.50)	(20.53)	(183.50)
Observations	14091	52639	14091	52639

Source: own calculations based on panel data of Estonian firms 1995–2002.
Note: Spillovers are defined at NACE 2-digit level. The robust *t*-statistics are in parentheses. ***, **, * denotes statistical significance at the 1, 5 and 10 per cent level, respectively.

Table 5. Effect of inward FDI on TFP in Estonia, with dependent variable TFP found by using the LP model, spillover variables are defined at 3-digit NACE level

	Inward FDI				Outward FDI			
	Manufacturing		Services		Manufacturing		Services	
	Spillover definition variable		Spillover definition variable		Spillover definition variable		Spillover definition variable	
	assets	employees	assets	employees	assets	employees	assets	employees
INFDI_firm	0.296***	0.311***	0.322***	0.335***				
	(0.039)	(0.032)	(0.029)	(0.022)				
INFDI_change	0.162***	0.158***	0.231***	0.227***				
	(0.045)	(0.045)	(0.03)	(0.03)				
OUTFDI_firm					0.307***	0.354***	0.381***	0.407***
					(0.082)	(0.084)	(0.052)	(0.052)
OUTFDI_change					0.049	0.123**	0.131***	0.147***
					(0.049)	(0.057)	(0.032)	(0.037)
$(INFDI\_spillover)_{t-1}$	0.009	-0.006	0.213***	0.521***				
	(0.037)	(0.048)	(0.033)	(0.048)				
$(INFDI\_firm \cdot INFDI\_spillover)_{t-1}$	0.191**	0.336***	0.227**	0.404***				
	(0.089)	(0.079)	(0.092)	(0.095)				
$(OUTFDI\_spillover)_{t-1}$					-0.052	-0.796	0.351	0.997
					(0.088)	(0.721)	(0.371)	(0.772)
$(OUTFDI\_firm \cdot OUTFDI\_spillover)_{t-1}$					0.108	-0.071	0.097*	0.194*
					(0.45)	(0.138)	(0.058)	(0.103)
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Location dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	3.663***	3.712***	21.393***	21.1175***	6.436***	6.302***	21.408***	21.099***
	(0.172)	(0.203)	(0.289)	(0.289)	(0.171)	(0.19)	(0.311)	(0.273)
Observations	14104	14094	49028	49005	14065	11497	48919	39728

Note: results from the RE model, models also included the Herfindahl index and logarithm of firm size as independent variables.
Source: own calculations based on panel data of Estonian firms 1995–2002.
Note: Spillover variables are defined at 3-digit NACE level. The robust standard errors are in parentheses. ***, **, * denotes statistical significance at the 1, 5 and 10 per cent level, respectively.

Table 6. Effect of out ward and inward FDI on TFP in Estonia with dependent variable TFP found by using the LP model, spillover variables are defined at 3-digit NACE level and based on the share of assets of FDI firms in a sector

	infdi		outfdi		both		Spillovers in		Spillovers out		Both	
	1		2		3		4					
	manuf	services	manuf	services	manuf	services	manuf	services	manuf	services	manuf	services
INFDI_firm	0.2069***	0.313***			0.212***	0.31***						
	(0.039)	(0.022)			(0.027)	(0.019)						
INFDI_change	0.101**	0.222***										
	(0.042)	(0.029)										
OUTFDI_firm			0.171**	0.279***	0.222***	0.281***						
			(0.076)	(0.047)	(0.086)	(0.051)						
OUTFDI_change			0.044	0.152***								
			(0.045)	(0.03)								
INFDI_firm*OUTFDI_firm					-0.095	-0.192**						
					(0.131)	(0.095)						
$(INFDI\_spillover)_{t-1}$							-0.022	0.241***			0.035	0.321***
							(0.037)	(0.032)			(0.036)	(0.031)
$(INFDI\_firm \cdot INFDI\_spillover)_{t-1}$							0.354***	0.733***				
							(0.065)	(0.062)				
$(OUTFDI\_spillover)_{t-1}$									-0.061	0.093	-0.054	0.068
									(0.088)	(0.058)	(0.088)	(0.058)
$(OUTFDI\_firm \cdot OUTFDI\_spillover)_{t-1}$									0.460	0.565*		
									(0.415)	(0.318)		
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Location dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	5.45***	19.715***	2.644***	19.974***	5.447***	19.875***	3.275***	20.358***	5.836***	20.31***	5.842***	20.336***
	(0.154)	(0.243)	(0.1863)	(0.272)	(0.154)	(0.254)	(0.188)	(0.268)	(0.163)	(0.271)	(0.163)	(0.27)
Observations	15207	52219	15207	52219	15207	52219	14104	52219	14094	49028	14094	48990

Note: results from the RE model, all models included also the Herfindahl index and logarithm of firm size as independent variables.
Source: own calculations based on panel data of Estonian firms 1995–2002. Note: Spillover variables are defined at 3-digit NACE level. The robust standard errors are in parentheses. ***, **, * denotes statistical significance at the 1, 5 and 10 per cent level, respectively.

Table 7.Augmented production function in first differences, spillover variable is based on total assets of firms and defined at 3-digit NACE level

	Only inward		only outward		Both	
dep. variable is Δy	1		2		3	
	manuf	services	manuf	services	manuf	services
Δ(INFDI_spillover)$_{t-1}$	-0.007	0.005			0.005	0.005
	(0.021)	(0.019)			(0.019)	(0.019)
Δ(INFDI_firm·INFDI_spillover)$_{t-1}$	0.099*	0.008				
	(0.053)	(0.051)				
Δ(OUTFDI_spillover)$_{t-1}$			-0.053	0.052	-0.053	0.052
			(0.04)	(0.041)	(0.04)	(0.041)
Δ(OUTFDI_firm·OUTFDI_spillover)$_{t-1}$			-0.031	-0.016		
			(0.074)	(0.248)		
ΔHerfindahl	0.081	-0.129	0.072	-0.117	0.072	-0.117
	(0.089)	(0.126)	(0.089)	(0.126)	(0.089)	(0.126)
Δk	0.112***	0.097***	0.112***	0.097***	0.112***	0.098***
	(0.01)	(0.004)	(0.01)	(0.004)	(0.01)	(0.004)
Δl	0.257***	0.258***	0.259***	0.258***	0.259***	0.258***
	(0.016)	(0.009)	(0.016)	(0.009)	(0.016)	(0.009)
Δm	0.492***	0.449***	0.492***	0.449***	0.492***	0.449***
	(0.014)	(0.009)	(0.014)	(0.009)	(0.014)	(0.009)
Constant	0.099	0.068***	0.101	0.146***	0.102	0.146***
	(0.086)	(0.008)	(0.086)	(0.01)	0.086	(0.01)
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Location dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	9979	35491	9979	35455	9979	35455
R^2	0.619	0.584	0.619	0.584	0.619	0.584

Source: own calculations based on panel data of Estonian firms 1995–2002. Note: Spillover variables are defined at 3-digit NACE level. The robust standard errors are in parentheses. ***, **, * denotes statistical significance at the 1, 5 and 10 per cent level, respectively.

Table 8. The effect of FDI, first differences, spillover variable is based on total assets of firms and defined at 3-digit NACE level

	only inward		only outward		BOTH	
dep. variable is Δtfp	1		2		3	
	manuf	services	manuf	services	manuf	services
Δ(INFDI_spillover)$_{t-1}$	0.003	0.009			0.014	0.022
	(0.053)	(0.041)			(0.051)	(0.04)
Δ(INFDI_firm·INFDI_spillover)$_{t-1}$	0.079	0.154*				
	0.101	(0.085)				
Δ(OUTFDI_spillover)$_{t-1}$			0.162	0.182*	0.164	0.178*
			(0.156)	(0.095)	(0.156)	(0.095)
Δ(OUTFDI_firm·OUTFDI_spillover)$_{t-1}$			0.06	-0.145		
			(0.613)	(0.559)		
ΔHerfindahl	-1.046**	-2.085***	-1.017**	-2.082***	-1.016**	-2.078***
	(0.510)	(0.575)	(0.511)	(0.573)	(0.511)	(0.573)
Δln(size)	-0.057*	-0.02	-0.057*	-0.019	-0.057*	-0.019
	(0.029)	(0.015)	(0.029)	(0.015)	(0.029)	(0.015)
Constant	-1.417***	-0.487**	-1.466***	-0.485**	-1.417***	
	(0.525)	(0.244)	(0.314)	(0.245)	(0.314)	
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Location dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	9598	32230	9590	32197	9590	32197
R^2	0.062	0.017	0.062	0.017	0.062	0.017
Do the signs and significance of spillovers change if 2nd and 3rd differences are used?	Not for 2nd, but yes (+ effect) for 3rd diff.	No significant effects found if 2nd and 3rd diff-s are used.	2nd diff.: no; 3rd diff: + effect of INFDI and – of OUTFDI	The same results in 2nd and 3rd diffe-rences.	Not for 2nd, but yes (+ both effects) for 3rd diff.	The same in 2nd and 3rd differences

Source: own calculations based on panel data of Estonian firms 1995–2002. Note: Spillover variables are defined at 3-digit NACE level. The robust standard errors are in parentheses. ***, **, * denotes statistical significance at the 1, 5 and 10 per cent level, respectively.

Appendix. The Levinsohn-Petrin semiparametric approach to the production function estimation

This appendix shortly outlines the main logic of the Levinsohn and Petrin (2003, LP) semi-parametric approach. The firms' production technology is assumed to be represented by a Cobb-Douglas production function (note that the approach here can be applied to other functional forms as well). If we use v_{it} to denote the natural log of value added (defined as sales y_{it} net of intermediate inputs m_{it}), the value-added based production function can be written as

$$\begin{aligned} v_{it} &= \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \omega_{it} + \eta_{it} \\ &\equiv \beta_l l_{it} + \phi_{it}(k_t, m_t) + \eta_{it} \end{aligned},$$

where l_{it} is the natural log of the freely variable labour input and k_{it} is the logarithm of the state variable capital. The error term has two components. The term η_{it} is uncorrelated with the input choices. The second of them, ω_{it}, is the transmitted productivity component that is a state variable and affects positively the choice of inputs by the profit-maximizing firm. It is not observable for the econometrician and affects the input choices, thus introducing the well-known endogeneity (simultaneity) bias in the production function estimation. Approaches like OLS that do not control for the endogeneity problem and lead to inconsistent results. Differently from fixed effects model the LP approach does not restrict that correlation to be time invariant.

Olley and Pakes (1996) dealt with the endogeneity bias by employing the investments as a proxy (instrument) for the productivity shock ω_{it}. The investments are correlated with the productivity shock since a firm with larger productivity shock in period t is expected to do better also in the future. Levinsohn and Petrin (2003) suggested that it is more fruitful to use the intermediate inputs instead; while firm level fixed investments are usually lumpy due to adjustment costs, intermediate inputs respond

more fully to productivity shock as they are less costly to adjust. Thus, demand for m_{it} can be written as a function of the state variables k_{it} and ω_{it}, $m_{it} = m_{it}(k_{it}, \varpi_{it})$. If the demand function is monotonically increasing in ω_{it}, the latter can be written as a function $\omega_{it} = \omega_{it}(k_{it}, m_{it})$. For identification, it is assumed that ω_{it} follows first-order Markov process, $\omega_{it} = E[\omega_{it} \mid \omega_{it-1}] + \xi_{it}$, where ξ_{it} is an innovation to productivity uncorrelated with k_{it}.

Given the above, the term $\phi_{it}(k_t, m_t) = \beta_0 + \beta_k k_{it} + \omega_{it}(k_{it}, m_{it})$ on the production function is thus an unknown function capital and intermediate inputs strictly increasing in ω_{it}. Levinsohn and Petrin (2003) used the third order polynomial $\sum_{r=0}^{3}\sum_{s=0}^{3-s}\delta_{rs}k_{it}^{r}m_{it}^{s}$ approximate the term $\phi_{it}(k_t, m_t)$, and then applying OLS obtain estimates on β_l and $\phi_{it}(k_t, m_t)$; that is the first-stage regression. At the 2nd stage the elasticity of capital β_k is estimated as a solution to $\min_{\beta_k^*}\sum_i\sum_t\left(y_{it} - \hat{\beta}_l l_{it} - \beta_k^* k_{it} - \varpi_{it}\right)^2$, where ϖ_{it} is the nonparametric approximation to $E[\omega_{it} \mid \omega_{it-1}]$ derived from regressing the predicted values for ω_{it} ($\hat{\omega}_{it} = \hat{\phi}_{it} - \beta_k^* k_{it}$) on the lagged estimates of ω_{it} obtained from the 1st stage results.

The calculation of the covariance matrix of the parameter estimates $\hat{\beta}_l$ and $\hat{\beta}_k$ allowing for the variation due to all estimators in the 2 stages is undertaken by employing bootstrapping. The reason is that deriving an analytical covariance matrix may be, though possible, nontrivial.

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