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Productivity spillovers from FDI: Empirical evidence from Estonia

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Abstract

Numerous countries strive to attract foreign direct investment (FDI) hoping for productivity to spill over from multinationals to domestic firms. This paper studies the possible productivity spillovers from FDI for domestic firms, through contact with foreign-owned firms in horizontal, downstream and upstream industry sectors. The analysis uses a large panel of Estonian manufacturing firms for the period 2010 to 2018 and implements a fixed effects methodology. The study shows that domestic firms experience positive FDI productivity spillovers through backward and forward linkages with multinationals in downstream and upstream sectors. Contrastively, local firms do not experience significant productivity spillovers from FDI through contact with foreign-owned firms in horizontal sectors. Such findings can be implemented by policy makers for the evaluation of policies directed at attracting foreign funds.

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1. Introduction

1.1 Motivation

Foreign direct investment (FDI) is thought to have formally emerged in the Victorian Era, where European powers sent their surplus savings to their colonies across the globe. Nowadays, FDI plays a deterministic role in the upsurge of global value chains and the intertwining of economies. However, the extent to which FDI flows have benefited transition and developing countries has been thoroughly questioned. Some argue that FDI generates substantial productivity increases for domestic economies, leading to greater economic growth. Contrastively, others stress FDI's power to hinder domestic capabilities and extract natural resources without sufficient compensation (Velde, 2006).

Although FDI is of a contested nature, attracting foreign direct investment has become a fundamental factor for developing and transition economies' growth strategies. Many nations offer distinctive incentives to foreign investors, such as tariff reductions and tax holidays, in order to accelerate inward FDI flows (Liu, 2002). Policy makers formulate such incentives based on the belief that FDI inflows will generate positive externalities in the form of new technologies, processes, marketing methods and management skills (Meyer & Sinani, 2009). Whilst these possible benefits are viewed as imperative, special attention is placed on FDI's contributions to increment the productivity and competitiveness of domestic industries. It is mostly hoped that technology transfers, which accompany FDI inflows, will transgress the projects developed by foreign investors and favour domestic firms through knowledge spillovers.

Nonetheless, there is a limited amount of evidence that foreign presence does contribute to productivity improvements for domestic firms. Even though numerous papers have used diverse forms of data and methodologies to explore the topic, many of these studies provide mixed or inconclusive results. For example, by using firm-level data, Keller and Yeaple (2003) were able to find significant knowledge spillovers from multinationals to domestic firms in the United States. However, Kinoshita (2000) and Haddad and Harrison (1993) find that foreign presence led to insignificant spillovers amongst Czech and Moroccan firms, respectively. Moreover, Aitken and Harrison (1999) implement panel data on Venezuelan firms to determine that multinational corporations had a negative effect on domestic companies.

The divergent nature of these findings casts doubt on the existence of FDI spillovers. However, this divergence stems from the fact that these studies focus on horizontal spillovers and overlook spillovers' vertical nature. Spillovers are more likely to be vertical than horizontal because multinationals have an enticement to prevent information leakage that would boost competitors' performance, whilst they may benefit from transferring knowledge and technologies to their local suppliers and purchasers (Javorcik, 2004). Nonetheless, few studies actually take these vertical linkages into account and the ones that do, implement a limited amount of observations and time spans.

1.2 Relevance

In our contemporaneity, various countries strive to attract FDI, expecting that knowledge brought by multinationals will spill over to domestic firms and increase their productivity. An increase in domestic firm productivity, caused by spillovers from FDI, would not only signify an increment in profits, but would also increase economic growth and development. It is based on this notion that governments commonly create policies favourable for foreign investors without sound empirical evidence to back up their decisions. Unfortunately, this leads to instances where governments offset the possible benefits from FDI by offering costly tax incentives to attract this foreign capital (Lembcke & Wildnerova, 2020). Thus, nations end up decreasing the standards of living that they initially strived to improve.

Critically questioning and testing these FDI spillover effects is highly relevant because, by means of econometric analysis, one is able to establish how FDI and its different spillover channels affect domestic firms and industries. By studying this matter, the economically relevant results and evidence needed to generate prudent FDI policies are gathered and examined. Numerous papers have assembled evidence on the effects of FDI inflows on domestic firm productivity in the same industry. However, a limited amount of studies take into consideration the vertical spillover channels through which FDI could affect domestic productivity. These vertical channels entail spillovers through backward and forward linkages. Foreign-owned companies have no reason to prevent backward spillovers to upstream sectors, as they would benefit from the improved productivity of intermediate domestic suppliers (Javorcik, 2004). Likewise, multinational presence in upstream sectors may generate forward spillovers in the form of less costly intermediate inputs, which improve domestic firms' productivity (Liu, 2008). Therefore, these vertical linkages are the most relevant channels through which FDI might affect productivity.

Research concerning these spillover channels is highly relevant for comprehending how multinational presence impacts specific firms. A clear example of this is the case of Aqris, an Estonian software development company founded in 1999. When the multinational, tech-giant Microsoft setup a subsidiary in Estonia, this represented a threat for Aqris as the companies were expected to compete in the same industry sector. Contrary to the expected, Microsoft played the role of a downstream costumer by purchasing Aqris' services and patents, and thereby enhancing the domestic firm's profits. Not only is this research relevant for firms, but it is also crucial for policy makers. This is because it may be used to reassure or refute policies targeted at increasing FDI inflows into specific market segments and industries.

Although highly relevant, this sort of research is limited. Ergo, this paper will analyse how FDI inflows into different market sectors affect the productivity of domestic firms. For this purpose, Estonian firm-level data for the years 2010 to 2018 has been chosen and the following research question is developed:

Did Estonian firms experience significantly positive productivity spillovers from FDI, through contact with foreign-owned firms in horizontal, downstream and upstream industry sectors?

1.3 Structure

Proceeding the Introduction, the Theoretical Framework Section 2 will be presented. In this section, the theoretical evidence underlying the subject matter will be discussed and previous literature will be used to formulate hypotheses. Thereafter, the data implemented in the analysis will be introduced in Section 3; the data sources, sample selection method and descriptive statistics will be discussed.

Subsequently, the methodology selected for the analysis will be explained and justified in Section 4. The rationale behind these methods and techniques will be presented, and their statistical legitimacy will be examined by means of statistical tests. The empirical analysis and discussion of pertinent results will then be developed in Section 5. In this section, each hypothesis will be linked to the relevant findings. Finally, the conclusion will be displayed in Section 6, in which a concise summary will be formulated, leading to a clear answer to the research question. This will be followed by a discussion and examination of the study's limitations, policy implications and suggestions for future research.

2. Theoretical Framework:

The IMF defines foreign direct investment (FDI) as enterprises in the financial or non-financial corporate sectors of an economy, in which a foreign investor owns 10 percent or more of the voting power of an incorporated enterprise (Graham, 1995). FDI is thought to be crucial for developing and transition market economies; not only do these countries require private investments in matters such as infrastructure, but their firms may also benefit from multinational funding and spillovers from FDI. FDI spillovers occur when the entry or presence of foreign-owned firms increments the productivity of domestic firms in a host nation, whilst the multinational corporations do not internalize these benefits entirely (Javorcik, 2004).

Many studies explore the possible spillover effects from FDI, one of the most relevant is the paper written by Javorcik (2004). In this influential paper, the author examines FDI spillover effects operating across industries. To do so, Javorcik implements unbalanced panel data consisting of Lithuanian firm-level statistics, covering the period 1996 to 2000. Unlike other studies, Javorcik recognizes that spillovers from FDI are more likely to be vertical than horizontal in nature, meaning that spillovers are likely to occur through backward and forward linkages. Backward linkages refer to the contact between domestic suppliers of intermediate inputs and their multinational purchasers (Javorcik, 2004). Forward linkages refer to the contact between multinational suppliers of intermediate inputs and their domestic clients.

To capture these FDI spillover effects, three proxy variables are generated by the author: *Horizontal*, *Backward* and *Forward*. Each variable represents the effect of FDI presence in horizontal, downstream and upstream industry sectors, respectively. The effect of these proxy variables on firms' output is then tested by means of ordinary least squares regressions (OLS) and non-linear least squares regressions with the Olley and Pakes semiparametric correction. Even though the brief duration of the panel makes it difficult to detect spillovers, the analysis produces evidence consistent with the presence of productivity spillovers through backward linkages. Moreover, the horizontal and forward linkages produce insignificant effects. Javorcik's (2004) focus on the different spillover channels has a considerable influence on the purpose of this paper. Thus, this study uses similar independent variables to explore spillover effects through these channels.

The first channel by which FDI might generate productivity spillovers for domestic firms is through horizontal linkages. Horizontal linkages refer to the interactions between firms at the same level of the value chain and within the same industry sectors. Horizontal spillovers may occur when domestic companies increase their efficiency by adopting the technologies of multinationals operating in the same industry, either through observation or by hiring workers trained by these firms (Javorcik, 2004). Additionally, these spillovers also occur if multinational presence causes more intense competition in the domestic market, forcing domestic firms to search for new technologies or use their resources more efficiently (Javorcik, 2004).

These horizontal linkages are examined by Aitken and Harrison (1999); they explore how multinational presence affects the productivity of domestically owned firms in the same industry. In this study, the authors implement unbalanced panel data on over 4,000 Venezuelan firms, for the period 1976 to 1988. They formulate a log-linear production function and by means of OLS regressions in differences, the effect of multinational presence on local firms' output is tested. Based on this methodology, they find that, as FDI increases, the productivity of domestically owned plants decreases. These negative spillovers from FDI are attributed to, what they refer to as, the market-stealing effect. This effect refers to the short run case in which multinationals producing for the domestic market can draw demand from local firms, causing domestic firms to reduce production (Aitken & Harrison, 1999). Domestic firms' productivity then decreases as they spread their fixed costs across a reduced market, pushing them back up their average cost curve (Aitken & Harrison, 1999). Based on Aitken and Harrison's (1999) findings, this study's first hypothesis is formulated as follows:

Estonian manufacturing firms experience negative productivity spillovers from FDI, through contact with foreign-owned firms in horizontal industry sectors.

The second and third channels by which FDI might cause productivity spillovers are the two forms of vertical linkages, namely backward and forward linkages. These vertical linkages are analysed by Liu (2008). A panel of Chinese manufacturing firms is used by the author to examine how technology transfers from FDI affect local firms' productivity. Liu (2008) implements the Olley Pakes procedure to generate firm-specific total factor productivity. Thereafter, this factor productivity is used as the dependent variable in a fixed effects model with firm dummies. Within this model, the independent variables are proxy variables representing the different spillover channels in the short and long term.

Liu (2008) finds that spillovers through backward and forward linkages have similar positive effects on the productivity of domestic firms. Akin to Javorcik (2004), backward linkages are found to be the most statistically important channel. This is because multinationals are incentivized to allow technology transfer to upstream sectors in order to benefit from the productivity of intermediate suppliers (Javorcik, 2004). Likewise, domestic companies may become more productive due to the less costly inputs sold by multinationals in upstream sectors (Liu, 2008). Intuitively, these results lead to the second and third hypotheses:

Estonian manufacturing firms experience positive productivity spillovers from FDI, through contact with foreign-owned firms in downstream industry sectors

and,

Estonian manufacturing firms experience positive productivity spillovers from FDI, through contact with foreign-owned firms in upstream industry sectors.

Similarly, Sinani and Meyer (2004) also research FDI spillovers, but they focus on how domestic firms' characteristics determine these spillovers. Sinani and Meyer (2004) implement a production function framework to evaluate the effect of technology transfers from FDI on the output growth of Estonian firms, for the period 1995 to 1999. For this purpose, the authors use Ordinary Least Squares (OLS), Fixed Effects (FE) and Generalized Least Squares (GLS) methods. To prevent biases that might arise from inflation, they deflate all their variables to 1995 prices using PPI deflators. They find that the positive spillover effects from multinationals to domestic firms are moderated by domestic firms' size, ownership structure and trade orientation (Sinani & Meyer, 2004).

Sinani and Meyer's (2004) use of an Estonian sample seems appropriate, since Eastern European transition economies are adequate for empirical analyses of FDI spillovers due to their accelerated privatization and high endowments of skilled labour (Javorcik, 2004). These labour endowments make them particularly prone to productivity spillovers through worker mobility. Analogous to Sinani and Meyer (2004), this study also utilizes a sample of Estonian firms. Contrastively, the larger sample period used in this paper entails Estonia's final and post-transition periods, from 2010 to 2018.

3. Data:

3.1 Sources & Content:

The data used for the methodology comes from two different sources. To begin with, a firm-level dataset is extracted from the ORBIS database. ORBIS is a brand, owned by Bureau van Dijk (BvD), which collects data on roughly 365 million companies around the globe. The for-profit database contains data on public and private companies distributed among 56 industry sectors. This data contains financial statement and balance sheet information gathered by regional chambers of commerce. The data is then clustered, treated and standardized by BvD, allowing for universal, micro-level comparability.

From this database, company-specific, Estonian data is extracted. The dataset extracted contains the variables: profit per employee, NACE Rev. 2 code, NACE description, foreign ownership, region, capital, number of employees and material costs. The monetary variables, such as capital, are in thousands of US dollars and are calculated based on the exchange rate at each closing date. These variables are implemented to construct panel data spanning from the year 2010 until 2018. This panel dataset contains the information required to formulate the independent, dependent and control variables, as will be further explained in Section 4.2.

Secondly, industry level input-output data is extracted from the World Input-Output Database (WIOD). The WIOD's 2016 publication contains input-output matrixes, covering 43 countries and 56 sectors, for the period 2000-2014. The sectors are classified according to the ISIC Rev. 4[1] and the NACE Rev. 2[2]. Estonian, sector-specific data is excerpted from the WIOD for the base year 2010. It is then used to calculate the proportion of output supplied from one sector to another and merged with the initial

[1] International Standard Industrial Classification revision 4

[2] The Statistical Classification of Economic Activities in the European Community revision 2

panel data. These proportions are then implemented to generate the *Forwards* and *Backwards* proxy variables, as will be explained in Section 4.2.

Thirdly, in order to visualize how FDI is distributed across sectors, industry specific FDI inflows are extracted from the Organisation for Economic Co-operation and Development (OECD) iLibrary. The OECD iLibrary incorporates all publications and statistics published since 1998 by the OECD. FDI inflows for the relevant sectors, at the base year 2010, are taken from this database and used to create Table A.2 in Appendix A. This table depicts how FDI has been distributed across sectors and firms. It is relevant to note that the previously mentioned databases identify each industrial segment based on the standardized European NACE Rev. 2 code. Therefore, their industry sectors are characterized in the same manner and the problem of mismatching does not arise. These sectors can be visualized in Table A.1 in Appendix A.

3.2 Sample Selection & Data Description:

The data observations incorporated into the analysis were included based on a strict but simple selection criteria. As previously mentioned, the transition economies of Eastern Europe are appropriate for empirical analyses of FDI spillovers due to their high endowments of skilled labour (Javorcik, 2004). This labour availability makes them especially prone to productivity spillovers through worker mobility (Javorcik, 2004). Therefore, considering Estonia's recent and successful transition towards a high-income nation, the country was selected for this study of FDI spillovers. The time span chosen for the analysis ranges from the year 2010 until 2018. This time period was chosen because it avoids the effects of the 2008 financial crisis on the volatility of firms and FDI. Moreover, it also entails Estonia's final transition years and captures the nation's initial high-income years before and after joining the eurozone in 2011. This time span therefore presents an opportunity for analysing spillovers from FDI in an economy that has recently completed its process of economic transition.

Influenced by Javorcik (2004), this paper focuses on manufacturing firms only (NACE Rev. 2 sectors C10 to C32). These sectors were chosen because, after examining all industrial sectors' input-output proportions, it is evident that the manufacturing sectors have the largest and most clear intra-industry, vertical linkages. Excluding all non-manufacturing companies reduced the sample size from 290,692 to 12,573 active firms per year. For the sake of robustness, the number of observations was further reduced by dropping those with missing values for foreign ownership and number of employees. The selection criteria yielded in 2,355 companies with values for the period 2010-2018, producing a total of 21,195 observations for each variable. The sectoral distribution of firms and FDI in the first year of the sample is presented in Appendix A, Table A.2.

3.3 Descriptive Statistics:

Table 1 gives statistical insight into all the variables included in the panel dataset used. Over a period of 8 years, between 2010 and 2018, a total of 2,355 Estonian manufacturing firms were analysed. The variable *Profits per Employee* has a mean of 5.394, varying from -99.525 to 757.872. The natural logarithm of this variable has a similar mean but has a much smaller standard deviation of 0.136. The variable *Foreign Shares* is in percentage terms; therefore, it only takes values from 0 to 100. Its mean of 12.533 is above the 10% foreign ownership threshold used to define FDI. *Capital* has an average of 192.677, whilst *Cost of Materials* has a much higher average of 2,331.59.

Table 1
Descriptive Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
Profits per Employee	21195	5.394	17.145	-99.525	757.872
Ln(Profits per Employee)	21195	4.648	0.136	-0.743	6.754
Foreign Shares	21195	12.533	30.783	0	100
Capital	21194	192.677	2073.403	-.001	73054.09
Employees	21195	27.228	90.482	1	3300
Cost of Materials	16662	2331.59	30553.29	0.01	1700000
NACE Sectors	21195	-	-	1	18
Regions	20988	-	-	1	15
Years	21195	-	-	2010	2018
Horizontal	21195	16.865	12.785	-315.918	155.696
Backwards	21195	4.625	2.7	-2.508	14.011
Forwards	21195	12.028	15.304	-45.179	46.567

Notes: Values that are not calculated due to the categorical nature of the variable are represented by a slash (-). The monetary variables, *Profits per Employee*, *Capital* and *Cost of Materials* are in thousands of US dollars. *Foreign Shares* is in percentages.
Source: ORBIS database

The maximum number of employees recorded for a company is 3,300. *NACE Sectors*, *Regions* and *Years* are categorical variables that present the sector, region and year in which a firm is observed. There is a total of 18 manufacturing sectors and 15 Estonian regions. The first independent variable generated, *Horizontal*, has a mean value of 16.865, similar to *Forwards*' mean of 12.028 and in contrast to *Backwards*' mean of 4.625. *Backwards* may have the lowest mean value but it has a considerably smaller standard deviation of 2.7.

4. Methodology

4.1 Intended Method & Reasoning

The general statistical method chosen for this analysis is the fixed effects method. Fixed effects (FE) regressions are most used with panel data to calculate within-individual variations. Whilst OLS regressions assume that there is neither unit-specific nor group-specific unobserved heterogeneity (Brüderl & Ludwig, 2014), FE regressions relax this assumption by including individual-specific or group-specific constants (fixed effects) that control for time-invariant heterogeneity. Moreover, FE regressions can also control for time-specific variation by including time dummies. This sort of regression is known as a two-way fixed effects regression.

The general two-way FE regression model is defined as follows:

$$Y_{it} = \alpha_i + \beta_0 X_{it} + \gamma_t + \varepsilon_{it} \quad i = 1, \dots, n \;\; t = 1, \dots, T$$

Where Y_{it} and X_{it} are the dependent and independent variables for individual i at time t, β_0 is the fixed effects estimator, γ_t is the time dummy and ε_{it} is the error term. Most importantly, α_i is the individual-specific intercept for i *=1,…,n*, where each value can be interpreted as the fixed effect of individual i.

Using this method brings about a series of limitations that must be considered. One of the main limitations is that FE regressions can only estimate the effect of time-varying variables. Therefore, the effect of time-invariant variables, such as cultural aspects, can never be estimated. Another drawback is that this model is unable to control for omitted variables that vary over time. These variables can be included in the model, albeit this may lead to unwanted noise and over-dampening of the model.

4.2 Variables

4.2.1 Dependent Variable:

The dependent variable in the analysis is the firms' (i) profits per employee, Y_{ijrt}, calculated within a given industry (*j*) and region (*r*), and at a given year (*t*). The variable functions as a proxy of firm productivity. Other papers, such as Javorcik (2004) and Liu (2008), implement the Olley Pakes procedure to generate firm-specific total factor productivity. This procedure requires firms' internal investment levels in order to generate productivity measures. Unfortunately, the Orbis database does not include firm-specific investment levels and therefore this proxy variable cannot be computed. Hence, instead of using this semi-parametric productivity measure, this study implements a similar proxy, namely profits per employee.

As pointed out by Lowell (2007)**,** profits per employee is a more representative measure of the contributions and productivity of employees and firms, in comparison to other performance measures. Thus, an increment in productivity is likely to be embodied by an increase in the profits per employee. Therefore, use of this dependent variable is appropriate for the study of knowledge and technology spillovers from FDI.

4.2.2 Independent Variables:

The equations used to generate the independent variables are inspired by the ones formulated by Javorcik (2004). The first variable of interest is the proxy for horizontal spillovers. $Horizontal_{jt}$ captures the level of foreign presence in sector j at time t. Hence, this variable represents the effect of foreign presence on the profits per employee of domestic firms in the same industry sector. As depicted in the equation below, $Horizontal_{jt}$ is defined as foreign equity participation weighted by each firm's share in sectoral profits per employee, averaged over all firms in the sector.

$$Horizontal_{jt} = \left[\sum_{i\ for\ all\ i \in j} ForeignShare_{it} * Y_{it} \right] \Big/ \sum_{i\ for\ all\ i \in j} Y_{it}$$

In $Horizontal'_{jt}$s equation, $ForeignShare_{it}$ is the percentage of firm i that is owned by foreign shareholders at time t. Moreover, Y_{it} represents firm i's profits per employee at time t. This definition is analogous to that in Javorcik (2004), but instead of implementing output weights, profits per employee weights are applied. The reason being that profits per employee are thought to be more representative of firms' profitability and scale of operations, in comparison to output. The value of this independent variable rises with the share of foreign equity and the profits per employee of foreign investment corporations.

The second variable of interest is the proxy for backward spillover effects. $Backward_{jt}$ functions as a proxy for foreign presence in sector j's downstream industry sectors (the sectors that are being supplied by sector j). This variable represents the potential spillovers from foreign-owned customers (in sector k) to their domestic suppliers (in sector j). Following Javorcik (2004) and Liu (2008), the variable is defined as:

$$Backward_{jt} = \sum_{k\ if\ k \neq j} \alpha_{jk} * \ Horizontal_{kt}$$

in which α_{jk} is the proportion of total output sold by sector j to sector k and $Horizontal_{kt}$ is sector k's *Horizontal* variable, at time t. As previously explained, the proportion α_{jk} is calculated using the 2010 input-output matrix extracted, for Estonian manufacturing sectors (C10-C32), from the WIOD. The proportion is computed including imports of intermediate goods but excluding products sold for final consumption. Inputs supplied within sector j are not incorporated, since this effect is already embodied by the *Horizontal* variable. Therefore, the value of this variable increases, the higher the share of inputs supplied by sector j to sectors with foreign presence and the greater the multinational presence within these sectors.

The third variable of interest is the proxy for forward spillover effects. $Forward_{jt}$ captures the extent of foreign presence in sector j's upstream sectors (supplying sectors). This variable is defined as supplying sectors' weighted share of total output, produced by multinational firms. Therefore, it represents the potential spillover effects from multinational suppliers (in sector m) to their domestic customers (in sector j). The variable is described by the following equation:

$$Forward_{jt} = \sum_{m \; if \; m \neq j} \sigma_{jm} * \; Horizontal_{mt}$$

where σ_{jm} is the proportion of inputs bought by sector j from sector m, in terms of the total inputs sourced by sector j, at time t. Akin to the *Backward* variable, the inputs supplied within sectors are not included and the same WIOD dataset was used to generate the proportion σ_{jm}. $Horizontal_{mt}$ is sector m's *Horizontal* variable at time t. Ergo, the value of this variable increases, the higher the share of inputs purchased by sector j from sectors with foreign presence and the greater the multinational presence within these upstream sectors.

Whilst the input-output proportions calculated for the proxies remain unchanged, the levels of foreign ownership and profit per employee vary considerably during the period in question. Thus, the proxies generated for the horizontal and vertical linkages are both sector-specific and time-varying variables. The time-varying character of these variables makes them appropriate for the methodology chosen.

4.2.3 Control Variables:

In order to get as close as possible to the real productivity effects of FDI spillovers, three control variables were collected from the Orbis database. Besides the economic theoretical reasoning used to select these control variables, their selection was also inspired by the control variables used in Javorcik (2004) and Liu (2008).

The first time-varying control variable chosen is *Capital*. This control variable refers to the business capital used by firms as a factor of production. This form of capital is made up by working capital, equity capital, and debt capital. The second control variable chosen is *Cost of Materials*. This control variable refers to the direct cost of materials used to manufacture a product or provide a service. The third time-varying control variable chosen is (number of) *Employees*. These controls serve as time-varying indicators of companies' time-varying size and scale of operations. Controlling for these variables is relevant because employees, inputs and capital are used to generate tangible and intangible assets, such as new technologies and processes. By means of these assets, the controls may then be significantly correlated with firm's profits and productivity.

4.3 Method & Explanation

In order to determine how the flows of FDI into different industry sectors affect the productivity of domestic firms, three hypotheses were formulated. To test for these three hypotheses, the following fixed effects model is used:

$$\text{Ln}Y_{ijrt} = \alpha_i + \beta_1 Horizontal_{jt} + \beta_2 Backward_{jt} + \beta_3 Forward_{jt} + \beta_4 K_{ijrt} + \beta_5 M_{ijrt} + \beta_6 E_{ijrt} + \alpha_{tr} + \varepsilon_{ijrt}$$

The three independent variables in the model, $Horizontal_{jt}$, $Backward_{jt}$ and $Forward_{jt}$, each test the first, second and third hypotheses, respectively. As explained in the previous section, $Horizontal_{jt}$ is a proxy for FDI spillovers through horizontal linkages. Thus, this independent variable tests for the effect of multinational presence on the profits per employee of domestically owned firms in the same sector. $Backward_{jt}$ is a proxy for FDI spillovers through backward linkages. This independent variable tests for the effect of multinational presence in downstream sectors on the profits per employee of domestically owned firms in upstream sectors. $Forward_{jt}$ is a proxy for FDI spillovers through forward linkages. This independent variable tests for the effect of multinational presence in upstream sectors on the profits per employee of domestically owned firms in downstream sectors. The beforementioned variables are sector specific (j) and time specific (*t*).

All three independent variables are used to test for FDI spillover effects on firms' productivity, thus the dependent variable functions as a proxy for productivity. As previously explained, the variable Y_{ijrt} is domestic firm i's profit per employee, within a given industry (*j*) and region (*r*), and at a given year (*t*). The natural logarithm of Y_{ijrt} is calculated and used as the dependent variable in this regression analysis. This allows for the variable to be interpreted in percentage terms and for coefficients to be interpreted as semi-elasticities.

Furthermore, α_i is the firm fixed effect. Using this fixed effect is statistically valuable for this model because it adopts a different value for each firm and therefore controls for all firm-specific and time-invariant heterogeneity. For the sake of decreasing biases, the time-varying control variables for *Capital* (K_{ijrt}), *Cost of Materials* (M_{ijrt}) and number of *Employees* (E_{ijrt}) are included in the regression. These variables are firm (*i*), sector (*j*), region (*r*) and time (*t*) specific. Moreover, α_{tr} is the time-region fixed effect used to account for time trends and region-specific factors that may affect the correlation between foreign presence and firm productivity. Henceforth, this fixed effect controls for unobserved heterogeneity driven by time trends and the attractiveness of specific regions. ε_{ijrt} is the error term, representing the amount by which the equation may differ during this analysis.

This model will be run including all control variables that are theoretically relevant, namely *Capital*, *Cost of Materials* and number of *Employees*. Thereafter, the statistically insignificant control variables will be excluded from the regression, in order to reduce noise. Furthermore, standard errors will be clustered at the industry sector level. This is to correct for the fact that observations in the dataset are at the firm level whilst the spillover measures are grouped at the industry sector level. As pointed out by Moulton (1990), neglecting such a correction would lead to a considerable downward bias in the estimated errors, resulting in spurious measures of statistical significance for the variables of interest.

Apart from the FE model's benefits mentioned in Section 4.1, implementing a FE specification is statistically valuable for this model for an additional reason. The FE specification prevents the possible reverse causality, where more foreign investments are targeted towards sectors that already have higher productivity levels. It also helps prevent the case of reverse causality where more foreign investments are targeted at regions that are resource abundant or already have more productive firms. (Liu, 2008)

5. Results

At first, the Hausman test was conducted in order to determine if a fixed effects or random effects model should be used. The test's statistically significant p-value signalled that an FE regression has a better fit for the model in question. The results for this test can be viewing in Appendix A, Table A.1**.** The three hypotheses formulated in the Theoretical Framework were initially tested with all the manufacturing firms in the sample. The results for this process are depicted in Table 2. Subsequently, the hypotheses were tested with a subsample of domestically owned firms only. The results for this process are shown in Table 3.

Table 2
Regression Results for All Manufacturing Firms

	(1) Fixed Effects	(2) Fixed Effects with Controls	(3) Final Fixed Effects	(4) Random Effects GLS	(5) Random Effects GLS with Controls	(6) Final Random Effects GLS
Horizontal	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Backwards	0.0013*	0.0009	0.0012*	0.0014*	0.0010	0.0014*
	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)
Forwards	0.0001*	0.0002**	0.0001*	0.0001*	0.0002**	0.0001*
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Employees		-0.0006***	-0.0001**		-0.0001***	0.0000
		(0.0001)	(0.0001)		(0.0000)	(0.0000)
Capital		-0.0000			0.0000**	
		(0.0000)			(0.0000)	
Cost of Materials		0.0000			0.0000**	
		(0.000)			(0.0000)	
Foreign Shareholders					0.0003***	0.0002**
					(0.0001)	(0.0001)
Firm Dummy	Yes	Yes	Yes			
Year-Region Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Sector Dummy				Yes	Yes	Yes
Constant	4.6371***	4.6506***	4.6406***	4.6439***	4.6443***	4.6409***
	(0.0051)	(0.0057)	(0.0054)	(0.0081)	(0.0095)	(0.0081)
Obs.	20988	16500	20988	20988	16500	20988
R^2	0.0087	0.0146	0.0091	0.0025	0.0049	0.0024

Standard errors are in parenthesis, **** p<0.01, ** p<0.05, * p<0.1*

Table 3
Regression Results for Domestic Firms Only

	(1) Fixed Effects	(2) Fixed Effects with Controls	(3) Final Fixed Effects	(4) Random Effects GLS	(5) Random Effects GLS with Controls	(6) Final Random Effects GLS
Horizontal	-0.0001	-0.0000	-0.0001	-0.0001	-0.0000	-0.0001
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Backwards	0.0018*	0.0017*	0.0018*	0.0018*	0.0017*	0.0018*
	(0.0010)	(0.0010)	(0.0010)	(0.0010)	(0.0010)	(0.0010)
Forwards	0.0002*	0.0002**	0.0002*	0.0002**	0.0002**	0.0002**
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Employees		-0.0011***	-0.0002		-0.0006***	0.0000
		(0.0002)	(0.0002)		(0.0001)	(0.0001)
Capital		-0.0001			-0.0001	
		(0.0000)			(0.0000)	
Cost of Materials		0.0000***			0.0000***	
		(0.0000)			(0.0000)	
Foreign Shareholders					0.0012	0.0001
					(0.0025)	(0.0021)
Firm Dummy	Yes	Yes	Yes			
Year-Region Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Sector Dummy				Yes	Yes	Yes
Constant	4.6361***	4.6453***	4.6391***	4.6412***	4.6451***	4.6405***
	(0.0064)	(0.0065)	(0.0067)	(0.0091)	(0.0103)	(0.0094)
Obs.	17451	13793	17451	17451	13793	17451
R^2	0.0085	0.0260	0.0087	0.0028	0.0161	0.0027

Standard errors are in parenthesis, **** p<0.01, ** p<0.05, * p<0.1*

5.1 Horizontal Spillovers

The first hypothesis assumes that Estonian manufacturing firms experience negative productivity spillovers from FDI, through contact with foreign-owned firms in horizontal industry sectors. At first, the hypothesis was analysed using the whole sample of manufacturing firms, thereafter it was analysed using domestically owned firms only. The results of this analysis are in Tables 1 and 2, respectively.

Initially, the fixed effects model described in the methodology was used to test this hypothesis, for the whole sample. The table's eight row shows that a firm fixed effect was implemented to control for firm-specific heterogeneity. Moreover, the table's ninth row demonstrates that a time-region dummy was used in the regression to account for any time trends and regional characteristics that may cause biases. As shown in the first column of Table 1, the FE regression was initially run without control variables. As mentioned in Section 4.3, the regression's standard errors are clustered at the industry sector level. The first row of the table presents the coefficient for the *Horizontal* independent variable.

As explained in Section 4.2.2, this variable represents the effect of foreign presence on the profits per employee (productivity) of domestic firms in the same industry sector. Hence, *Horizontal* was used to test for the first hypothesis and was expected to have a significantly negative value. The actual value of *Horizontal*'s coefficient is 0.0001 but is found to be statistically insignificant at the 10% level. This signifies that, when using the whole sample, multinational firms do not have a statistically significant productivity spillover effect on domestic firms in the same sector.

Subsequently, the regression was run with all the theoretically relevant control variables. The significance of the *Horizontal* coefficient did not rise. The time-varying control variables *Capital* and *Cost of Materials* were found to be statistically insignificant, whilst the variable *Employees* is significant at the 1% level. Including these insignificant control variables may lead to unnecessary noise around the treatment effect. Statistically speaking, these variables are not omitted variables since they are simply not significantly correlated with the dependent variables. Therefore, the insignificant control variables were excluded from the regression to arrive at the final FE model. The first row of the third column shows that this regression does not produce a statistically significant *Horizontal* coefficient. Hence, the same insignificant FDI productivity spillover still holds.

As an alternative for testing the first hypothesis, a random effects Generalized Least Squares (GLS) model was used. While the fixed effect assumption is that the independent variables are correlated with the individual specific effect, the random effects (RE) model assumes that the unobserved individual heterogeneity is uncorrelated with the independent variables. Thus, RE models also capture time-invariant firm effects. Instead of implementing firm fixed effects, sector and time-region dummies were used in this model. These fixed variables capture all the sector-specific and region-specific time-invariant heterogeneity that may cause biases. Similarly, the time-region dummy was also used to account for time trends. The regression was initially run without control variables. As seen in the fourth column, this did not produce a statistically significant *Horizontal* coefficient.

Thereafter, the regression was run with the same time-varying control variables as the FE regression. Additionally, a variable which controls for the percentage of foreign ownership (foreign shares) per firm, was also included. Apart from being a control variable, *Foreign Shareholders* also shows how foreign investment into Estonian firms may be associated with an increase in these firms' productivity. The variable is found to have a positive and significant (at the 1% level) coefficient. This proves the variable's suitability as a control and demonstrates the aforementioned association. The control variable *Employees* has a negative and significant (at the 1% level) coefficient. The two other controls have significant (at the 5% level) coefficients with a value of 0, meaning that they do not have a considerable impact on the dependent variable. In order to reduce noise and improve the robustness of the analysis, the two later controls were excluded from the regression to arrive at the final RE model depicted in the sixth column. This regression does not produce a statistically significant *Horizontal* coefficient. Therefore, this model also signals that foreign-owned firms do not have a statistically significant productivity spillover effect on domestic firms in the same sector.

This whole process was then repeated for a subsample of domestically owned firms only. These companies are considered as domestically owned because foreign shareholders have less than 10 percent of the firms' voting power. Results are shown in Table 2. The FE model was run with and without the significant control variables. The *Employees* control is found to be significant at the 1% level. As predicted by the hypothesis, the Horizontal coefficient became negative, but it was found to be statistically insignificant.

The RE regression was then run with and without control variables. Unlike the case with all manufacturing firms, *Foreign Shareholders* has an insignificant coefficient. Not only does this invalidate the variable's controlling power, it also shows that when the amount of foreign shares is below 10 percent, these foreign funds are not significantly association with increased firm productivity. The control variables *Capital* and *Cost of Materials* were then removed from the regression. The final RE model also produces a negative but insignificant *Horizontal* coefficient. Therefore, the first hypothesis is rejected by stating that multinational firms do not have a statistically significant productivity spillover effect on domestic firms in the same sector.

5.2 Backward Spillovers

The second hypothesis assumes that Estonian manufacturing firms experience positive productivity spillovers from FDI, through contact with foreign-owned firms in downstream industry sectors. Alike the first hypothesis, the same process and regressions were used to test this hypothesis. The proxy variable *Backwards* was used to test for these productivity spillovers through backward linkages. As explained in Section 4.2.2, this independent variable represents the potential spillovers from multinational customers to their domestic suppliers.

At first, the FE model was regressed without controls, for the whole sample. The third row and first column of Table 1 show a positive and significant (at the 10% level) *Backwards* coefficient, with a value of 0.0013. Afterwards the regression was run with all control variables and then the insignificant controls were dropped. Surprisingly, the final FE regression then lowered the value of the *Backwards* coefficient; the new value of 0.0012 is significant at the 10% level. Thus, when using control variables, a one-standard-deviation increase in the foreign presence in downstream sectors is associated with an increase in the profits per employee of upstream domestic firms by 0.12 percentage points. By dividing this coefficient by $\text{Ln}Y_{ijrt}$'s standard deviation, it can be stated that this result explains 0.9% of the dependent variable's variation. Similarly, when the final RE regression was run, a statistically significant (at the 10% level) *Backwards* coefficient, with a value of 0.0014, was found. These significant findings indicate that, when using the whole sample, domestic firms receive productivity spillovers from downstream multinationals.

Subsequently, these models were then regressed for a subsample of domestically owned firms. Results are shown in Table 2. When using this sample, the *Backwards* coefficients considerably increased in value: the final FE and RE regressions produced a coefficient of 0.0018. These coefficients were found to be statistically significant at the 10% level and explain 1.3% of the dependent variable's variation. The significant coefficients for both samples indicate that backward linkages are a significant channel for FDI spillovers. These findings are consistent with the hypothesis and reaffirm that domestic manufacturing firms experience positive FDI productivity spillovers from multinationals in downstream sectors.

5.3 Forward Spillovers

The third hypothesis assumes that Estonian manufacturing firms experience positive productivity spillovers from FDI, through contact with foreign-owned firms in upstream industry sectors. The same process and regressions were used to test this hypothesis. The proxy variable *Forwards* was used to test for these productivity spillovers through forward linkages. As explained in Section 4.2.2, this independent variable represents the potential spillovers from multinational suppliers to their domestic customers.

Initially, the FE model was regressed without controls, for the whole sample. As shown in the third row and first column of Table 1, a positive and significant (at the 10% level) *Forwards* coefficient, with a value of 0.0001, was found. This coefficient explains 0.07% of the dependent variable's variation. Afterwards the regression was run with all control variables and then the insignificant controls were dropped. The final FE regression then produced the same significant (at the 10% level) *Forwards* coefficient. Therefore, a one-standard-deviation increase in the foreign presence in upstream sectors is associated with an increase in the profits per employee of downstream domestic firms by 0.01 percentage points. Likewise, when the final RE regression was run, an identical and statistically significant *Forwards* coefficient was found. These significant findings indicate that, when using the whole sample, domestic firms receive productivity spillovers from upstream multinationals.

These models were then regressed for a subsample of domestically owned firms. Results are shown in Table 2. The *Forwards* coefficients generated are all positive and significant, either at the 10% or

5% significance levels. These significant coefficients are indicative of FDI spillovers through forward linkages. These findings are consistent with the hypothesis and corroborate that domestic manufacturing firms experience positive productivity spillovers from multinationals in upstream sectors.

5.4 Robustness Checks

In order to check the robustness of the models implemented, these models were regressed using first, second, third and fourth differences. Using longer time differences is beneficial because, even though sample sizes are reduced, relatively more weight is given to persistent changes in the variables of interest, therefore reducing the influence of noise (Javorcik, 2004). The models were initially differenced using a fixed effects specification for the whole sample and for a subsample of domestic firms. Results are shown in Appendix B, Tables B.2 and B.3, respectively. This specification contained firm and time-region fixed effects. Subsequently, the models were differenced using a pooled OLS specification for the whole sample and for domestic firms only. Results are depicted in Appendix B, Tables B.4 and B.5, respectively. This specification contained time-region and sector fixed effects.

By means of differenced fixed effects estimation, all fixed effects and unobserved, time-invariant variables are accounted for within the regressions. As shown in Tables B.2 and B.3, when using both samples, first differences produce statistically insignificant coefficients for all variables of interest. Thereafter, when the models are regressed in second, third and fourth differences, the *Forwards* coefficient gradually become larger and more significant, whilst the *Backwards* coefficient remains insignificant. Horizontal spillovers also remain insignificant throughout the models.

The differenced models were then regressed using pooled OLS estimation. As depicted in Tables B.4 and B.5, first differences produce statistically insignificant coefficients for all variables of interest, when using both samples. In second, third and fourth differences, the *Forwards* coefficient is positive and statistically significant at the 1% significance level. Meanwhile, the *Backwards* coefficient is only significant (at the 10% level) in fourth differences. Horizontal spillovers remain insignificant throughout the models.

These findings are consistent with productivity spillovers taking place through forward and backward linkages, but they also constitute evidence that these spillovers may have a lagged effect. Backward spillovers may take longer to arise due to the time needed for knowledge and technology to completely transfer and be implemented by domestic firms. On the other hand, forward spillovers may arise sooner since downstream domestic firms benefit promptly from new inputs purchased from multinationals. It is important to note that these results should be treated with caution as they are based on a smaller number of observations.

6. Conclusion & Discussion

In this paper three hypotheses were tested in order to answer the initial research question. The first hypothesis predicted that Estonian manufacturing firms would experience negative productivity spillovers from FDI, through contact with foreign-owned firms in horizontal industry sectors. By means of a fixed effects regression and a random effects GLS regression, this horizontal spillover effect was proven to be statistically insignificant. This insignificant finding is consistent with the existing literature that fails to find a significant intrasector effect. This study's insignificant horizontal spillovers stem from the competitive nature of firms' intrasectoral relations. In the context where multinationals and domestic firms compete for market shares in the same sector, the latter have an incentive to prevent spillovers from occurring. They can achieve this by paying higher wages to avoid labour turnover, protecting their intellectual property and trade secrets, or locating in sectors or regions in which domestic firms have limited capacities (Javorcik, 2004).

The second hypothesis assumed that Estonian manufacturing firms would experience positive productivity spillovers from FDI, through contact with foreign-owned firms in downstream industry sectors. By using the previously mentioned regressions, it was significantly proven (at the 10% level) that a one-standard-deviation increase in the foreign presence in downstream sectors is associated with an increase in the profits per employee of upstream domestic firms by 0.12 percentage points. This demonstrates that domestic firms did benefit from productivity spillovers from multinationals in downstream sectors. This is in accordance with Javorcik's (2004) and Liu's (2008) findings on the significant spillover effects through backward linkages. These backward FDI spillovers are economically justified by the cost-cutting benefits that multinationals obtain by allowing for productivity spillovers to their domestic suppliers. These spillovers may appear through: direct knowledge transfers, higher product quality requirements that incentivise local firms to enhance their production, and increased demand for intermediates which allow domestic suppliers to reap the benefits of scale economies (Liu, 2008).

Furthermore, the third hypothesis predicted that Estonian manufacturing firms would experience positive productivity spillovers from FDI, through contact with foreign-owned firms in upstream industry sectors. By means of the same regressions, it was significantly found that a one-standard-deviation increase in the foreign presence in upstream sectors is associated with an increase in the profits per employee of downstream domestic firms by 0.01 percentage points. These forward spillovers are associated with a small increase in firms' productivity and have a relatively low significance, at the 10% level. Therefore, spillovers through the forward linkage channel are less statistically relevant, relative to the backward linkage channel. Even though this is the case, the economic rationale behind such spillovers is as follows. Through the forward linkage channel, domestic firms in downstream sectors may become more productive due to the less expensive or improved inputs produced by upstream multinationals. These inputs make firms' processes more cost effective and may also be accompanied by other beneficial services that increase productivity.

To conclude, the above-mentioned findings are combined to develop the following answer to the research question: Estonian firms did not experience significant productivity spillovers from FDI through contact with foreign-owned firms in horizontal sectors. Conversely, Estonian firms experienced positive and significant FDI productivity spillovers through backward and forward linkages with multinationals in downstream and upstream sectors. Among these two vertical spillover channels, backward spillovers from downstream sectors are the most statistically important channel through which spillovers occur.

There are many limitations that arise from this study, one of the main ones being the high level of aggregation in the NACE sector classification. The fact that observations in the dataset are at the firm level whilst the dependent variables are at the aggregated sector level, limits this study's robustness. In order to correct for this, standard errors are clustered at the sector level, but a downward bias may still exist. Moreover, when using *Employees* as a control variable, one is unable to distinguish between skilled and unskilled workers. It is through the observations made by skilled workers and the hiring of skilled workers trained by multinationals that spillovers from FDI usually occur. Thus, not being able to control for this specific type of workers also limits the robustness of the model used.

Furthermore, the input-output proportions, used to generate the *Backwards* and *Forwards* proxy variables, are only calculated for the base year 2010. Even though these proportions might be representative, it would be preferable to calculate proportions for each year. Unfortunately, input-output matrices are not available for the time span used in this study. Moreover, employing a matrix which excludes imports would be preferable, but such a matrix does not exist.

Even though many limitations exist, findings concerning the subject studied may still be relevant for policy makers. This is because they help establish how FDI and its spillover channels impact domestic firms and industries. Policy makers may use such findings to develop cost-benefit analyses concerning policies directed at attracting foreign funds. They may also be used as the theoretical backbone for the development of policies that facilitate the creation of business linkages between domestic and multinational firms.

The results from this research could be built on by using data that describe individual firms as purchasers or suppliers to multinationals, instead of using sectoral data to generate input-output proportions. It would also be interesting to learn about investor and domestic firms' characteristics that dictate the size of spillovers and the channels through which they appear. Moreover, studying the effect of host country policies and characteristics on the inflows of FDI into certain sectors, would also be of interest.

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8. Appendices

8.1 Appendix A

Table A.1
All 18 Manufacturing Sectors Used in the Analysis

Sector Code	Sector Description
C10-C12	Manufacture of food products, beverages and tobacco products
C13-C15	Manufacture of textiles, wearing apparel and leather products
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
C17	Manufacture of paper and paper products
C18	Printing and reproduction of recorded media
C19	Manufacture of coke and refined petroleum products
C20	Manufacture of chemicals and chemical products
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
C22	Manufacture of rubber and plastic products
C23	Manufacture of other non-metallic mineral products
C24	Manufacture of basic metals
C25	Manufacture of fabricated metal products, except machinery and equipment
C26	Manufacture of computer, electronic and optical products
C27	Manufacture of electrical equipment
C28	Manufacture of machinery and equipment n.e.c.
C29	Manufacture of motor vehicles, trailers and semi-trailers
C30	Manufacture of other transport equipment
C31-C32	Manufacture of furniture; other manufacturing

Source: World Input-Output Database (WIOD)

Table A.2
Distribution of FDI and Firms

Sector Code	FDI Inflows									Total firms	Total dom. firms	Total mult. firms
	2010	2011	2012	2013	2014	2015	2016	2017	2018			
C	131.3	573.3	79.3	-133.6	-128.6	167.1	215.4	858.6	245.0	2,355	1,960	395
C10-C12	56.1	-9.8	-100.5	23.3	-32.7	59.3	11.3	62.4	61.6	237	205	32
C13-C15	3.4	12.3	8.7	7.0	6.4	-63.4	2.3	0.7	2.3	301	247	54
C16, C17, C18	45.2	52.3	60.5	-15.0	59.4	85.7	93.5	27.1	123.9	559	499	60
C19	.. (C)	.. (C)	0.0 (C)	0.2	0.0 (C)	0.0 (C)	0.0 (C)	0.0 (C)	0.0 (C)	1	1	0
C20	-0.5	326.0	-14.2	-247.3	10.5	24.9	-85.4	-25.8	39.3	31	21	10
C21	-2.1	0.2	3.3	6.0	-4.9	-0.6	4.7	-0.1	-7.5	4	1	3
C22	5.8	4.7	-16.3	6.8	6.5	2.5	3.0	10.8	7.6	97	60	37
C23	3.0	330.9	-27.2	-234.3	12.1	26.9	-77.6	-15.1	39.5	103	88	15
C24	46.7	124.9	64.7	11.5	-122.1	-13.3	-0.5	73.4	4.8	10	7	3
C25	-0.3	1.6	-2.7	10.6	-8.2	3.0	9.7	5.2	-23.5	463	396	67
C26	38.6	119.0	51.5	1.1	-119.7	-14.9	-17.3	46.9	31.4	43	25	18
C27	5.4	116.3	34.7	-5.8	-122.9	-22.6	-19.8	36.3	17.8	47	23	24
C28	8.3	4.2	15.8	-0.2	5.8	-1.4	7.1	21.3	-3.1	660	46	20
C29	-15.2	38.3	15.0	48.6	-74.1	30.9	88.5	705.6	24.0	29	24	5
C30	0.0 (C)	0.0 (C)	0.0 (C)	0.0 (C)	.. (C)	0.0 (C)	.. (C)	.. (C)	0.0 (C)	21	19	2
C31-C32	-7.9	24.4	58.1	25.3	22.3	41.1	97.8	4.5	-11.0	343	298	45

Source: OECD.Stat
Notes: FDI values are in thousands of US dollars. '..' are missing values and values with (C) are non-publishable and confidential values.

8.2 Appendix B

Table B.1
Hausman Test

	Fixed Coeff. (b)	Random Coeff. (B)	Difference (b-B)	Sqrt (diag(V_b – V_B)) S.E.
Horizontal	0.001	0.003	-0.002	0.003
Backwards	0.221	0.320	-0.099	0.097
Forwards	0.015	0.102	0.004	0.001
Year				
2011	0.928	0.907	0.021	0.043
2012	0.066	0.112	-0.046	0.025
2013	0.413	0.473	-0.059	0.015
2014	-0.222	-0.228	0.006	0.044
2015	-0.683	-0.704	0.021	0.019
2016	-1.384	-1.347	-0.036	0.069
2017	0.218	0.271	-0.052	0.022
2018	-0.345	-0.213	-0.132	0.043

b = consistent under Ho and Ha; obtained from xtreg

B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(11) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 14.24

Prob>chi2 = 0.2202

(V_b-V_B is not positive definite)

Table B.2
Fixed Effects Regression Results in Differences for Whole Sample

	(1) First Differences	(2) Second Differences	(3) Third Differences	(4) Fourth Differences
Horizontal	0.0001	-0.0000	0.0001	0.0001
	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Backwards	0.0008	-0.0015	-0.0013	0.0015
	(0.0010)	(0.0011)	(0.0011)	(0.0015)
Forwards	-0.0000	0.0002**	0.0002**	0.0003***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Firm Dummy	Yes	Yes	Yes	Yes
Year-Region Dummy	Yes	Yes	Yes	Yes
Sector Dummy				
Constant	0.0005**	-0.0015***	-0.0037***	-0.0066***
	(0.0002)	(0.0004)	(0.0005)	(0.0006)
Obs.	18840	16485	14130	11775
R-squared	0.0001	0.0006	0.0006	0.0010

Standard errors are in parenthesis
**** p<0.01, ** p<0.05, * p<0.1*

Table B.3
Fixed Effects Regression Results in Differences for Domestic Firms

	(1) First Differences	(2) Second Differences	(3) Third Differences	(4) Fourth Differences
Horizontal	-0.0003	-0.0002	-0.0002	-0.0000
	(0.0002)	(0.0002)	(0.0004)	(0.0006)
Backwards	0.0009	-0.0015	-0.0009	0.0014
	(0.0012)	(0.0013)	(0.0013)	(0.0019)
Forwards	0.0000	0.0002**	0.0002**	0.0003**
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Firm Dummy	Yes	Yes	Yes	Yes
Year-Region Dummy	Yes	Yes	Yes	Yes
Sector Dummy				
Constant	0.0004	-0.0013***	-0.0035***	-0.0062***
	(0.0003)	(0.0004)	(0.0006)	(0.0007)
Obs.	15664	13706	11748	9790
R-squared	0.0003	0.0010	0.0008	0.0010

Standard errors are in parenthesis
**** p<0.01, ** p<0.05, * p<0.1*

Table B.4
Pooled OLS Regression Results in Differences for Whole Sample

	(1) First Differences	(2) Second Differences	(3) Third Differences	(4) Fourth Differences
Horizontal	0.0001	-0.0000	0.0001	0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0002)
Backwards	0.0010	-0.0010	-0.0006	0.0022*
	(0.0010)	(0.0010)	(0.0010)	(0.0013)
Forwards	0.0000	0.0002***	0.0002***	0.0003***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Firm Dummy				
Year-Region Dummy	Yes	Yes	Yes	Yes
Sector Dummy	Yes	Yes	Yes	Yes
Constant	0.0005	-0.0014	-0.0037***	-0.0067***
	(0.0011)	(0.0011)	(0.0014)	(0.0016)
Obs.	18840	16485	14130	11775
R-squared	0.0001	0.0005	0.0005	0.0011

Standard errors are in parenthesis
**** p<0.01, ** p<0.05, * p<0.1*

Table B.5
Pooled OLS Regression Results in Differences for Domestic Firms

	(1) First Differences	(2) Second Differences	(3) Third Differences	(4) Fourth Differences
Horizontal	-0.0003	-0.0002	-0.0002	-0.0001
	(0.0002)	(0.0002)	(0.0002)	(0.0003)
Backwards	0.0010	-0.0008	-0.0002	0.0023*
	(0.0012)	(0.0012)	(0.0012)	(0.0016)
Forwards	0.0000	0.0002***	0.0002***	0.0003***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Firm Dummy				
Year-Region Dummy	Yes	Yes	Yes	Yes
Sector Dummy	Yes	Yes	Yes	Yes
Constant	0.0004	-0.0012	-0.0035**	-0.0062***
	(0.0003)	(0.0012)	(0.0015)	(0.0017)
Obs.	15664	13706	11748	9790
R-squared	0.0003	0.0009	0.0007	0.0011

Standard errors are in parenthesis
*** $p<0.01$, ** $p<0.05$, * $p<0.1$