

UNIVERSITY COLLEGE LONDON
School of Slavonic and East European Studies
IMESS Economics and Business

UNIVERSITY OF TARTU
Faculty of Social Science
School of Economics and Business Administration
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**Analysis of Relationship between Foreign Direct Investment (FDI) and Labour
Productivity by Using Estonian Firm-level Data**

Runkang Ma

Master's Thesis

Supervisors:
Priit Vahter
Jaan Masso

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.....(signature of the supervisor and date)

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UCL Student number: 21054221

UT Student number: C310875

.....(signature of the author and date)

Student's signature

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Abstract

This study examines the relationship of foreign ownership on the labour productivity of local firms. Utilizing administrative firm-level data between 1995 to 2021 from Estonian Business Registry databank, the key inquiries in this study are as following: 1) Does foreign ownership bring a positive effect to labour productivity in Estonian firms? 2) Does the pattern exist in different time frames? and 3) To what extent do these effects vary across different industries or sectors? 4) Does foreign ownership have a lag effect to labour productivity? The novelty of this study is observing an overall positive effect of FDI on labour productivity by using a long-term scale data and analyzing the data with different time frames and different sectors --- manufacturing sector and services sector. Employing OLS, standard fixed effect model, and propensity score matching approach (PSM) with nearest-neighbor matching, the findings reveal significantly positive relationship between foreign ownership and firm-level labour productivity in Estonian firms by controlling firms' size, firms' age, and capital intensity within different time frames. Furthermore, by using time-lead data (t+1 and t+2), it demonstrates that the association between foreign ownership and labour productivity may not occur in a company after 1 year of acquiring foreign investment.

Keywords: labour productivity, Foreign Direct Investment, Fixed Effect Model, Propensity Score Macthing, Treatment Analysis.

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1. Introduction

Foreign direct investment (FDI) has been a heated topic in recent years, particularly given its recent decline attributed to both the global pandemic and protectionist policies. Since the 1980s, numerous countries have prioritized attracting foreign direct investments (FDI) as a fundamental aspect of their economic policies. This strategy is primarily driven by two main factors. Firstly, the direct effect of foreign ownership presumes that affiliates of foreign multinationals have access to more advanced technologies and management practices, leading to greater productivity compared to domestic firms (Javorcik, 2004). Secondly, the spillover effect suggests that foreign-owned firms disseminate these improved production technologies to other firms within the host economy through mechanisms such as competition or supplier-client relationships (Dimelis & Louri, 2004; Vahter, 2011).

The objective of this paper is to describe how foreign ownership is associated with labour productivity. In more detail, this paper will answer these essential inquiries: 1) Does foreign ownership positively associate with labour productivity in Estonian firms? 2) Does the same pattern exist in different time frames? 3) To what extent do these effects vary across different industries or sectors? 4) Does foreign ownership have a lagged effect on labour productivity? In essence, I explore the diversity of the productivity relationship with foreign ownership across these dimensions – time frames, sectors, and the timing when FDI benefits labour productivity.

The challenge in studying the effects of inward FDI on firms lies in addressing endogeneity issues (Hale & Long, 2011). Since this study cannot randomly assign foreign ownership, a research design is necessary to mitigate the selection bias of foreign investors. One approach to tackling this challenge is using instrumental variables, where the categorical variable representing foreign ownership is instrumented with variables correlated with FDI but not the error term (Hale & Long,

2011). However, finding suitable instruments that do not correlate with the error term can be complex.

Foreign direct investment in Estonia has been a transforming factor for the economy and has played a vital role in the development of the sector and the economy's integration with the world economy. Therefore, this comprehensive analysis covers the effects of FDI on the local firms, the manufacturing and services sectors, the influence before and after joining the European Union (EU), and during the financial crisis in 2008. FDI is a base for growth in Estonia's economy.

The benefits that FDI has brought to local firms in Estonia mainly result from technological transfers and improved management practices. In this case, the benefits have sometimes accrued as horizontal spillovers, where foreign-owned firms significantly enhance the productivity of domestic firms. For example, foreign-owned firms in the manufacturing sector have generally exhibited higher productivity levels than their domestic counterparts. This disparity suggests that whereas FDI might bring advanced practices and technologies, their respective effects may not diffuse widely across the broader local economy (Vahter, 2004).

The year 2004, when EU accession was completed, was a year of landmark in Estonia's history, making the country even more appealing to foreign investors. With EU membership came regulatory harmonization and large single markets that formed the right environment for FDI. The integration formed the platform for increased economic activities and has since developed structural support yearly amounting to 3-4% of GDP. Harmonization of regulations and standards unlocked the markets of the Baltics to FDI, which developed as a significant factor behind the Estonian economic transition and growth. The positive impacts of the EU accession on the Estonian economy have been felt in almost all sectors. For example, the tourism industry grew by leaps and bounds with assured security and return on investments. Also, the open-air access has been responsible for the low-cost airlines that have been entering the Estonian market, thereby increasing tourism with the increased access to Estonia. The visibility of the tourism sector among EU citizens and tour operators is also due to the

presence of tourism-friendly policies at the EU and national levels (Jarvis & Kallas, 2008).

However, the global financial crisis in 2008 had severe shocks to FDI flows around the world, and that was the case in Estonia. There was an unprecedented pullback of investments, especially in the sectors that are highly dependent on international capital. However, FDI remains an important component in the eventual recovery of the Estonian economy. The support mechanisms of EU and the increased integration of Estonia with the global markets partly mitigated the overall negative impact of the crisis. Therefore, the strategic role of FDI in developing resilience and recovery would be viewed in the backdrop of crisis situations in Estonia. Such investments, especially in more stable and strategic sectors, absorbed shocks and helped the economy to recover faster than the less integrated FDI flows. It has also pointed out the need for strong economic policies that could lead to the inflow of FDI and sustain them, which Estonia, time and again, had been successful in formulating and implementing.

Data from the Estonian Business Registry, covering firm characteristics such as financial data, ownership, location, sector, and capital intensity from 1995 to 2021 are utilized in this study. Using this long-time data will be helpful in generating an idea of how foreign ownership is associated with labour productivity in the post-transition economy. By using Estonian data, the relationship between FDI and labour productivity of the manufacturing and services sectors can be analyzed, which has become increasingly important in recent years, especially in transition economies (Köllő et al., 2021). It is reasonable to divide the overall sample into multiple subperiods based on significant developments in the Estonian economy, which can analyze what was the association between FDI and labour productivity after joining the EU and during the financial crisis.

To address endogeneity to some extent, this study employs propensity score matching (PSM) and standard fixed effects. Combining these methods, the study aims to estimate the average treatment effect on the treated (ATT). This involves estimating

the labour productivity of foreign-acquired firms without FDI and then comparing it with the actual labour productivity to derive the ATT.

The study categorizes firms into different groups based on technological intensity for the manufacturing sector and knowledge intensity for the services sector using the Statistical Classification of Economic Activities in the European Community (NACE Rev.2). These groups include low technology, medium-low technology, medium-high technology, and high technology for the manufacturing sector. Less knowledge-intensive, and high knowledge-intensive firms are the sub-groups for the services sector. Technology intensity in the manufacturing sector or knowledge intensity in the services sector is an area that is at the heart of FDI and labour productivity. This allows a more differentiated view of how different segments of the economy benefit from foreign investments. The positive impact of FDI on labour productivity might be different, depending on the intensity of technology and knowledge of the companies. More generally, high-tech and knowledge-intensive firms will benefit most as technology transfer, innovation, and better management practices which characterize FDI activities. High-tech and knowledge-intensive firms would benefit most as technology transfer, innovation, and better management practices are an influence of FDI, which brings about significant gains in productivity through the most absorptive capacity as a principle. That is, through technology transfer, innovation, and better management practices. This has been the case in various studies using firm-level data. These firms are better placed to use advanced technologies and practices introduced by foreign investors, which, in turn, enhance more significant productivity spillovers and skill development among the workforce (Blomström & Kokko, 1998; Cohen & Levinthal, 1990). The manufacturing sector has been a major beneficiary of FDI in Estonia, especially in low-value-added segments. This investment facilitated the modernization of the manufacturing sector, efficiency, and globalization of Estonian manufacturing in international supply chains. The positive correlation between developed manufacturing sectors and FDI inflows is shown, with low-value-added manufacturing sectors receiving substantial foreign investment. This trend shows that FDI has helped support

the manufacturing sector to increase production capacity and competitiveness (Cohen & Levinthal, 1990). However, according to Gaygysyz, Gavaille, Haukås, Holmen, and Masso (2024), the services sector has also been comparatively more conducive to the FDI. The services sector, especially tourism and financial services, has gained increased advantages from FDI. The entrance into the EU in 2004 significantly helped this process through investment security, relaxation in border controls, and better infrastructure. The same is true with respect to tourism, which surged ahead post-accession on the back of enhanced security in the perception that investments in tourism infrastructure were positively inculcated. The second impetus to the sector came with the rise of low-cost airlines, which significantly made Estonia an even more accessible and appealing destination.

By using standard fixed effect model, the study finds that, from 1995 to 2021, foreign ownership may bring a 6.2% increase in labour productivity in Estonian firms. Besides, in the three different time frames (1995 to 2003, 2004 to 2009, and 2010 to 2021), foreign ownership is associated with an increase of 7.1% in labour productivity between 2010 to 2021. In the manufacturing sector, foreign ownership brings a 4.1% increase to labour productivity. In the services sector, foreign ownership may increase labour productivity by 5.8% on average.

After controlling for covariates and employing the 5-nearest-neighbor matching method, the study finds that one year after a firm becomes majority foreign-owned, it brings approximately 14.3% higher labour productivity by using the overall sample on average. By using 1-year lead data and 2-year lead data, the positive relationship is not statistically significant. The higher productivity is particularly evident in less knowledge-intensive services. Especially in the services sector, the positive relationship is still significant by using 1-year lead data. However, there is no evidence to show that foreign acquisition has a positive association with firm-level labour productivity in the manufacturing sector.

The study structure is as follows: Section 2 presents relevant literature on FDI and productivity; Section 3 describes the methodology; Section 4 provides a brief overview

of the data; Section 5 reports the results of standard fixed effects and PSM; Section 6 discusses the implications of the study; Section 7 limitations of the study; and Section 8 conclusion.

2. Literature Review

This research paper delves into the relationship between Foreign Direct Investment (FDI) and the level of productivity in companies based in Estonia that are under foreign ownership. The central premise underlying this investigation is the challenge faced by foreign firms in navigating the local market due to their inherent liability of foreignness. In overcoming this obstacle, multinational enterprises (MNEs) must establish advantages that outweigh their "foreignness" when compared to local enterprises, a concept elucidated by Dunning (1977).

2.1 Theoretical Framework

Dunning's eclectic (OLI) paradigm posits that the decision of MNEs to invest is contingent upon factors such as "ownership", "location", and "internalization" (Dunning, 2001). This framework offers insights into the considerations that guide foreign firms in making strategic investments. An exciting dimension of this interplay is the ability of MNEs to leverage intangible assets, such as patents or unique work cultures, to offset their disadvantages in unfamiliar markets.

Empirical evidence, as found by Girma and Görg (2007) and Taylor and Driffield (2005), emphasizes the tangible benefits that increase MNEs over local firms. The advantages that facilitate the entry of multinational enterprises into foreign markets also manifest in measurable outcomes, thereby reinforcing the theoretical foundations of Dunning's framework. This empirical support strengthens the argument that overcoming the challenges of "foreignness" can lead to a substantial competitive advantage.

The OLI paradigm attempts to explain why companies will choose to do foreign direct investment rather than using other methods to go into a foreign market, such as exporting or licensing. The implication is that for a firm to undertake FDI, three sets of advantages that must be present: ownership, location, and internalization. Dunning's work on the MNE and its global strategy has left one of the most basic impacts on the study of international business.

Ownership advantages are those firm-specific assets and capabilities that allow an MNE to compete successfully in foreign markets. These might include such elements as proprietary technology, brand reputation, managerial expertise, or economies of scale. Dunning and Narula (1995) noted that U.S. manufacturing affiliates in the UK exhibited higher labour productivity than their local counterparts, even when these affiliates were no more efficient than their local competitors. This gave him the basis for conceptualizing ownership advantages as part of the OLI framework; it explains why some firms have resources unique to them that will provide a competitive edge over local firms in foreign markets. Location advantages are the characteristics of the host country that make it an attractive location for investment. These could be in the form of natural resources, good economic conditions, regulatory framework, and abundance of skilled labour. For example, most countries that have stable political climates, efficient legal systems, and friendly trade policies attract more FDI. According to Dunning's theory, for a firm to invest in a foreign country, the location-specific advantages must be greater than those in the home country, hence justifying the investment.

The advantages of internalization explain why firms would go to the trouble of managing and controlling foreign operations rather than licensing the know-how to foreign firms. Internalization minimizes transaction costs and risks associated with depending on external partners—that is, such things as the risk of opportunism, conflicts of interest, and risks to intellectual property. More specifically, with internalized operations, the firm can better protect its proprietary knowledge and be assured of quality and consistency across its global operations. Dunning's framework suggests that

firms will select FDI over other modes of entry when the benefits of internal control and coordination exceed the costs.

Dunning constantly reviewed and developed the OLI model to adapt to the changing international business environment. One of the major developments was the inclusion of institutional and cultural variables. Chang-nan (2008) gives examples of how Dunning addressed criticism that the eclectic paradigm was static and, therefore, dynamic components were included. This flexibility has made the OLI model timely despite the dynamic changes in global economic activities. Also, the OLI paradigm was extended to a wide variety of contexts, hence proving its flexibility. Thus, Erdener and Shapiro (2005) based the OLI model in a paper to study the international activities of Chinese family enterprises. Based on their empirical study, one concludes that culture and economic drivers much influence the success of those firms, thus underpinning the general applicability of Dunning's theory to MNEs other than Western ones. Eden and Dai's (2010) analyzed the evolution of the ownership advantages, saying that although the changes have had mixed fortunes, the typology of ownership advantages remains central to understanding the existence of MNEs.

In addition, learning-based perspectives have added more significance to the OLI framework. Pitelis (2007) puts across the assertion that the approach by Penrose can endogenize and synthesize the elements in Dunning's triad, thereby making the OLI paradigm be considered as being more dynamic and strategic. In this way, the perspective would put more emphasis on the cognitive dimension of the decision-making by MNEs about expected action that firms take concerning expected changes in the environment in which they operate.

A significant amount of empirical work has concluded that the OLI framework for analyzing foreign direct investment flows has both descriptive and normative validity. For example, Brouthers, Brouthers, and Werner (1999) investigated the relationship between Dunning's OLI variables and the mode of entry of German and Dutch firms investing in Central and Eastern Europe. They find strong evidence with respect to predictive explanation, both as far as the most frequent choices and the best-performing

modes of entry are concerned. These findings stress that the paradigm developed by Dunning is solid and can be considered as a guideline for strategic decisions on international market entry.

2.2 The relationship between FDI and Productivity

Productivity consequences of FDI on the host country's economy have long been the subject of a great number of studies and literature. Two ways are possible in the occurrence of this productivity effect. The first is the direct FDI effect, which claims that there is an increase in firm's productivity in the target country because the acquiring firm provides the target firm with more sophisticated technology. In this light, Kim and Park (2018) found that FDI inflows have a positive effect on TFP in the host country, more importantly, if the FDI inflow originates from developed countries. In another way, Driffield and Love (2007) analyzed the relationship between FDI motivation and host country productivity effects, and it showed that for technology-based FDI, which is considered beneficial for the host country, significant productivity spillovers were available, while no such spillovers were available for technology-sourcing FDI. They considered that the positive effects on host country firms as a result of FDI and the relationship between FDI and economic growth depend on the host economy's technological and social capabilities. According to Derado and Horvatin (2019), the effect of FDI on labour productivity in the EU shows M&As are more affecting productivity in innovative economies, and greenfield investments favour countries that are less technologically developed. Hale and Xu (2016) noted that, as a rule, FDI brings in more wages and has a positive productivity spillover into the developing country through the transfer of technology and knowledge by the MNEs. These papers underline the strong effect of FDI on host-country productivity through direct technology transfer and various spillover effects that are impacted by the entry mode and host-country characteristics.

The relationship between foreign ownership and labour productivity can also be influenced by different factors, such as joining global organizations or facing a financial

crisis. The 2008 financial crisis fundamentally changed the correlation between FDI and labour productivity across most regions and industries. The growth rate of labour productivity fell sharply around the world, and especially in the event of a banking crisis, short-term growth was negatively affected by up to 0.7% every year (Oulton & Sebastia-Barriel, 2013). In emerging markets like Mexico, the elements of informality, foreign ownership, and external auditing prior to the crisis had a positive influence on productivity. In contrast, the elements of bribery and informality after the crisis had a negative influence on it (Young-Hee & Na, 2018). Generally, FDI tended to increase labour productivity over time in the case of Central and Eastern Europe. In contrast, the direct impact was stronger on the rate of unemployment than on growth during the period of the financial crisis (Diaconu & Şterbuleac, 2017). In the case of the construction industry in Australia, results were mixed, with national productivity increases but regional declines (Ma & Liu, 2014). Generally, then, while FDI supported productivity growth, the financial crisis created substantial variability for its effects across contexts.

The EU membership has a colossal impact on the relationship between FDI and labour productivity among member states. Data evidence that, on average, the EU membership improves labour productivity by provoking the rise in FDI. This rise will be motivated by the propensity for technology diffusion and productivity spillovers. For example, Diaconu and Şterbuleac (2017) found for states that entered the EU in 2004 that, despite the partial negative effect on employment, real labour productivity had a positive effect on FDI. At the same time, Kutan and Yigit (2009) emphasized that both FDI and exports influenced labour productivity in new member states of the EU. Also, as evidenced in the study by Bellak et al. (2008), it has been found that the countries with higher labour productivity received more FDI, while those with higher labour costs received less. Overall, in this way, the EU membership allows one to gain in terms of productivity through FDI; still, specifics in their impacts can vary from region to region and across economic contexts.

Besides, in different sectors, the relationship between foreign ownership and labour productivity may be different because of firms' characteristics. The impact of FDI on labour productivity is also felt across most sectors. In fact, it is very significant in the manufacturing sector. The FDI inflow increases the productivity of labour in the manufacturing sector by infusing capital, technology, and management practices. For example, it has been evidenced in Mauritius and in the electronics industry of China that FDI increases productivity by injecting new technologies and managerial skills into the long run (Fauzel et al., 2014). Again, because of firm-level data evidence in Estonia and Slovenia, there are positive intra-industry spillovers, further enhancing productivity (Vahter, 2006). The services sector, on the other hand, has improved productivity growth as a result of advancements in knowledge-intensive services and improvements in human capital. Drawing from Japan, it has been realized that, from a relative perspective, the total factor productivity of FDI in the services sector is greatly influenced by FDI in the manufacturing industry (Ito, 2015). More so, FDI in upstream services in transition countries of Europe has been found to benefit local manufacturing firms through improvements in human capital and intangible assets (Stojcic, Hashi, & Orlić, 2018). In general, while FDI positively affects labour productivity in the two sectors, the mechanisms and extent of the effect differ between direct investment in manufacturing and services, with the latter thriving on knowledge and human capital enhancements.

2.3 Technology Gap and Absorptive Capacity

An idea initially proposed by Stephen Hymer (1960), which has gained considerable acceptance, suggests that foreign investment isn't merely about transferring capital, as suggested by neoclassical models like MacDougall's, but instead involves the transfer of a comprehensive "package" that includes capital, managerial expertise, and innovative technology (Caves, 2000). Ronald Findlay (1978) constructs a dynamic framework to scrutinize the technology dissemination mechanism,

particularly via direct foreign investment. His core argument posits that the pace of technological advancement in less developed regions depends heavily on the technological disparity between these and more advanced regions. Thus, a rapid technological catch-up that occurs based on the level of openness to direct foreign investments. Findlay brings out technological convergence in developing regions as an interplay among economic development, technological change, and international capital flows. This line of argument, therefore, calls for a more subtle understanding of how direct foreign investment can spur on technological convergence in these developing regions.

Sometimes, foreign direct investment may bring some new knowledge to firms, but how much new knowledge can be utilized is quite uncertain. Cohen and Levinthal (1990) delve into the concept of absorptive capacity as pivotal for firms' innovation and competitiveness. They define absorptive capacity as the ability of a firm to recognize the value of new information, assimilate it, and apply it to commercial ends (Cohen and Levinthal, 1990). According to their theory, a firm's existing knowledge base significantly shapes its ability to absorb and deploy new knowledge. Moreover, Cohen and Levinthal contend that investing in R&D bolsters a firm's absorptive capacity by furnishing it with the skills needed to efficiently comprehend and exploit external innovations. They also explore how absorptive capacity influences firms' strategic decisions concerning R&D investments and engagement in collaborative ventures. Absorptive capacity mainly determines foreign direct investment's (FDI) impacts on an affiliate's productivity and performance. According to Coviello and Munro (1995), the ability to sense, assimilate, and apply new knowledge heightens the benefits derived from FDI. Even one study shows that firms with higher absorptive capacity receive higher benefits in terms of rising productivity through inter-industry linkages and increased innovation. For example, in high-technology sectors, heightened competition accrues, while in mid-technology sectors, demonstration effects accrue, whereas, in low-technology sectors, there is labour mobility because of the FDI (Hamida & Gugler, 2008). Besides, firms with a higher absorptive capability are in place to benefit more in

terms of knowledge spillovers acquired from FDI because of the higher productivity and innovation gains (Blalock & Simon, 2009). In this context, absorptive capacity plays a moderating role that consistent with increases in both the positive spillovers of FDI and the competitive advantage of host firms (Girma, 2005).

3. Methodology

Estonia stands out as an intriguing case study for understanding the multifaceted effects of Foreign Direct Investment (FDI), given its unique status as a post-transition economy that has attracted a substantial amount of FDI per capita. In terms of per capita stock of FDI, Estonia has consistently ranked ahead of most other locations among the Central and Eastern European (CEE) countries, showcasing its attractiveness to foreign investors (UNCTAD, 2009). Estonia provides a compelling context for examining the intricate dynamics of FDI.

The Estonian Business Registry serves as a valuable source, offering detailed firm characteristics such as wages, location, sector, and capital intensity spanning the period from 1995 to 2021. During the analysis, I will divide the overall sample into different segments. There are two dimensions: time period and the type of sector.

From 1995 to 2021, Estonia has experienced several big moments in history; for example, Estonia joined the European Union in 2004 and experienced major financial crisis during 2008 to 2009. These two events significantly influenced the volume of foreign direct investment, so the overall sample will be divided into 3 different sub-groups, which are 1995 to 2003, 2004 to 2009, and 2010 to 2021. The other dimension is based on the sector of companies. Two main types of sectors are the manufacturing sector and the services sector. Within the manufacturing sector, based on the intensity of technology, it can be divided into high-technology firms, medium-high technology firms, medium-low technology firms, and low-technology firms. Within services sector, companies can be divided into two sub-groups based on their knowledge intensity, which are knowledge-intensive firms and low knowledge-intensive firms. If it is found

appropriate to differentiate firms along the lines of technology or knowledge intensity, this method will give a more in-depth understanding of how different types of firms benefit from FDI. High-tech and knowledge-intensive firms usually have more significant absorptive capacity, due to which they can incorporate the new technologies and practices brought by FDI better. The productivity gain is, therefore, more for this type of firms compared to the case of low-tech firms. The other side of the coin is that knowledge-intensive firms are more likely to induce innovation activity in them. This innovative action is further augmented by FDI in terms of technology transfer and innovation spill-over. The role of FDI is, therefore, significant when the labour productivity of the knowledge-intensive firms will be determined. The other important factor that significantly influences the effect of FDI on labour productivity is the sector. High-technology or knowledge-intensive industries are more productive due to advanced products and processes. Yet, it is indeed likely that low-technology or less knowledge-intensive firms will have a significant relationship between FDI and labour productivity, whereas high technology or high knowledge-intensive firms will not. This is since lower and medium technology firms typically have more extensive initial technology gaps; hence, it can benefit more from advanced technologies and practice related FDI (Blomström & Kokko, 1998). Furthermore, the marginal return on their investment will be higher, the flexibility of resource allocation is more significant and the basic operational improvement more substantial compared to high technology firms, which are more likely to be near the technological frontier already and hence exhibit diminishing return to any extra FDI (Girma, 2005). Therefore, these companies can gain substantial productivities from FDI, while those of high technology companies might not benefit as much from it (Javorcik, 2004).

3.1 Methodology in Analysis of FDI and Productivity --- OLS and FE Model

I aim to analyze the transformation of domestic firms into foreign entities in Estonia between 1995 and 2021. The Estonian economy underwent significant changes during this period, transitioning from a developing economy in the late 1990s to a more

developed one in the late 2010s (Varblane, 2020). Initially, Estonia attracted inward Foreign Direct Investment (FDI) as it transitioned economically (Varblane, 2001). Besides, Estonia joined European Union in 2004, and experienced global financial crisis during 2008 to 2009. Neglecting these economic shifts across the 1995-2021 timeframe could undermine the reliability of estimating FDI's impact on productivity. Consequently, I segmented my estimations into four distinct periods: 1995-2021, 1995-2003, 2004-2009, and 2010-2021. In this way, it will be helpful to analyze is there any differences in the relationship between FDI and labour productivity caused by these two major events. And all the data are from the Estonia Business Registry databank. I utilize Ordinary Least Square (OLS) model, standard fixed effects (FE) method, and propensity score matching (PSM) to analyze the correlation between foreign direct investment (FDI) and the productivity within Estonian firms. Moreover, the study employs the Statistical Classification of Economic Activities in the European Community (NACE Rev.2) to categorize firms within the manufacturing and services sectors based on their technological and knowledge intensity. In the manufacturing sector, firms will be divided into four different groups---high technology firms, medium-high technology firms, medium-low technology firms, and low technology firms based on their technology intensity. In the services sector, firms will be divided into two different groups---knowledge-intensive firms, less knowledge-intensive firms,

Productivity, at its core, embodies the efficiency of production, measuring the amount of output derived from a given set of inputs (Syverson, 2011). It is commonly expressed as an output-input ratio, with single-factor productivity gauging units of output produced per unit of a specific input. While labour productivity is the most prevalent measure of single-factor productivity, occasional considerations extend to capital or materials productivity. However, the intensity of excluded inputs significantly influences single-factor productivity levels, introducing variability even among producers with the same technology but with different factors that use intensities. The gross value-added volume gives an idea of the difference between gross production

at fixed prices and intermediates at fixed prices, so by using gross valued-added volumes per capita can be less vulnerable to measurement errors in fixed capital.

To address this challenge, researchers often turn to a productivity concept that remains invariant to the intensity of observable factor inputs: labour productivity. Labour productivity, which is defined as gross value-added per worker, is much easier to value as well as to comprehend, since it involves just output and labour inputs that can easily be got and more reliable compared to total factor productivity. This again makes it simple to make a perfect comparison between sectors. It is also highly related to employment and wages; therefore, it is an important measure used in the policy setting to improve standards of living and economic well-being.

With standard fixed effects, I incorporate controls for firm-specific characteristics that remain constant over time. I adapt the standard fixed effects equation proposed by Wooldridge (2012) to accommodate this analysis. Doms and Jensen (1998) suggest that the disparity between foreign-owned, and domestically owned firms could stem from various factors such as industry, size, age. By accounting for these four covariates, I aim to refine the estimation of the association between productivity and foreign direct investment, thereby capturing a more accurate relationship. Based on the information, the Equation (1) is generated as follows:

$$lprod_{it} = \alpha + \beta_1 Foreign_{it} + \beta_2 Size_{it} + \beta_3 Sizesq_{it} + \beta_4 Age_{it} + \beta_5 Agesq_{it} + \beta_6 Capintensity_{it} + \mu_i + \tau_t + \varepsilon_{it} \quad (1)$$

Equation (1) establishes a connection between the dependent variable logarithms of labour productivity ($lprod_{it}$) and the independent variable is the dummy ($Foreign_{it}$) represents if a firm is majority foreign-owned, and the control variables about firms' size ($Size_{it}$), the square of firms' size ($Sizesq_{it}$), firm's age (Age_{it}), square of firms' age ($Agesq_{it}$), and capital intensity ($Capintensity_{it}$) along with additional firm-specific fixed effects (FE) (μ_i), yearly effects (τ_t), and an error term (ε_{it}).

3.2 Methodology in Analysis of FDI and Productivity --- PSM

To conduct my treatment analysis, I employ propensity score matching (PSM) as developed by Rosenbaum and Rubin (1983). PSM calculates the probability of receiving foreign direct investment (FDI) based on specified covariates. Initially, the likelihood of FDI receipt for all firms is estimated using a probit model. Subsequently, firms without foreign investment are matched with domestically-owned firms based on their propensity scores. The closest match in propensity score between a treated (foreign owned) firm and a control (domestically owned) firm establishes the counterfactual. Before delving into the intricacies of propensity score matching (PSM), it's essential to grasp and address the two key assumptions underlying matching methodologies. The first assumption, known as conditional independence, posits that the potential outcomes are independent of treatment assignment once confounding factors are considered. In other words, conditional independence assumes that, given the covariates used for matching, there are no unobserved variables influencing both the treatment assignment and the outcome simultaneously. This assumption is fundamental in ensuring that the matching process effectively mimics a randomized controlled trial, thereby mitigating bias in the estimation of treatment effects.

$$E[y_1|X, d = 1] = E[y_0|X, d = 0] \quad (2)$$

Rosenbaum and Rubin (1983) denote this assumption with Equation (2), where (d) represents the treatment status, (X) denotes the set of covariates that have been adjusted for, and (y) signifies the outcome variable. y_1 means that the potential outcome if the treatment is applied, and y_0 means that the potential outcome if the treatment is not applied

The conditional independence assumption essentially means that relevant covariates were controlled, the untreated observations can serve as a suitable counterfactual for the treated group, allowing us to estimate the causal effect of the treatment more reliably. Furthermore, the common support assumption ensures that there is sufficient overlap in the distribution of covariates between the treated and

untreated groups. In other words, after adjusting for covariates, the probability of receiving treatment should fall strictly between 0 and 1 as shown in the Equation (3).

$$0 < P(d = 1|X) < 1 \quad (3)$$

This condition ensures that there are comparable units in both groups, making meaningful matches possible. Both assumptions are crucial for the success of propensity score matching (PSM) because they help to ensure that the matched groups are sufficiently similar, enabling us to draw valid causal inferences from observational data.

The first step involves conducting a probit regression where the dependent variable is the change of ownership status – domestic firms acquired by foreign investor, classified as 0 for domestically owned firms and 1 for foreign-owned firms, while the independent variables consist of confounding factors. Hence, the selection of these explanatory variables is pivotal for ensuring the study's validity. According to existing literature, the covariates chosen should be those that impact the treatment and/or are associated with the outcome variable. In this context, it's essential to consider variables that could influence a firm's foreign ownership status as well as those that might affect firms' productivity. Neglecting to account for a confounder could introduce bias into the treatment effect during the impact evaluation study, as noted by Barrowman et al. (2019). However, it's important to note that including irrelevant explanatory variables can mitigate bias, as highlighted by Imbens (2004). Furthermore, according to Imbens (2004), variables influenced by the treatment should be omitted from the analysis to prevent bias in the estimated treatment effect derived from propensity scores. Additionally, Abadie and Imbens (2002) argue against using confounders that exhibit perfect collinearity with the treatment, as they cannot generate a suitable control group of untreated units. Finally, if independent variables display perfect collinearity with other covariates, they may need to be omitted. Thus, meticulous selection of covariates is crucial for accurately estimating propensity scores, thereby reducing bias and obtaining precise treatment effect estimates. The selection of covariates is guided by

prior literature and the available data. The model for probit regression is shown as Equation (4)

$$Foreign_{it} = \phi(\alpha + \beta_1 lprod_{it-1} + \beta_2 Size_{it-1} + \beta_3 Sizesq_{it-1} + \beta_4 Age_{it-1} + \beta_5 Agesq_{it-1} + \beta_6 Capintensity_{it-1} + Industry_i + year_i + \varepsilon_{it}) \quad (4)$$

Following the selection of covariates and the computation of propensity scores, it is essential to verify the common support assumption to ascertain whether the propensity scores adequately facilitate matching for both treated and untreated groups. As noted by Imbens (2004), the propensity scores should also achieve balance between the treated and control groups. The standardized difference for a continuous variable is shown in Equation (5), and for categorical variables, the standardized difference is given by Equation (6)

$$d = \frac{(\hat{x}_{treatment} - \hat{x}_{control})}{\sqrt{\frac{s_{treatment}^2 + s_{control}^2}{2}}} \quad (5)$$

$$d = \frac{(\hat{p}_{treatment} - \hat{p}_{control})}{\sqrt{\frac{\hat{p}_{treatment} \times (1 - \hat{p}_{treatment}) + \hat{p}_{control} \times (1 - \hat{p}_{control})}{2}}} \quad (6)$$

In the Equation (5), $\hat{x}_{treatment}$ and $\hat{x}_{control}$ are the sample mean of the covariate in treated and untreated, and $s_{treatment}^2$ and $s_{control}^2$ are the standard deviations for each groups. For the equation (6), $\hat{p}_{treatment}$ and $\hat{p}_{control}$ are the prevalence of the covariate in the two groups

According to Austin (2009), a standardized difference below 0.1 has traditionally been deemed negligible between the two means. Consequently, covariates that fall within this range effectively represent both the treated and untreated groups, thereby enabling the researcher to estimate the treatment effect accurately.

After conducting analyzing covariates and matching technique, I proceed to compute the average treatment effect on the treated (ATT). According to Ho et al. (2007), the ATT is particularly significant as it signifies the treatment's effect when it is administered. As depicted in Equation (7), the ATT is determined by subtracting the average labour productivity of foreign-owned firms from the average labour productivity of foreign-owned firms if they had not undergone foreign ownership. The

ATT is particularly focused on changes for those firms really acquired; it provides the direct impact of foreign acquisitions on the firms' post-acquisition. This is particularly of policy-relevant concern in understanding real-world impacts that foreign acquisitions exert on acquired entities. By focusing on the ATT, the analysis captures the benefits or drawbacks that a given set of acquired firms faces, which can subsequently be more effectively relevant for future strategy and policy consideration than the ATE, which averages the effect across the entire population, including non-acquired firms. Thus, the ATT provides a more precise and actionable understanding of the productivity effects of foreign acquisitions.

$$ATT = E[y_{1i} - y_{0i} | D_i = 1] = E[\{E[y_{1i} | X_i, D_i = 1] - E[y_{0i} | X_i, D_i = 1]\} | D_i = 1] \quad (7)$$

In the Equation (7), (y_{1i}) signifies the labour productivity of a foreign-owned firm, (y_{0i}) denotes the labour productivity of a domestically owned firm, (D_i) represents the treatment assignment, where 1 indicates a domestic firm changes its ownership from domestically owned to foreign-owned from t-1 to t, and (X_i) refers to the controlled covariates for the firm.

After outlining the detailed steps required to conduct this study, I will elaborate on the software and commands employed for the analysis. I utilize Stata to execute standard fixed effects, propensity score matching, and calculate the average treatment effect on the treated (ATT). Subsequently, it is essential to employ the standardized difference to ensure that the covariates exhibit reasonably similar means across different treatment assignments. For this purpose, I utilize the `-pstest-` command, which facilitates the balancing test by computing the standardized percentage bias.

4. Data and Statistic Description

In this paper, the major databank will be utilized: Estonian Business Registry Databank, and the time frame of the data is from 1995 to 2021 which cover the beginning of post-transition economy to the recent year.

4.1 Data Source and Variables

The *Estonian Business Registry* contains financial information for the entire population of Estonian companies, including data such as balance sheets, profit and loss statements, and cash flow statements. Additionally, it provides general information about companies, such as 5-digit industry classification codes, ownership details, the number of employees, and turnover by industries for certain years. Companies are required to submit their annual reports by June 30th of the following year, and data for specific years typically becomes available around December of the subsequent year.

In details, As mentioned earlier, I will utilize Estonian Business Registry for my analysis, encompassing data spanning from 1995 to 2021, featuring records from 154,294 distinct firms after the removal of missing data and outliers. Outliers were identified by observing at least one key variable falling within the lowest 1% or highest 1% range, and the overall size of the observations is 932,298. This dataset at the firm level contains an indicator indicating whether each firm is predominantly foreign owned. Alongside this foreign ownership indicator, the data encompasses various characteristics of each firm, including size and sector, drawn from the firms' balance sheets. Besides, other variables such as labour productivity will be gathered. Throughout this study, I utilize the natural logarithms of labour productivity to decrease the standard deviation, and the dummy variable for categorical variables such as foreign ownership. Besides, in the study, firms' size, square of firms' size, firm's age, square of firms' age, and capital intensity will be controlled.

To expand on this idea, I have further categorized firms based on the degree to which their sectors utilize technology or knowledge in manufacturing and services. Utilizing NACE Rev.2, I distinguish between four levels of technology intensity and two levels of knowledge intensity. Therefore, particular emphasis is placed on specific sectors when matching treated firms to their controls, as sector-specific characteristics have been shown to significantly influence the allocation of FDI (Hoi & Pomfret, 2010; Pittiglio et al., 2015). Additionally, I incorporate lagged variables to address the potential for foreign investors to selectively target the most productive firms (Lipsey &

Sjöholm, 2004). Firm size is considered because larger firms may appear more appealing to foreign investors (Girma & Görg, 2007; Görg et al., 2007; Vahter & Masso, 2007). While incorporating age and size, I include squared firm size to accommodate the possibility of a non-linear relationship between these variables and foreign acquisition. Additionally, it's likely that more productive and capital-intensive firms would also attract foreign investors (Görg et al., 2007; Peluffo, 2015). Labour productivity is measured as value-added per employee, while capital intensity is measured by the amount of capital relative to the number of workers. By including these variables from the previous period, I mitigate the influence of the treatment. The details of these variables are shown in the Table 1.

Table 1.

The Description of Variables

Variables	Definition	Measurement / Equation
Dependent Variable: Labour productivity	Labour productivity is determined by the gross value-added volumes per employed individual in natural logarithm form (lprod).	$lprod = \ln\left(\frac{value-added\ volumes}{employees}\right)$
Independent Variable: Foreign	Foreign is a dummy variable which shows the ownership of firms (foreign).	Foreign ownership = 1 / Local firms = 0
Control Variable: Firms' size	Firms' size shows how many employees in the firm by taking its natural logarithm (size).	Size = ln (number of employees)
Control Variable: Square of firms' size	Square of the number of firms' employees which measures the non-linear relationship (sizesq).	$sizesq = (size)^2$
Control Variable: Firms' age	Firms' age measures how long do the firm exist and it's measured by natural logarithm of the number of years (age).	Age = ln (number of years)
Control Variable: Square of firms' age	Square of the number of firms' existing years which measures the non-linear relationship (agesq)	$agesq = (age)^2$
Control Variable: Capital Intensity	Capital intensity is the deflated stock of capital relative to the number of employees (capital intensity) in natural logarithm form.	$capintensity = \ln\left(\frac{deflated\ stock}{employees}\right)$

4.2 Data Description

Table 2 presents the average values of several key variables under consideration. lprod represents the natural logarithm of the labour productivity disbursed by the firm. Size reflects the workforce size of the firm, and Sizesq represents the square of firms' size. Age denotes the firm's duration in years, and Agesq represents the square of firms' age. Capital intensity signifies the logarithms of deflated capital stock in relation to the

number of employees. These descriptive statistics allow for a fundamental understanding of the sample's characteristics. In the Table 2, it shows the g basic information of different variables from 1995 to 2021. The mean of logarithms of labour productivity is 1.3652 for the whole period, and the dummy variable shows that the mean is 0.0589, which means that the majority of companies in Estonia are domestically owned.

Table 2:
Descriptive statistics for data from 1995 – 2021

<i>Time period: 1995 - 2021</i>	<i>Variable</i>	<i>Observations</i>	<i>Mean</i>	<i>Standard Deviation</i>
	<i>lprod</i>	898,958	10.3652	1.3648
	<i>Foreign</i>	932,981	0.0589	0.2355
	<i>Size</i>	932,981	1.1362	1.2010
	<i>Sizesq</i>	932,981	2.7333	4.9427
	<i>Age</i>	932,981	1.9021	0.8530
	<i>Agesq</i>	932,981	4.3457	2.9840
	<i>Capital Intensity</i>	766,188	8.5956	1.9615

Source: Estonian Business Registry, calculated by author, with STATA

In the next step, I will divide all the firms into two groups: domestic firm and foreign-owned groups, and I will separate the data into 4 different groups according to the time period: 1995 – 2021, 1995 – 2003, 2004 – 2009, and 2010 - 2021. The results are shown as below (Table 3):

Table 3.

Data Description for Different Time Periods

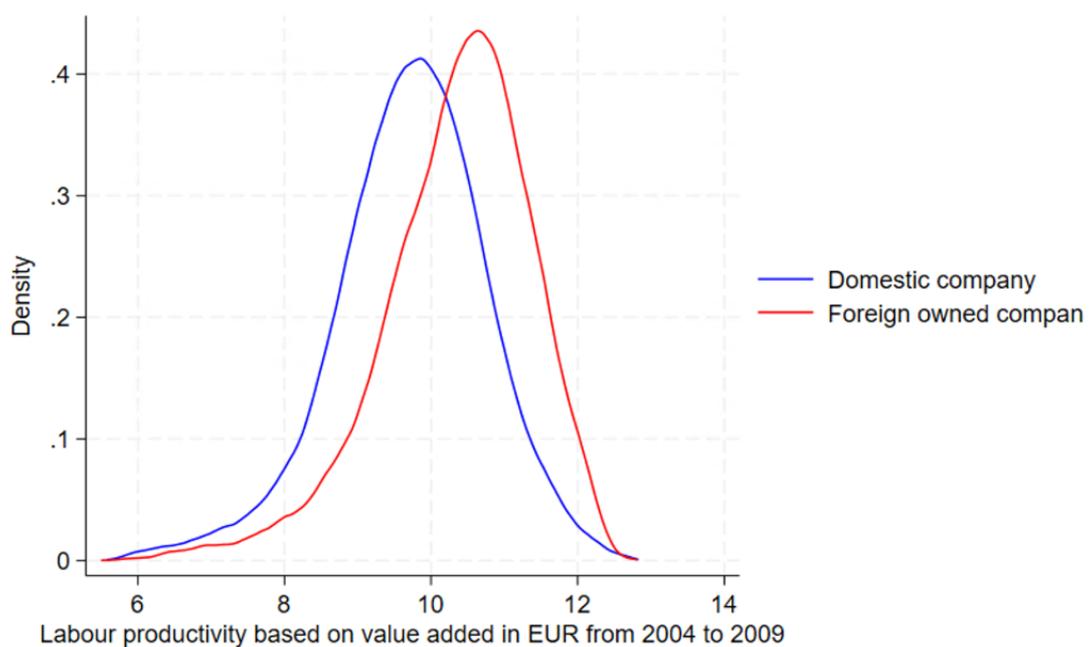
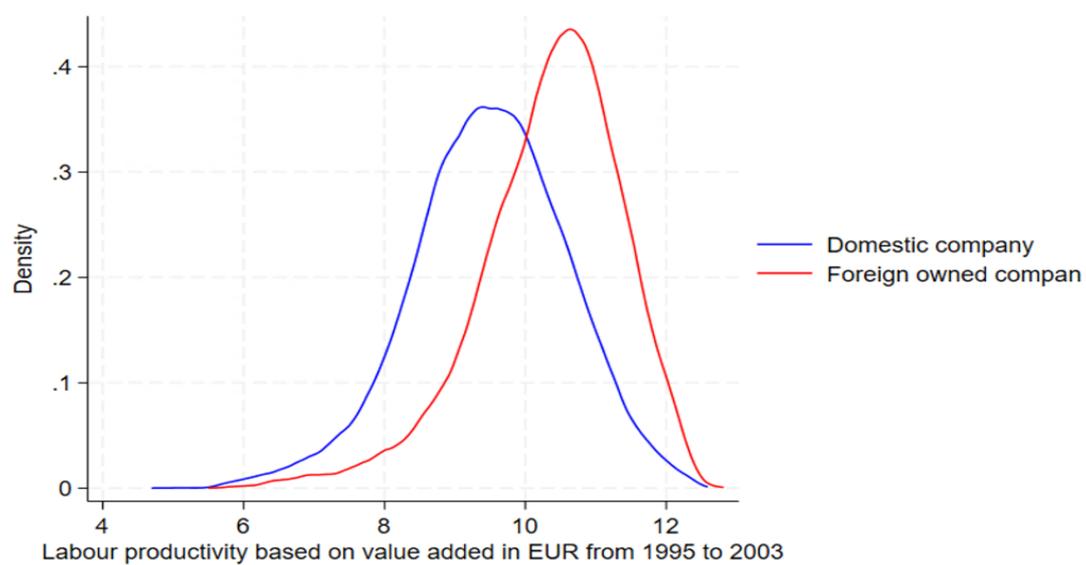
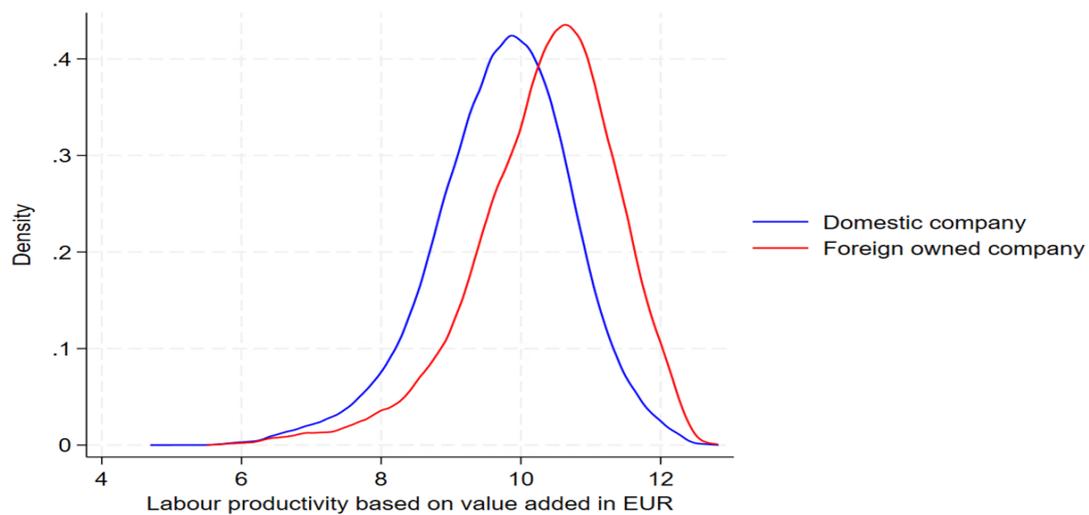
<i>Variables</i>	<i>Time Period: 1995 - 2021</i>		<i>Time Period: 1995 - 2003</i>		<i>Time Period: 2004 - 2009</i>		<i>Time Period: 2010 - 2021</i>	
	<i>Domestic Firms</i>	<i>Foreign-owned Firms</i>						
<i>lprod</i>	10.3153 (1.3330)	11.1768 (1.5997)	9.8128 (1.3742)	10.7253 (1.5286)	10.2753 (1.3248)	11.0699 (1.5901)	10.4494 (1.2956)	11.3858 (1.5909)
<i>Size</i>	1.0902 (1.1566)	1.8711 (1.5937)	1.7131 (1.2234)	2.1869 (1.4510)	1.2985 (1.1619)	2.0073 (1.5721)	0.8572 (1.0596)	1.6896 (1.6294)
<i>Sizesq</i>	2.5262 (4.5579)	6.0410 (6.4360)	4.4315 (5.7400)	6.8876 (8.0027)	3.0362 (4.9054)	6.5006 (8.6870)	1.8577 (3.8754)	5.5096 (8.4335)
<i>Age</i>	1.9046 (0.8527)	1.8621 (0.8723)	1.5550 (0.6632)	1.5561 (0.6415)	1.8408 (0.7743)	1.8371 (0.7685)	2.0170 (0.8943)	1.9898 (0.9337)
<i>Agesq</i>	4.3547 (2.9841)	4.2023 (2.9789)	2.8577 (1.8470)	2.8328 (1.7859)	3.9881 (2.5353)	3.9457 (2.5077)	4.8312 (3.2078)	4.8312 (3.3293)
<i>Capital Intensity</i>	8.5664 (1.9286)	8.9025 (2.1653)	7.9992 (1.8140)	8.7349 (1.8852)	8.7572 (1.8484)	9.1197 (2.0722)	8.6569 (1.9632)	8.8532 (2.3136)
Obs	877,994	54,987	141,526	11,039	188,933	14,138	547,535	29,810
<i>Number of Firms</i>	373,367	42,466	79,037	7,196	128,262	12,008	292,162	33,633

Source: Estonia Business Registry, calculated by author, with STATA

In Table 3, it shows the mean of each variable, and their standard deviations are shown in the parentheses. Overall, in the sample, the total number of firm-years is 373,367 and the total number of foreign-owned firms is 42,466. From the table, it shows that from 1995 to 2021, companies increase the level of productivity. For example, in 1995 the average labour productivity of domestic firms is 9.8128 but the number increase to 10.4494 in 2021. The average labour productivity of foreign firms is 10.7253 in 1995, and the number increase to 11.3858 in 2021. Besides, from both overall sample size and different time segments, the average labour productivity of foreign firms is higher than domestic firms. This pattern will be analyzed in detail during the empirical analysis part.

From the data of the number of firms, it indicates that, during 1995 to 2003, there were fewer foreign firms in Estonia due to the less connection with the world. But after Estonia joined the EU, the number of foreign-owned firms jumped from 7,196 to 12,008, and this number increase to 33,633 in 2021. It shows the process of internationalization in Estonia. This pattern also gives support that the research needs to be divided into different time frames to analyze the pattern between FDI and productivity.

These summary statistics allow me to consider the potential for variability among companies owned by foreigners and those owned domestically. To ascertain whether labour productivity distributions differ between these two groups, a Kernel Density Graph is employed. The figures are shown in the Figure 1.



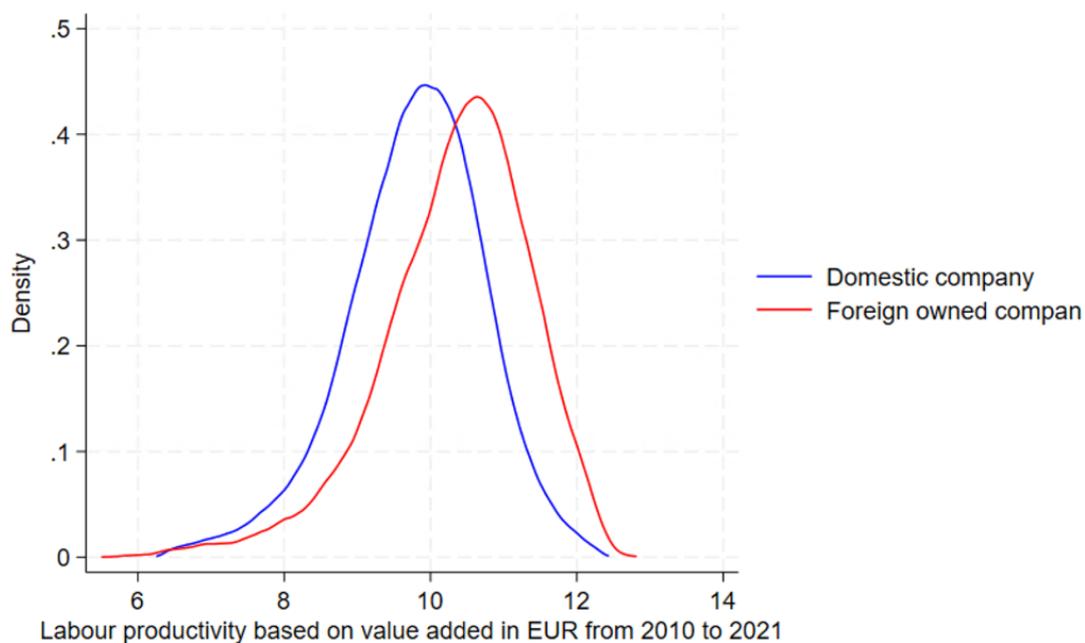


Figure 1.

Kernel Density Graph with Domestic versus Foreign-owned Firms

Source: Estonia Business Registry, generated by author, with STATA

This finding is further supported by the kernel density plot depicted in Figure 1. As illustrated in Figure 1, the peaks of foreign-owned firms indicate a denser concentration of higher labour productivity compared to domestically owned firms, and the density of the highest labour productivity in foreign-owned companies is higher than that of domestic companies. This heightened concentration warrants further investigation into the correlation between foreign ownership and labour productivity. To confirm the finding, the correlation of each variable is generated, and the results are shown in Table 4.

Table 4.
Correlation Coefficients Table

Variables	lprod	Foreign	Size	Sizesq	Age	Agesq	Capital Intensity
lprod	1						
Foreign	0.1432	1					
Size	0.0829	0.1700	1				
Sizesq	0.0580	0.1841	0.9067	1			
Age	0.1350	-0.0091	0.1708	0.1567	1		
Agesq	0.1360	-0.0082	0.1733	0.1616	0.9657	1	
Capital Intensity	0.3201	0.0388	-0.0064	0.0246	0.1605	0.1609	1

Source: Estonia Business Registry, calculated by author, with STATA

From Table 4, it shows that the correlation coefficients between foreign ownership and labour productivity is 0.1432 which is positive, and it shows that there is a potential significantly positive relationship between foreign ownership and labour productivity, which confirms the hypothesis mentioned before.

Utilizing data sourced from the Estonian Business Registry between 1995 to 2021, I have a general picture of whether foreign ownership correlates with labour productivity. Based on the descriptive statistics mentioned earlier, I anticipate that foreign ownership will have a favorable impact on labour productivity, even after accounting for potential influencing factors.

4.3 Stationarity Test

In this section, the test for stationary in panel data will be used and the results are shown in the Table 5.

Table 5.

Im-Pearson-Shin Unit-root Test

Ho: All panels contain unit roots (Non-stationary)

Ha: Some panels are stationary

AR parameter: Panel-specific	Asymptotics: T,N->Infinity sequentially	
Panel means: Included	Cross-sectional means removed	
Time trend: Not included	ADF regressions: 0 lags	
Variables	w-t-bar Statistics	P-value
lprod	-6.7182	0.000
Foreign	-3.0779	0.007
Size	-3.4709	0.003
Sizesq	-2.6068	0.009
Age	-2.1268	0.017
Agesq	-2.0244	0.019
Capital intensity	-7.3244	0.000

Source: Estonia Business Registry, calculated by author, with STATA

From Table 5, it shows the result of the stationary test for all the variables. Based on the results, all the P-value are lower than 0.1 which means that variables are stationary at 10% significance level. In more details, the P-value of lprod, foreign, size, sizeaq, and capital intensity are less than 0.01. Besides, the P-value of age and agesq are 0.017 and 0.019 which are slightly higher than 0.01 but less than 0.05. Based on the results of the stationary test, all the null hypotheses of variables can be rejected at 5% significance level, which means that these variables pass the stationary test for panel data.

5. Empirical Analysis and Result

After basic statistical description, a more detailed analysis will be conducted to capture the relationship between foreign ownership and labour productivity. To analyze the correlation between foreign ownership and labour productivity among Estonian firms, I employ standard fixed effects (FE) and propensity score matching (PSM) techniques on the unbalanced panel data obtained from the Estonian Business Registry spanning the years 1995 to 2021. As previously mentioned, the treatment under investigation involves a domestic firm transitioning to majority foreign ownership through acquisition. Additionally, I segment the data into three distinct periods: 1995-2003, 2004-2009, and 2010-2021, as the nature of foreign direct investment (FDI) entering Estonia may vary across these timeframes. This section presents estimations for all periods using three different models: ordinary least squares (OLS), fixed effects (FE), and propensity score matching (PSM).

5.1 Empirical Results by Using OLS and FE Model

The ordinary least squares (OLS) model may exhibit bias due to endogeneity; however, this regression still offers insights into the potential association between foreign firms and labour productivity. To start the empirical analysis, the overall sample (1995 – 2021) will be analyzed by using OLS and FE model, and the results are shown in Table 6. In this model, I analyze the relationship between foreign ownership and labour productivity, rather than foreign acquisition, which will be examined using the standard fixed-effects model and propensity score matching (PSM). To accurately interpret the relationship between a binary variable such as foreign ownership and a logarithmic variable like real wages, I apply the OLS method proposed by Halvorsen and Palmquist (1980). As indicated in Table 6, foreign-owned firms have approximately 48.7% higher labour productivity on average, by controlling other factors which may influence the relationship. This difference is significant at 0.01

significance level. Employing the standard fixed effects model, which adjusts for time-invariant and firm-specific effects, allows me to analyze the correlation between foreign ownership and labour productivity within a firm. This approach enables me to mitigate potential biases stemming from factors specific to each firm. Thus, I assess the impact of foreign acquisition on labour productivity while considering the firm's individual characteristics. Within this model, I incorporate controls for factors such as the firm's age, size, capital intensity. According to the findings presented in Table 6, I observe a significant positive relationship between foreign ownership and labour productivity which increase in labour productivity by 6.2% across the entire sample period from 1995 to 2021. Overall, the fixed-effect model supports the findings by using OLS method.

From the results by using OLS method and FE model, all the control variables are significant at 0.01 significance level, which shows that these factors can influence the relationship between foreign ownership and labour productivity. From the results, it also confirms that firms' size and firms' age have a non-linear relationship with labour productivity.

Table 6.

Result by Using OLS and FE Model for Data Sample from 1995 to 2021

Dependent Variable: *lprod*

<i>Independent Variables</i>	<i>Time Period: 1995 - 2021</i>	
	<i>OLS</i>	<i>FE Model</i>
<i>Foreign</i>	0.4871*** (0.000)	0.0619*** (0.000)
<i>Size</i>	0.2255*** (0.000)	-0.1278*** (0.000)
<i>Sizesq</i>	-0.0322*** (0.000)	-0.0274*** (0.000)
<i>Age</i>	0.1225*** (0.000)	0.1152*** (0.000)
<i>Agesq</i>	-0.0565*** (0.000)	-0.0476*** (0.000)
<i>Capital Intensity</i>	0.2051*** (0.000)	0.1270*** (0.000)
<i>Constant</i>	7.1738*** (0.000)	9.0321*** (0.000)
<i>Industry Dummies</i>	Yes	Yes
<i>Year Dummies</i>	Yes	Yes
Obs	581,378	581,378
<i>F-test</i>	1,315.87	/
<i>Chi-sqaure</i>	/	17,732.01
<i>Adjusted R-square</i>	22.43%	8.46%

P-value is shown in the in the parentheses

* Statistical significance at 0.1 level

** Statistical significance at 0.05 level

*** Statistical significance at 0.01 level

Source: Estonia Business Registry, calculated by author, with STATA

After analyzing the overall sample, I will analyze the pattern between foreign ownership and labour productivity in different time segments. In this session, the OLS and FE model will be used for 3 different groups: 1995 – 2003, 2004 – 2009, and 2010 – 2021. The results are shown in Table 7. From Table 7, it shows that, by using OLS method, there is a significantly positive relationship between foreign ownership and labour productivity within all 3 different groups. Specifically, in the first period (1995 – 2003), foreign ownership was associated with 54.2% higher labour productivity on average, the number is 48.1% in the second time frame (2004 - 2009), and the number is 43.5% in the third time frame (2010 – 2021). Besides, all the numbers are significant at a 0.01 significance level. Considering the firms' characteristics and adjusting for time-invariant and firm-specific effects, the fixed-effect model is used in this analysis. In Table 7, it shows that, by conducting a fixed effect model, the positive relationship between foreign ownership and labour productivity is still significant within all 3 different groups. Specifically, in the first time frame (1995 – 2003), foreign ownership can bring 3.2% increase in the firm's labour productivity on average, the number is 2.0% in the second time frame (2004 - 2009), and the number is 7.1% in the third time frame (2010 – 2021). However, only in the third time period, the positive influence is significant at 0.01 significance level. It shows that, after joining the EU, foreign ownership can positively influence labour productivity in Estonian companies.

After analyzing the pattern in different time frames, we can conclude that the positive relationship between FDI and labour productivity is significant within Estonian market between 1995 to 2021. After becoming one part of the EU, foreign ownership has a significantly positive relationship with firm-level labour productivity.

Table 7.

Result by Using OLS and FE Model for Different Time Segments

Dependent Variable: *lprod*

<i>Independent Variables</i>	<i>Segments by Time Period</i>					
	<i>1995 - 2003</i>		<i>2004 - 2009</i>		<i>2010 - 2021</i>	
	<i>OLS</i>	<i>FE Model</i>	<i>OLS</i>	<i>FE Model</i>	<i>OLS</i>	<i>FE Model</i>
<i>Foreign</i>	0.5424*** (0.000)	0.0323 (0.259)	0.4806*** (0.000)	0.0201 (0.585)	0.4351*** (0.000)	0.0714*** (0.000)
<i>Size</i>	0.0688*** (0.000)	-0.4663*** (0.000)	0.1939*** (0.000)	-0.4297*** (0.000)	0.2620*** (0.000)	-0.1620*** (0.000)
<i>Sizesq</i>	-0.0061*** (0.000)	0.0139*** (0.004)	-0.0306*** (0.000)	-0.0320*** (0.000)	-0.0345*** (0.000)	-0.0164*** (0.007)
<i>Age</i>	-0.0237 (0.243)	-0.0083 (0.694)	0.1684*** (0.000)	0.1450*** (0.000)	0.3062*** (0.000)	0.3039*** (0.000)
<i>Agesq</i>	-0.0399*** (0.000)	-0.0032 (0.904)	-0.0755*** (0.000)	-0.1210*** (0.000)	-0.0935*** (0.000)	-0.0658*** (0.000)
<i>Capital Intensity</i>	0.2960*** (0.000)	0.1853*** (0.000)	0.2472*** (0.000)	0.0788*** (0.000)	0.1649*** (0.000)	0.0842*** (0.000)
<i>Constant</i>	5.6260*** (0.000)	8.9366*** (0.000)	8.0041*** (0.000)	9.2714*** (0.000)	7.7333*** (0.000)	8.5949*** (0.000)

<i>Industry Dummies</i>	Yes	Yes	Yes	Yes	Yes	Yes
<i>Year Dummies</i>	Yes	Yes	Yes	Yes	Yes	Yes
Obs	97,954	97,954	137,319	137,320	346,121	346,122
F-test	3,625.56	/	5017.18	/	793.16	/
Chi-sqaure	/	6,238.92	/	4,717.68	/	9,637.93
Adjusted R-square	31.78%	16.48%	24.21%	19.50%	19.46%	4.98%

P-value is shown in the in the parentheses

* Statistical significance at 0.1 level

** Statistical significance at 0.05 level

*** Statistical significance at 0.01 level

Source: Estonia Business Registry, calculated by author, with STATA

After breaking down the time frames, this research also divided the sample into two different segments based on their characteristics which are manufacturing factor or services sector.

In the manufacturing sector, there are 4 different groups: high-technology firms, medium-high-technology firms, medium-low-technology firms, and low-technology firms. From the results shown in Table 8, it shows that in manufacturing sectors, the relationship between foreign ownership and labour productivity is significantly positive at 0.1 significance level by using fixed-effect model in general, which can bring a 4.1% increase in labour productivity.

Moreover, after controlling other factors, all these four different segments show a positive relationship between foreign ownership and labour productivity at 0.01 significance level. The OLS model shows that medium-low and low-technology firms have the most positive relationship with foreign ownership, which can bring about a 35.5% and 31.6% increase in labour productivity on average, respectively. In the high-technology firms, foreign ownership can bring a 26.23% increase in labour productivity. In medium-high technology firms, foreign ownership can bring a 23.17% increase in labour productivity.

To address endogeneity problem, the FE model is utilized, which demonstrated the finding by using OLS model. In detail, by using fixed-effect model, the positive relationship between foreign ownership and labour productivity is significant at 0.1 significance level within high-technology group and it can increase the firm-level labour productivity by 14.9% on average. And in Medium-high technology firms, foreign ownership may bring a 11.4% increase in labour productivity, which is significant at 0.05 significance level. Within the medium-low technology groups, foreign ownership can bring a 7.6% increase in firm-level labour productivity at a 0.1 significance level. However, in the low technology firms, the positive pattern is not statistically significant.

Based on the results, it can be concluded that foreign ownership can bring a positive influence on firm-level labour productivity in Estonian manufacturing firms, and this

situation can be explained by the theory from Findlay (1978). Foreign Direct Investment or foreign ownership can bring new technologies to these companies, and they will be triggered to close the technology gap by adopting these new technologies. This will potentially increase the labour productivity after equipping with new technologies.

Table 8.

Result by Using OLS and FE Model for Manufacturing Sector

<i>Dependent Variable:</i>		<i>Segments in Manufacturing Sector</i>									
<i>lprod</i>		<i>Overall Sample</i>		<i>High Technology</i>		<i>Med-high Technology</i>		<i>Med-low Technology</i>		<i>Low Techonoly</i>	
<i>Independent Variables</i>	<i>OLS</i>	<i>FE Model</i>	<i>OLS</i>	<i>FE Model</i>	<i>OLS</i>	<i>FE Model</i>	<i>OLS</i>	<i>FE Model</i>	<i>OLS</i>	<i>FE Model</i>	
<i>Foreign</i>	0.3065*** (0.000)	0.0414* (0.098)	0.2623*** (0.000)	0.1485* (0.086)	0.2317*** (0.000)	0.1140** (0.032)	0.3548*** (0.000)	0.0759* (0.095)	0.3158*** (0.000)	0.0287 (0.180)	
<i>Size</i>	0.2274*** (0.000)	-0.1590*** (0.000)	0.2239*** (0.000)	-0.2879** (0.032)	0.1641*** (0.000)	-0.2724*** (0.000)	0.2859*** (0.000)	-0.2153*** (0.000)	0.2048*** (0.000)	0.1315*** (0.000)	
<i>Sizesq</i>	-0.0267*** (0.000)	-0.0069* (0.098)	-0.0346*** (0.000)	0.0087 (0.565)	-0.0249*** (0.000)	0.0160 (0.155)	-0.0333*** (0.000)	0.0022 (0.808)	-0.0217*** (0.000)	-0.0116** (0.038)	
<i>Age</i>	0.0675*** (0.003)	0.0020 (0.952)	-0.3355* (0.081)	-0.2616 (0.454)	-0.0656 (0.381)	0.2089* (0.067)	0.0868* (0.052)	-0.0186 (0.785)	0.0840*** (0.000)	0.0030 (0.942)	
<i>Agesq</i>	-0.0452*** (0.000)	0.0074 (0.730)	0.1019** (0.029)	0.0827 (0.654)	0.0031 (0.865)	-0.1365** (0.037)	-0.0729*** (0.000)	0.0743* (0.086)	-0.0447*** (0.002)	0.0047 (0.863)	

Capital Intensity	0.2128*** (0.000)	0.1343*** (0.000)	0.2298*** (0.000)	0.1035*** (0.002)	0.2016*** (0.000)	0.1110*** (0.000)	0.1960*** (0.000)	0.0994*** (0.000)	0.2181*** (0.000)	0.1457*** (0.000)
Constant	6.7246*** (0.000)	8.3277*** (0.000)	7.0924*** (0.000)	8.8556*** (0.000)	7.9892*** (0.000)	9.5784*** (0.000)	6.7390*** (0.000)	8.4929*** (0.000)	6.6137*** (0.000)	7.9485*** (0.000)
Industry Dummies	Yes									
Year Dummies	Yes									
Obs	54,397	54,397	1,359	1,359	5,350	5,350	12,064	12,064	36,638	36,638
F-test	3,638.99	/	51.82	/	288.47	/	597.39	/	2,822.66	/
Chi-square	/	2,720.63	/	59.05	/	353.24	/	635.91	/	1,876.14
Adjusted R-square	29.05%	10.15%	26.03%	13.11%	23.78%	13.06%	26.87%	8.47%	26.47%	10.73%

P-value is shown in the in the parentheses

* Statistical significance at 0.1 level

** Statistical significance at 0.05 level

*** Statistical significance at 0.01 level

Source: Estonia Business Registry, calculated by author, with STATA

In the services sector, there are 2 different groups which are high knowledge-intensive firms and low knowledge-intensive firms. From the results shown in Table 9, it shows that in services sectors, the relationship between foreign ownership and labour productivity is significantly positive at 0.01 significance level. Overall, the foreign-owned firms may increase labour productivity by 53.5% by using OLS method. By using fixed-effect model, it shows that labour productivity may be increased by 5.8% in foreign-owned companies.

In more details, from OLS model, it shows that low knowledge-intensive firms have the most positive effect. After controlling other factors, the effect of foreign ownership on the low knowledge-intensive firm is positive—that is, it increases the labour productivity by 54.8%, as compared to high knowledge-intensive firms, where labour productivity increases by 47.5%. However, after taking endogeneity into account, the results of FE model are generated. The results would be different in the form that foreign ownership increases the labour productivity of high knowledge-intensive firms by 7.8% and that of low knowledge-intensive firms by 4.9%. This means that the initial findings of OLS are probably subject to endogeneity and the FE model is a better representation of what the effect of foreign ownership on labour productivity really is: stronger for high knowledge-intensive firms, but at a smaller rate.

After analyzing the results, we can find that foreign ownership can have a significant relationship with labour productivity within Estonian services sector, and for different firms' knowledge intensity, the pattern will be different. This situation may be explained by how much knowledge can be absorbed by firms. different firms may have different ability to adopt new knowledge. By receiving more foreign direct investment, firms may be more likely to invest in R&D expenses which may increase their ability to using the new knowledge. In this way, firms' labour productivity may be increased by fully utilizing new knowledge.

Table 9.

Result by Using OLS and FE Model for Services Sector

<i>Independent Variables</i>	<i>Segments in Services Sector</i>					
	<i>Overall Sample</i>		<i>Knowledge-intensive Firms</i>		<i>Low Knowledge-intensive Firms</i>	
	<i>OLS</i>	<i>FE Model</i>	<i>OLS</i>	<i>FE Model</i>	<i>OLS</i>	<i>FE Model</i>
<i>Foreign</i>	0.5352*** (0.000)	0.0582*** (0.001)	0.4749*** (0.000)	0.0779** (0.012)	0.5477*** (0.000)	0.0490** (0.013)
<i>Size</i>	0.2362*** (0.000)	-0.1606*** (0.000)	0.2839*** (0.000)	-0.2138*** (0.000)	0.2184*** (0.000)	-0.1532*** (0.000)
<i>Sizesq</i>	-0.0345*** (0.000)	-0.0289*** (0.000)	-0.0423*** (0.000)	-0.0252*** (0.002)	-0.0314*** (0.000)	-0.0296*** (0.000)
<i>Age</i>	0.1424*** (0.000)	0.1407*** (0.000)	0.1341*** (0.000)	0.1246*** (0.000)	0.1432*** (0.000)	0.1438*** (0.000)
<i>Agesq</i>	-0.0592*** (0.000)	-0.0508*** (0.000)	-0.0461*** (0.000)	0.0098 (0.600)	-0.0630*** (0.000)	-0.0661*** (0.000)
<i>Capital Intensity</i>	0.2006*** (0.000)	0.1180*** (0.000)	0.1810*** (0.000)	0.0952*** (0.000)	0.2072*** (0.000)	0.1231*** (0.000)

<i>Constant</i>	8.0620*** (0.000)	9.5865*** (0.000)	8.3772*** (0.000)	8.4938*** (0.000)	7.9831*** (0.000)	9.6419*** (0.000)
<i>Industry Dummies</i>	Yes	Yes	Yes	Yes	Yes	Yes
<i>Year Dummies</i>	Yes	Yes	Yes	Yes	Yes	Yes
Obs	349,477	349,477	88,059	88,059	261,418	261,418
<i>F-test</i>	2,816.31	/	2,680.10	/	7,012.52	/
<i>Chi-sqaure</i>	/	8,525.68	/	3,330.04	/	5,817.21
<i>Adjusted R-square</i>	21.13%	9.13%	15.21%	8.86%	23.08%	9.48%

P-value is shown in the in the parentheses

* Statistical significance at 0.1 level

** Statistical significance at 0.05 level

*** Statistical significance at 0.01 level

Source: Estonia Business Registry, calculated by author, with STATA

5.2 Lagged Effect Analysis by Using FE Model

From previous section, the general pattern of relationship between foreign ownership and labour productivity has been generated. In this session, the lag effect of foreign ownership on labour productivity will be discussed, and the 1-year lead data will be utilized in this section to discuss, and 2-year lead will be analyzed, and the results are shown in the Appendix A. Table 10 shows the relationship between FDI and time-leading labour productivity by different time frame. In general, the independent variable (foreign) in the overall sample is significant at 0.01 significance level, demonstrating that the effect of foreign ownership will last at least 1 year. It shows that 1-year after getting foreign ownership, the effect can still bring a 5.6% increase in labour productivity on average. By using 2-year lead data, the positive relationship between foreign ownership and labour productivity is not statistically significant (Appendix A).

In detail, by using 1-year lead data, the foreign ownership can bring approximately a 7.2% increase in labour productivity between 2010 and 2021, and this pattern is significant at a 0.01 significance level. However, for the other two different time frames, the relationship is not statistically significant, demonstrating that 1 year after getting foreign direct investment, the labour productivity won't be significantly different before changing to foreign-owned firms. In order to find out the reasons of the lagged effect between 2010 to 2021, the later analysis in different sectors will be conducted. As for the previous session, manufacturing sector and services sector will be analyzed.

Table 10.

Result of FE Model for Different Time Frame by Using 1-year Lead Data

<i>Independent Variables</i>	<i>Segments by different time frames</i>			
	<i>Overall Sample</i>	<i>1995 - 2003</i>	<i>2004 - 2009</i>	<i>2010 - 2021</i>
	<i>FE</i>	<i>FE</i>	<i>FE</i>	<i>FE</i>
<i>Foreign</i>	0.0557*** (0.000)	0.0090 (0.767)	0.0640 (0.234)	0.0722*** (0.000)
<i>Size</i>	-0.0669*** (0.000)	-0.1091*** (0.000)	-0.2587*** (0.000)	-0.0438*** (0.000)
<i>Sizesq</i>	-0.0048** (0.046)	-0.0083 (0.118)	0.0392*** (0.000)	-0.0014 (0.739)
<i>Age</i>	-0.0086 (0.425)	-0.0472* (0.069)	0.0083 (0.699)	0.0589* (0.052)
<i>Agesq</i>	-0.0173** (0.020)	-0.0404 (0.171)	-0.0676*** (0.001)	-0.0020 (0.829)
<i>Capital Intensity</i>	0.0612*** (0.000)	0.0467*** (0.000)	-0.0275*** (0.001)	0.0338*** (0.000)

<i>Constant</i>	9.0969*** (0.000)	9.9544*** (0.000)	9.3657*** (0.000)	8.9541*** (0.000)
<i>Industry Dummies</i>	Yes	Yes	Yes	Yes
<i>Year Dummies</i>	Yes	Yes	Yes	Yes
Obs	478,190	82,634	114,070	281,486
<i>Adjusted R-square</i>	2.65%	2.18%	6.48%	3.27%

P-value is shown in the in the parentheses

* Statistical significance at 0.1 level

** Statistical significance at 0.05 level

*** Statistical significance at 0.01 level

Source: Estonia Business Registry, calculated by author, with STATA

In Table 11, it shows the relationship between FDI and time-leading labour productivity within the manufacturing sector by using 1-year lead data. In general, the independent variable (foreign) is not statistically significant by using all data from Estonian firms in the manufacturing sector, which demonstrates that the effect of foreign ownership will not have a lag effect within the manufacturing sector in general.

In detail, by using 1-year lead data, foreign ownership can bring approximately a 5.4% increase in labour productivity within the medium-high technology firms, which is statistically significant at a 0.1 significance level. However, for the rest of the 3 different sub-groups, the relationship between foreign ownership and labour productivity is not statistically significant. By using the 2-year lead data, there are no significant results showing that there is a lag effect of foreign ownership (Appendix B). This result shows that, in the manufacturing sector, foreign ownership may still have a positive influence on firm-level labour productivity within medium-high technology firms. This circumstance demonstrates that the firms belonging to medium-high technology groups will take more time to utilize new technologies. When foreign direct investment brings new technologies to these companies, they have a longer learning process of how to use the new technologies and how to make the most use of them to increase labour productivity. This may explain why foreign ownership can still bring a positive relationship to labour productivity after 1 year of getting foreign direct investment within medium-high technology firms in Estonia.

Table 11.

Result of FE Model within Manufacturing Sector by Using 1-year Lead Data

Dependent Variable: *lprod* with
1-year lead

Segments in Manufacturing Sector

<i>Independent Variables</i>	<i>Overall Sample</i>	<i>High Technology</i>	<i>Med-high Technology</i>	<i>Med-low Technology</i>	<i>Low Technology</i>
	<i>FE</i>	<i>FE</i>	<i>FE</i>	<i>FE</i>	<i>FE</i>
<i>Foreign</i>	0.0283 (0.152)	0.1666 (0.170)	0.0540* (0.098)	0.0269 (0.264)	0.0153 (0.367)
<i>Size</i>	-0.0044 (0.839)	-0.01465 (0.202)	-0.1157 (0.113)	-0.0226 (0.639)	0.0107 (0.689)
<i>Sizesq</i>	-0.0205*** (0.000)	-0.0033 (0.789)	-0.0080 (0.494)	-0.0134 (0.165)	-0.0218*** (0.000)
<i>Age</i>	-0.0980*** (0.002)	-0.0309 (0.137)	-0.0778 (0.457)	-0.0596 (0.165)	-0.0988** (0.011)
<i>Agesq</i>	0.0409* (0.066)	0.1242 (0.346)	-0.0259 (0.703)	0.0685 (0.371)	0.0374 (0.183)
<i>Capital Intensity</i>	0.0575*** (0.000)	0.0574* (0.058)	0.0409** (0.015)	0.0335*** (0.004)	0.0628*** (0.000)

<i>Constant</i>	9.0729*** (0.000)	9.0695*** (0.000)	10.9380*** (0.000)	8.5433*** (0.000)	8.8827*** (0.000)
<i>Industry Dummies</i>	Yes	Yes	Yes	Yes	Yes
<i>Year Dummies</i>	Yes	Yes	Yes	Yes	Yes
<i>Obs</i>	45,903	1,166	4,596	10,197	30,832
<i>Adjusted R-square</i>	4.84%	8.99%	7.09%	3.45%	5.40%

P-value is shown in the in the parentheses

* Statistical significance at 0.1 level

** Statistical significance at 0.05 level

*** Statistical significance at 0.01 level

Source: Estonia Business Registry, calculated by author, with STATA

In Table 12, it shows the relationship between FDI and labour productivity by using 1-year lead data within the services sector.

By using 1-year lead data, foreign ownership can bring approximately 5.6% increase in labour productivity within the services sector in general, which is significant at 0.05 significance level. Besides, using 2-year lead data, the positive relationship between foreign ownership and firm-level labour productivity is not statistically significant (Appendix C).

Besides, in the low knowledge-intensive sub-group, foreign ownership can still bring a 6.2% increase in labour productivity after 1 year, which is significant at a 0.05 significance level. However, within knowledge-intensive firms, the pattern is not statistically significant. By comparing these two subgroups, the less knowledge-intensive firms may be more sensitive to FDI acquisitions, which means that foreign ownership may bring more positive effects on firm-level labour productivity to this group of firms in general, and for low knowledge-intensive firms, they may need more time to understand new knowledge bringing by foreign direct investment.

Less knowledge-intensive firms are typically more sensitive to FDI, particularly since they often rely on external sources of capital and expertise to enhance their competitiveness and boost their levels of productivity. Such firms have more to benefit from FDI inflows, especially through advanced technologies, better management practices, and new market access. However, many limitations have been identified regarding the sectoral taxonomy. For instance, the high-tech sector, such as the electronics industry, comprises both very low value-added assembly activities and high value-added semi-conductor business. This kind of diversity within sectors indicates that simple sectoral classification is likely to be highly misleading and deceptive in that it fails to capture its real nature of value addition (Kedia et al., 2012; Blalock & Gertler, 2009). On that score, while the sectoral taxonomy is a good starter, in providing a delineation for analysis, more careful analysis should be done to better inform policy and investment decisions (Von Nordenflycht, 2010).

Table 12.

Result of FE Model within Services Sector by Using 1-year Lead Data

Dependent Variable: *lprod* with 1-year lead

<i>Independent Variables</i>	<i>Segments in Services Sector</i>		
	<i>Overall Sample</i>	<i>Knowledge-intensive Firms</i>	<i>Low Knowledge-intensive Firms</i>
	<i>FE</i>	<i>FE</i>	<i>FE</i>
<i>Foreign</i>	0.0558*** (0.004)	0.0259 (0.471)	0.0620*** (0.005)
<i>Size</i>	-0.1008*** (0.000)	-0.0772*** (0.000)	-0.1104*** (0.000)
<i>Sizesq</i>	0.0031 (0.329)	0.0025 (0.639)	0.0040 (0.260)
<i>Age</i>	-0.0110 (0.458)	-0.0277 (0.326)	-0.0110 (0.526)
<i>Agesq</i>	-0.0163 (0.107)	0.0406** (0.039)	-0.0308*** (0.009)
<i>Capital Intensity</i>	0.0549*** (0.000)	0.0322*** (0.000)	0.0596*** (0.000)

<i>Constant</i>	9.0507*** (0.000)	9.2222*** (0.000)	9.1275*** (0.000)
<i>Industry Dummies</i>	Yes	Yes	Yes
<i>Year Dummies</i>	Yes	Yes	Yes
Obs	286,293	70,700	215,593
<i>Adjusted R-square</i>	3.06%	2.30%	3.44%

P-value is shown in the in the parentheses

* Statistical significance at 0.1 level

** Statistical significance at 0.05 level

*** Statistical significance at 0.01 level

Source: Estonia Business Registry, calculated by author, with STATA

5.3 Empirical Results by Using Propensity Score Matching (PSM)

To investigate the impact of foreign acquisition, I employ Propensity Score Matching (PSM) across multiple time periods: 1995-2021. Employing the 5-nearest-neighbor matching method, I pair untreated firms (those not acquired by foreign entities) with treated firms (those acquired). In Table 8, I present the likelihood of a firm being acquired by foreign entities, derived by estimating Equation (4) through a probit model. These probit models' estimations facilitate the treatment analysis by matching foreign-acquired firms with the five closest domestic counterparts within the same sector and year. This meticulous matching process ensures the creation of an artificial propensity score, emphasizing sector and year alignment. Table 13 shows the results of propensity score estimations, and all the explanatory variables are lagged by 1 year. Besides, I conducted the 2-nearest-neighbor matching method and the Epanecnikov Kernel matching method to produce robust results for the 5-nearest-neighbor matching method.

The findings suggest that firms acquired by foreign investors exhibit consistent differences from domestically owned firms, aligning with existing research. The pseudo R-squared value is 13.2% which is reasonable by using firm-level data studies. The variables, all lagged by one period, demonstrate the expected signs. Notably, past pre-acquisition productivity and firm size notably increase the likelihood of a foreign takeover in Estonia, and the firm size may have a non-linear pattern in this relationship.

Table 13.

Result of Probit Models by Using PSM for Overall Sample

<i>Dummy Variable</i>	<i>Overall Sample</i>
	<i>Foreign_entry</i>
<i>lprod</i>	0.1786*** (0.000)
<i>Size</i>	0.1584*** (0.000)
<i>Sizesq</i>	-0.0033 (0.452)
<i>Age</i>	0.2089*** (0.000)
<i>Agesq</i>	0.036** (0.030)
<i>Capital Intensity</i>	0.0327** (0.023)
<i>Constant</i>	-4.6523*** (0.000)
<i>Industry Dummies</i>	Yes
<i>Year Dummies</i>	Yes
Obs	20,508
<i>Chi-sqaure</i>	365.79
<i>Pseudo R2</i>	13.19%

P-value is shown in the in the parentheses

* Statistical significance at 0.1 level

** Statistical significance at 0.05 level

*** Statistical significance at 0.01 level

Source: Estonia Business Registry, calculated by author, with STATA

The primary outcome measures of the analysis, Average Treatment Effects on the Treated (ATTs), are presented for the baseline estimations in Table 14. These initial findings are derived using a 5-nearest-neighbor matching approach. Overall, the analysis reveals supportive evidence of the positive impacts of foreign acquisitions on the productivity of acquired domestic firms in Estonia within different time frames, Foreign Direct Investment (FDI) acquisitions lead to approximately 14.3% improvements over the years in Estonia, and the result is significant at a 0.05 significance level. However, there is no evidence to show that the positive relationship will exist at time $t+1$ and $t+2$. From the result of 2-nearest neighbor matching method and Epanechnikov Kernel matching method, they are similar to result by using 5-nearest-neighbor matching approach. The results shows that the foreign ownership can bring a 14% increase to firm-level labour productivity when a firm switch from domestic firms to foreign-owned firms. Besides, in Appendix D, the results of the balancing test for the overall sample also confirm that the matching quality is successful in the general case, except for minor exceptions.

However, by using 3 different matching methods, the positive productivity effects are not statistically significant by using 1-year lead and 2-year lead data according to the results of the whole period (1995 to 2021). This result gives evidence that the FDI acquisition may have a more immediate positive effect. After gaining knowledge of how FDI acquisition associates with labour productivity in general, there is a motivation to analyze this relationship in different sectors of Estonia.

Table 14.

Result of ATT for Overall Sample

Matching Method	Outcomes (labour productivity)			No. of treated	No. of untreated	Obs
	<i>t</i>	<i>t+1</i>	<i>t+2</i>			
5-nearest-neighbor Matching Method	0.1427** (1.97)	0.0896 (1.02)	0.1165 (0.44)	375	18,271	20,508
2-nearest-neighbor Matching Method	0.1397* (1.77)	0.7977 (0.92)	0.1083 (0.67)	375	18,271	20,508
Epanecnikov Kernel Matching Method	0.1408* (1.89)	0.8117 (0.98)	0.1097 (0.88)	375	18,271	20,508

T-statistics values are shown in the in the parentheses

* Statistical significance at 0.1 level

** Statistical significance at 0.05 level

*** Statistical significance at 0.01 level

Source: Estonia Business Registry, calculated by author, with STATA

In the next step, I will analyze the pattern in different sectors in Estonia. As mentioned before, the sectors will be divided into two major groups --- manufacturing sector and services sector. In manufacturing sector, there are four different segments which are high-technology firms, medium-high-technology firms, medium-low-technology firms, and low-technology firms. In services sector, there are two segments which are high knowledge intensive firms and low knowledge intensive firms.

The outcomes of probit models within the manufacturing sector are shown in the Table below (Table 15). Table 15 shows the results of propensity score estimations within the manufacturing sector, and all the Pseudo R-squares of these probit models are between 8% to 13% which is reasonable for using firm-level data.

In more detail, explanatory variables in the overall sample within the manufacturing sector show an expected result. The pre-acquisition labour productivity and firm size increase the possibility of a foreign takeover. In medium-high-technology firms, medium-low technology firms, and low-technology firms, the pre-acquisition labour productivity also show a higher probability to get foreign direct investment.

Besides, in Appendix E, the results of the balancing test for the manufacturing sector also confirm that the matching quality is successful in the general case, except for minor exceptions.

Table 15.

Result of Probit Models by Using PSM in Manufacturing Sector

<i>Dummy Variables</i>	<i>Segments in manufacturing sectors</i>				
	<i>Overall Sample</i>	<i>High Technology</i>	<i>Med-high Technology</i>	<i>Med-low Technology</i>	<i>Low Technology</i>
	<i>Foreign entry</i>	<i>Foreign entry</i>	<i>Foreign entry</i>	<i>Foreign entry</i>	<i>Foreign entry</i>
<i>lprod</i>	0.1667* (0.086)	0.1232 (0.683)	0.1847* (0.088)	0.3492* (0.099)	0.1510* (0.086)
<i>Size</i>	0.4948*** (0.003)	0.5920 (0.445)	0.3853 (0.397)	0.7908** (0.051)	0.5770** (0.016)
<i>Sizesq</i>	-0.0976*** (0.006)	-0.1122 (0.441)	-0.0608 (0.483)	-0.1935** (0.062)	-0.1049** (0.032)
<i>Age</i>	-0.4614 (0.376)	4.1296 (0.337)	-0.4487 (0.673)	0.4132 (0.719)	-1.2749* (0.090)
<i>Agesq</i>	0.3880 (0.747)	-1.2112 (0.294)	0.0721 (0.774)	-0.1660 (0.533)	0.2256 (0.192)
<i>Capital Intensity</i>	-0.0075 (0.861)	0.2000 (0.245)	-0.2011* (0.054)	0.0535 (0.546)	0.0628 (0.631)
<i>Constant</i>	-3.2075*** (0.003)	-5.3241 (0.245)	0.8253 (0.790)	-6.6428*** (0.006)	-2.1514 (0.172)

<i>Industry Dummies</i>	Yes	Yes	Yes	Yes	Yes
<i>Year Dummies</i>	Yes	Yes	Yes	Yes	Yes
Obs	1,767	108	209	432	1,018
<i>Chi-square</i>	37.95	4.89	5.20	16.07	23.92
<i>Pseudo R2</i>	8.32%	12.31%	10.97%	12.34%	9.88%

P-value is shown in the in the parentheses

* Statistical significance at 0.1 level

** Statistical significance at 0.05 level

*** Statistical significance at 0.01 level

Source: Estonia Business Registry, calculated by author, with STATA

The results of ATTs in the manufacturing sector are shown in Table 16. Overall, there is no evidence to show that foreign acquisitions have a positive relationship with firm-level labour productivity. Besides, within different sub-groups, the association between foreign acquisitions and labour productivity is not statistically significant.

The relationship between foreign acquisition and labor productivity in the Estonian manufacturing sector is not significant by using Propensity Score Matching method. This result may be caused by the absence of horizontal productivity spillovers. Foreign direct investment (FDI) in Estonia has not resulted in notable productivity gains for domestic firms. This lack of spillover effect suggests that the anticipated benefits from foreign acquisitions do not spread in the local economy, possibly due to insufficient interaction and technology transfer between foreign-owned and domestic firms (Vahter, 2004). In addition, strategic restructuring by foreign firms focuses on capital intensity and increased export growth, and this does not significantly enhance productivity in the domestic market in the short-term basis (Hannula & Tamm, 2003). Consequently, the expected positive impact on labor productivity from foreign acquisitions remains insignificant in the short term.

Table 16.

Result of ATTs within Manufacturing Sector

	<i>Segments in manufacturing sector</i>				
	<i>Overall Sample</i>	<i>High Technology</i>	<i>Med-high Technology</i>	<i>Med-low Technology</i>	<i>Low Technology</i>
5-nearest-neighbor Matching Method					
<i>ATT After Matching</i>	0.0982 (1.12)	0.0399 (1.13)	0.1328 (1.34)	0.1811 (1.06)	0.1301 (1.42)
<i>ATT After Matching (Lead 1)</i>	0.0872 (1.08)	0.0940 (0.82)	0.1021 (0.67)	0.1101 (0.61)	0.1555 (1.24)
<i>ATT After Matching (Lead 2)</i>	0.1735 (0.93)	-0.0953 (-1.31)	0.1512 (1.11)	0.2015 (1.23)	0.2141 (1.51)
2-nearest-neighbor Matching Method					
<i>ATT After Matching</i>	0.1008 (1.14)	0.0386 (0.81)	0.1486 (1.26)	0.1654 (0.98)	0.1362 (1.21)
<i>ATT After Matching (Lead 1)</i>	0.0809 (0.61)	0.0965 (0.39)	0.1215 (0.88)	0.1178 (1.33)	0.0739 (0.50)
<i>ATT After Matching (Lead 2)</i>	0.1829 (1.29)	-0.0964 (-0.52)	0.1497 (1.08)	0.1797 (0.96)	0.2028 (1.20)

Epanecnikov Kernel Matching Method					
<i>ATT After Matching</i>	0.1013 (1.08)	0.0423 (0.95)	0.1451 (1.27)	0.1611 (1.05)	0.1562 (1.26)
<i>ATT After Matching (Lead 1)</i>	0.0907 (0.78)	0.1008 (0.53)	0.1109 (1.02)	0.1172 (1.18)	0.0712 (0.54)
<i>ATT After Matching (Lead 2)</i>	0.1806 (1.38)	-0.0882 (-0.34)	0.1502 (0.83)	0.1803 (0.98)	0.1929 (1.08)
<i>No. of treated</i>	50	3	6	15	26
<i>No. of untreated</i>	1,717	105	203	417	992
Obs	1,767	108	209	432	1,018

T-statistics values are shown in the in the parentheses

* Statistical significance at 0.1 level

** Statistical significance at 0.05 level

*** Statistical significance at 0.01 level

Source: Estonia Business Registry, calculated by author, with STATA

The outcomes of probit models within services sector are shown in the Table below (Table 17). Table 17 shows the results of probit models within services sector, and all the Pseudo R-squares of these probit models are between 8.3% to 14.7% which are reasonable for using firm-level data.

In more detail, explanatory variables in the overall sample within the services sector show an expected result. The pre-acquisition labour productivity and firm size increase the possibility of a foreign takeover. In medium-high-technology firms, medium-low technology firms, and low-technology firms, the pre-acquisition labour productivity also shows a higher probability of getting foreign direct investment. Also, from the sample size, it shows that the number of the firms in services sector is much higher than the number in the manufacturing sector, which means that they are the majority in Estonian market.

Besides, in the Appendix C, the table shows the balancing test for assessing the matching quality. From the results, with some exceptions, the post-matching difference is not statistically significant, suggesting that the matching process is generally effective within services sector and its segments.

Table 17.

Result of Probit Models by Using PSM in Services Sector

<i>Dummy Variables</i>	<i>Segments in services sectors</i>		
	<i>Overall Sample</i>	<i>High Knowledge</i>	<i>Low Knowledge</i>
	<i>Foreign entry</i>	<i>Foreign entry</i>	<i>Foreign entry</i>
<i>lprod</i>	0.1751*** (0.000)	0.0341 (0.757)	0.2236*** (0.000)
<i>Size</i>	0.1462*** (0.002)	0.1954 (0.140)	0.1972*** (0.001)
<i>Sizesq</i>	0.0106 (0.230)	0.0198 (0.430)	-0.0059 (0.624)
<i>Age</i>	0.1378 (0.230)	-0.0247 (0.970)	0.1669 (0.568)
<i>Agesq</i>	-0.0595 (0.597)	-0.0380 (0.807)	-0.0618 (0.340)
<i>Capital Intensity</i>	0.0132 (0.309)	0.0941* (0.051)	0.0058 (0.752)
<i>Constant</i>	-4.1779*** (0.000)	-3.2275*** (0.009)	-4.6795*** (0.000)

<i>Industry Dummies</i>	Yes	Yes	Yes
<i>Year Dummies</i>	Yes	Yes	Yes
Obs	12,342	2,262	9,673
<i>Chi-sqaure</i>	227.85	47.89	170.94
<i>Pseudo R2</i>	9.44%	14.62%	8.35%

P-value is shown in the in the parentheses

* Statistical significance at 0.1 level

** Statistical significance at 0.05 level

*** Statistical significance at 0.01 level

Source: Estonia Business Registry, calculated by author, with STATA

The results of ATTs in services sector are shown in Table 18. Overall, the analysis reveals supportive evidence of the positive impacts of foreign acquisitions on the productivity of acquired domestic firms in Estonia within the services sector; Foreign Direct Investment (FDI) acquisitions lead to approximately 13.2% improvements in Estonian firms within services sector, which is significant at 0.01 significance level. After using 1-year lead data, it also shows that FDI acquisition may still bring a 11.74% increase in labour productivity at 0.05 significance level. By utilizing other two matching method, they all show a significantly positive relationship after 1 year of getting FDI acquisitions.

Besides, the outcome of the non-lag (t) data in low knowledge-intensity firms (12.2%) is significant at 0.05 significance level, but in knowledge-intensity firms' group, the outcome is not statistically significant. After using the data of t+1, the positive relationship between foreign ownership and labour productivity is significant at a 0.1 significance level for low knowledge-intensive companies, which can bring an 8.8% increase to firm-level labour productivity. According to the results from the other two matching methods, the outcomes are similar, which can be robust the result by using the 5-nearest-neighbor matching method. Besides, by using the data of t+2, there is no significant result except by using 2-nearest-neighbour matching method, and it shows that FDI acquisition can increase labour productivity by 12.4% after 2 years.

It is easy to find that less knowledge-intensity firms are more sensitive to FDI acquisitions, which means that they have a more apparent relationship than high knowledge-intensity firms, which confirms the results from the previous results by using OLS and fixed-effect method. The result also shows that, in the low knowledge-intensive firms, they need time to process new information and new knowledge. After absorbing this knowledge, they can potentially increase firm-level labour productivity. However, the learning process may take 1 or 2 years to fully utilized the information.

Table 18.

Result of ATTs within Services Sector

	<i>Segments in services sector</i>		
	<i>Overall Sample</i>	<i>Knowledge-intensive Firms</i>	<i>Low Knowledge-intensive Firms</i>
5-nearest-neighbor Matching Method			
<i>ATT After Matching</i>	0.1302*** (2.66)	0.0219 (0.16)	0.1233** (2.36)
<i>ATT After Matching (Lead 1)</i>	0.1174** (2.26)	0.0969 (0.70)	0.0884* (1.69)
<i>ATT After Matching (Lead 2)</i>	0.1052* (1.83)	0.1073 (0.71)	0.0873 (1.40)
2-nearest-neighbor Matching Method			
<i>ATT After Matching</i>	0.1111** (1.96)	0.0951 (0.17)	0.1606*** (2.72)
<i>ATT After Matching (Lead 1)</i>	0.1084* (1.83)	0.1244 (0.84)	0.1149* (1.86)
<i>ATT After Matching (Lead 2)</i>	0.0967 (1.48)	0.1104 (0.65)	0.1240* (1.77)

Epanecnikov Kernel Matching Method			
<i>ATT After Matching</i>	0.1008** (2.02)	0.0948 (0.21)	0.1509** (2.47)
<i>ATT After Matching (Lead 1)</i>	0.1080* (1.80)	0.1249 (0.98)	0.0945* (1.72)
<i>ATT After Matching (Lead 2)</i>	0.0969 (1.52)	0.1102 (0.62)	0.1189 (1.60)
<i>No. of treated</i>	246	31	213
<i>No. of untreated</i>	12,096	2,231	9,460
Obs	12,342	2,262	9,673

T-statistics values are shown in the in the parentheses

* Statistical significance at 0.1 level

** Statistical significance at 0.05 level

*** Statistical significance at 0.01 level

Source: Estonia Business Registry, calculated by author, with STATA

6. Discussion

After utilizing OLS, fixed effect model, and PSM approach, the relationship between FDI and labour productivity can be generated in Estonia. During the analysis, the data between 1995 to 2021 are used and the time frame is divided into another three sub-groups which are 1995 to 2003, 2004 to 2009, and 2010 to 2021. I cautiously interpret the findings from Table 7 as suggestive of shifts in the pattern of inward Foreign Direct Investment (FDI) into Estonia over time. The result shows that the FDI had the most positive relationship between 2010 and 2021, which shows that foreign ownership had a significantly positive relationship with labour productivity after becoming one of the EU countries. Estonia gained more and broader foreign direct investment from different countries, and it brought more equipment, technologies, knowledge etc., and had the most positive relationship with local labour productivity. Considering that there is no significant association brought by foreign ownership after immediately joining the European Union, the possible explanation may be the negative influence because of the global financial crisis. However, the relationship between FDI and labour productivity is not statistically significant during 1995 to 2003. It could be determined by the nature of FDI and the economic and policy environment prevailing from 1995 to 2003 in Estonia. If FDI was directed to a sector of the economy with little growth in productivity or if it was of a more extractive character than innovative, its influence on labour productivity would be negligible. This is more so when the FDI has not been accompanied by considerable technology transfer and skills development (Blomström & Kokko, 1998). Also, because of the considerable economic restructuring that Estonia went through over the transition period in the 1990s, the regulatory and institutional environment could not be most supportive for reaping the full benefits of the FDI. Policies that are unstable or inefficient institutions might further limit the positive impact of FDI on the labour productivity of an area (Campos & Kinoshita, 2002).

Another dimension of analyzing the relationship is dividing all the firms into two groups: manufacturing sectors and services sectors. The results presented in Table 8 shows the results of the manufacturing sector. From the overall sample, it can be concluded that, in Estonian manufacturing sector, foreign ownership can have a significantly positive association with labour productivity. In detail, within the sub-groups of medium-high technology and medium-low technology firms, the FDI has a relatively more positive relationship with labour productivity compared to those firms belonging to high-technology or low-technology firms. The investment in technologies from foreign ownership may cause this association. The new technologies may bring a higher productivity especially in high-technology firms or medium-high-technology and medium-low-technology firms. According to Findlay (1978), the new technologies imported from other advanced areas may trigger firms to close the technology gap, within medium-high-technology and medium-low-technology firms, they have room for improvement. Once they are fully equipped with these technologies, they may increase labour productivity of the firms belonging to these two groups. This may be an explanation for why these two groups have a more positive relationship between FDI and labour productivity.

The results in Table 9 show the relationship between FDI and labour productivity of the services sector. The result of the overall sample within the services sector exhibits a significant positive relationship between foreign ownership and labour productivity. However, the less knowledge-intensive firms may be more sensitive to foreign ownership compared to knowledge-intensive firms. The reason behind this may be that within knowledge-intensive firms, extra knowledge may have a limited influence on labour productivity compared to less knowledge-intensive firms, which can also apply the marginal effect theory. In this way, a foreign direct investment, which brings extra knowledge, can have a more positive association with labour productivity in less knowledge-intensive firms compared to those companies that belong to knowledge-intensive firms. Besides, absorptive capacity may be another reason. FDI may let firms to spend more money on R&D expenses which may increase firms' absorptive capacity.

In this way, firms may be more likely to know how to make the most use of these new knowledge. Utilizing these knowledges will potentially positively influence the firm-level labour productivity. Furthermore, these results give evidence that knowledge intensity may have an influence on the relationship between foreign ownership and labour productivity, so studies such as Köllő et al. (2021), which aggregate all services without considering the knowledge intensity of the sectors, may overlook a critical aspect of research.

By using propensity score matching approach, it shows that foreign acquisition is positively associated with labour productivity. Besides, using 1-year lead and 2-year lead data, it shows that FDI has no lagged effect in labour productivity in Estonian firms, except the firms belonging to low knowledge-intensive firms within services sector. It shows that less knowledge-intensive firms are more sensitive to FDI acquisitions, which confirms the previous results by using different methods (OLS and fixed-effect model). Less knowledge-intensive firms need more time to process new information and new knowledge, which means that the learning process may take longer than that of other groups. As mentioned before, the FDI may enlarge absorptive capacity and take more time to make effect. After absorbing this knowledge, they can potentially increase firm-level labour productivity. Specifically, the learning process may take 1 or 2 years to fully utilize new information or knowledge.

7. Limitations

Firstly, given that the current study is based on firm-level data, efforts are made to control for firm heterogeneity while investigating the effects of FDI on various types of manufacturing and services firms. However, a limitation of this study lies in the inability to control for worker heterogeneity. Studies utilizing linked employer-employee data, such as Malchow-Møller et al. (2013), can leverage worker fixed effects along with firm fixed effects to address endogeneity to some extent, because different

workers have their own characteristics such as education level, skills, or experiences. According to Cohen and Levinthal (1990), it shows that different individuals have different levels of understanding and processing new information, which relates to individual absorptive capacity again. As a potential avenue for future research, I propose exploring how FDI influences labour productivity across different sectors and intensities while also controlling for worker heterogeneity to some extent.

Secondly, for the limited sample size of the manufacturing sector, so it is hard to capture a representative relationship between foreign acquisition and labour productivity. Another drawback of our Propensity Score Matching (PSM) approach is that the FDI spillover effect is not considered in this estimation of the Average Treatment Effect on the Treated (ATT). Previous studies in Estonia, however, have demonstrated positive FDI spillover effects through labour mobility and transaction linkages (Masso and Vahter, 2019), which may potentially underestimate the result of ATT. To tackle this concern, one potential approach is to consider the recruitment process of local firms and control the group local businesses that have recruited staff with prior employment experience in foreign-owned companies. Besides, the paper assumes that nothing else changed during the period t and $t+1$ that may affect labor productivity in $t + 1$ and $t + 2$. However, this assumption is hard to achieve.

8. Conclusion

This research hypothesizes that the labour productivity varies by firms type and era, reflecting the Estonian economy's distinct phases captured in the study's three subperiods. The investigation is designed to assess the impact of foreign ownership—specifically, foreign acquisitions—on the manufacturing and services sectors. Employing Ordinary Least Squares (OLS) estimations, this study evaluates the potential firm-level labour productivity associated with both greenfield investments and foreign acquisitions while attempting to partially address endogeneity issues through the implementation of standard fixed effects and Propensity Score Matching (PSM).

The analysis anticipates a reduction in the estimated labour productivity when employing these methodologies. The focus is narrowed to foreign acquisitions in the estimations of the fixed effects and PSM models, which is in line with findings from Heyman et al. (2007). However, post-global financial crisis trends in Estonia have shown a decline in greenfield investments and a rise in mergers and acquisitions (Durán, 2019), justifying the research focus on acquisitions. This study explores how sectoral aggregations of technology-intensive and knowledge-intensive firms respond to foreign direct investment (FDI).

Firstly, the empirical results indicate that, in general, FDI has a significantly positive relationship with labour productivity in Estonia, especially during the period 2010 to 2021. Secondly, in the manufacturing sector, medium-high technology firms and medium-low technology firms may have more positive effects than other firms. Thirdly, in the services sector, foreign ownership may increase labour productivity more than in the manufacturing sector. Besides, after using the PSM approach, the low knowledge-intensive companies may be more sensitive to FDI. Furthermore, after one or two years of acquiring foreign investment ($t+1$ and $t+2$), it shows a lagged association of FDI in firm-level productivity within the services sector especially for firms that are less knowledge-intensive. For further exploration of the FDI-productivity nexus in Estonia, this paper proposes an investigation that considers sectoral intensities using employer-employee linked data to control the worker heterogeneity, which will enable the utilization of worker fixed effects to enhance the robustness of future analyses.

The contribution of this research is that the results shown in this paper may inform Estonian companies of their strategies according to their sectors or characteristics. Also, it will give a general picture to the companies about the patterns between foreign ownership and labour productivity. Besides, for the board of directors or the managers, when they are making decision, they will be more likely to think about the resources of financial support, which means that they may not only focus on the local resource but also foreign supports. Also, the contribution of this paper is that the results may positively influence policymakers: By giving them a general picture of the relationship

between FDI and productivity, it will help them come up with policies that set higher incentives for attracting FDI targeting high-productivity sectors—in particular, with tax breaks, grants, or easier regulatory requirements for foreign investors. This research enhances the need for policies that augment the absorptive capacity of firms through funding employee training programs, research and development incentives, and fostering co-operations between local companies and foreign investors. Finally, this paper also points out the time it takes for fuller employment of new technologies or knowledge, and thus underlines those policies must be developed fostering continuous learning and innovation. The increased absorptive capacity of firms will imply greater ability to understand and utilize advanced technologies and knowledge for improving labour productivity.

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Appendix A. Results of FE model in different time frames by using 2-year lead data

<i>Regression Result by Using FE Method</i>				
<i>Independent Variables</i>	<i>Segments by different time frames</i>			
	<i>Overall Sample</i>	<i>1995 - 2003</i>	<i>2004 - 2009</i>	<i>2010 - 2021</i>
	<i>FE</i>	<i>FE</i>	<i>FE</i>	<i>FE</i>
<i>Foreign</i>	0.0307 (0.156)	0.0256 (0.356)	0.0432 (0.324)	0.0232 (0.268)
<i>Size</i>	-0.0152* (0.071)	-0.0288 (0.223)	-0.0749*** (0.000)	0.0133 (0.321)
<i>Sizesq</i>	-0.0087*** (0.000)	-0.0099* (0.090)	0.0153*** (0.000)	0.0009 (0.853)
<i>Age</i>	-0.0036 (0.743)	-0.0495* (0.055)	0.0643*** (0.006)	0.0254* (0.090)
<i>Agesq</i>	-0.0292*** (0.000)	-0.0475 (0.118)	-0.0674*** (0.001)	-0.0023 (0.817)

<i>Capital Intensity</i>	0.0368*** (0.000)	0.0026 (0.618)	-0.0257*** (0.000)	0.0133*** (0.000)
<i>Constant</i>	9.4360*** (0.000)	10.2565*** (0.000)	9.9160 (0.000)	9.3840*** (0.000)
<i>Industry Dummies</i>	Yes	Yes	Yes	Yes
<i>Year Dummies</i>	Yes	Yes	Yes	Yes
Obs	417,278	76,971	105,163	235,144
<i>Adjusted R-square</i>	1.79%	1.00%	5.29%	6.39%

P-value is shown in the in the parentheses

* Statistical significance at 0.1 level

** Statistical significance at 0.05 level

*** Statistical significance at 0.01 level

Appendix B. Results of FE model in the manufacturing sector by using 2-year lead data

<i>Regression Result by Using OLS and FE Method</i>					
<i>Independent Variables</i>	<i>Segments in Manufacturing Sector</i>				
	<i>Overall Sample</i>	<i>High Technology</i>	<i>Med-high Technology</i>	<i>Med-low Technology</i>	<i>Low Techonoly</i>
	<i>FE</i>	<i>FE</i>	<i>FE</i>	<i>FE</i>	<i>FE</i>
<i>Foreign</i>	0.0134 (0.628)	0.1315 (0.254)	0.0390 (0.446)	0.0922 (0.212)	0.0078 (0.832)
<i>Size</i>	0.0441** (0.039)	-0.1516 (0.142)	0.0478 (0.521)	0.0314 (0.506)	0.0516** (0.054)
<i>Sizesq</i>	-0.0234*** (0.000)	-0.0001 (0.990)	-0.0244* (0.054)	-0.207** (0.037)	-0.0228*** (0.000)
<i>Age</i>	-0.0889*** (0.005)	-0.5455** (0.047)	-0.1348 (0.204)	-0.1417** (0.032)	-0.0588 (0.134)
<i>Agesq</i>	0.0296 (0.194)	0.2446 (0.127)	-0.0033 (0.962)	-0.1417** (0.039)	0.0082 (0.773)

<i>Capital Intensity</i>	0.0296 (0.194)	0.0219 (0.389)	0.0240 (0.140)	0.1001** (0.036)	0.0385*** (0.000)
<i>Constant</i>	9.1196*** (0.000)	9.4230*** (0.000)	10.2815*** (0.000)	7.9910*** (0.000)	9.1641*** (0.000)
<i>Industry Dummies</i>	Yes	Yes	Yes	Yes	Yes
<i>Year Dummies</i>	Yes	Yes	Yes	Yes	Yes
Obs	40,924	1,054	4,167	9,116	27,397
<i>Adjusted R-square</i>	4.18%	9.28%	7.65%	3.76%	4.58%

P-value is shown in the in the parentheses

* Statistical significance at 0.1 level

** Statistical significance at 0.05 level

*** Statistical significance at 0.01 level

Appendix C. Results of FE model in the services sector by using 2-year lead data

<i>Regression Result by Using OLS and FE Method</i>			
<i>Independent Variables</i>	<i>Segments in Services Sector</i>		
	<i>Overall Sample</i>	<i>Knowledge-intensive Firms</i>	<i>Low Knowledge-intensive Firms</i>
	<i>FE</i>	<i>FE</i>	<i>FE</i>
<i>Foreign</i>	0.0278 (0.170)	0.0306 (0.466)	0.0359 (0.112)
<i>Size</i>	-0.0333*** (0.001)	0.0060 (0.751)	-0.0437*** (0.000)
<i>Sizesq</i>	-0.0035 (0.180)	-0.0046 (0.435)	-0.0025 (0.383)
<i>Age</i>	-0.0017 (0.912)	-0.0208 (0.468)	-0.0046 (0.801)
<i>Agesq</i>	-0.0297*** (0.006)	0.0190 (0.361)	-0.0414*** (0.001)

<i>Capital Intensity</i>	0.0313*** (0.000)	0.0153*** (0.000)	0.0349 (0.000)
<i>Constant</i>	9.5712*** (0.000)	9.9114*** (0.000)	9.6420*** (0.000)
<i>Industry Dummies</i>	Yes	Yes	Yes
<i>Year Dummies</i>	Yes	Yes	Yes
Obs	249,809	61,014	188,795
<i>Adjusted R-square</i>	2.27%	1.96%	2.58%

P-value is shown in the in the parentheses

* Statistical significance at 0.1 level

** Statistical significance at 0.05 level

*** Statistical significance at 0.01 level

Appendix D. Balancing Test for Different Time Segments

<i>Table of Balancing Test</i>						
	<i>Segments by Time Period (1995 - 2021)</i>					
	<i>Lead: 0 year</i>		<i>Lead: 1 year</i>		<i>Lead: 2 years</i>	
	<i>Unmatched</i>	<i>Matched</i>	<i>Unmatched</i>	<i>Matched</i>	<i>Unmatched</i>	<i>Matched</i>
<i>lprod</i>	0.789*** (0.000)	0.062 (0.987)	0.809*** (0.000)	0.026 (0.725)	0.824*** (0.000)	0.020 (0.108)
<i>Size</i>	0.878*** (0.000)	-0.053 (0.887)	0.890*** (0.000)	-0.026 (0.144)	0.907*** (0.000)	0.116 (0.283)
<i>Sizesq</i>	4.074*** (0.000)	-0.286 (0.669)	4.114*** (0.000)	-0.139 (0.197)	4.229*** (0.000)	-0.131* (0.091)
<i>Age</i>	-0.030*** (0.000)	0.001 (0.843)	-0.013*** (0.000)	0.002 (0.740)	0.010*** (0.000)	-0.009 (0.198)
<i>Agesq</i>	-0.099*** (0.000)	-0.005 (0.786)	-0.040*** (0.000)	0.002 (0.934)	0.043*** (0.000)	-0.037 (0.138)
<i>Capital Intensity</i>	0.314*** (0.000)	-0.031 (0.122)	0.255*** (0.000)	-0.020* (0.092)	0.257*** (0.000)	-0.046* (0.098)

Appendix E. Balancing Test in Manufacturing Sector

<i>Table of Balancing Test</i>						
<i>Segments in Manufacturing Sector (Overall Sample)</i>						
	<i>Lead: 0 year</i>		<i>Lead: 1 year</i>		<i>Lead: 2 years</i>	
	<i>Unmatched</i>	<i>Matched</i>	<i>Unmatched</i>	<i>Matched</i>	<i>Unmatched</i>	<i>Matched</i>
<i>lprod</i>	0.583*** (0.000)	0.098 (0.887)	0.529*** (0.000)	0.058 (0.790)	0.532*** (0.000)	0.054 (0.116)
<i>Size</i>	1.390*** (0.000)	-0.039 (0.120)	1.351*** (0.000)	-0.029 (0.307)	1.346*** (0.000)	-0.030 (0.307)
<i>Sizesq</i>	7.526*** (0.000)	-0.372 (0.230)	7.204*** (0.000)	-0.270 (0.165)	7.230*** (0.000)	-0.229 (0.253)
<i>Age</i>	0.102*** (0.000)	0.040* (0.091)	0.072*** (0.000)	0.013 (0.352)	0.081*** (0.000)	0.004 (0.767)
<i>Agesq</i>	0.382*** (0.000)	0.153 (0.101)	0.260*** (0.000)	0.060 (0.277)	0.290*** (0.000)	0.017 (0.760)
<i>Capital Intensity</i>	0.451*** (0.000)	0.072 (0.659)	0.375*** (0.000)	-0.006 (0.853)	0.385*** (0.000)	0.028 (0.418)

Table of Balancing Test

	<i>Segments in Manufacturing Sector (High-tech Firms)</i>					
	<i>Lead: 0 year</i>		<i>Lead: 1 year</i>		<i>Lead: 2 years</i>	
	<i>Unmatched</i>	<i>Matched</i>	<i>Unmatched</i>	<i>Matched</i>	<i>Unmatched</i>	<i>Matched</i>
<i>lprod</i>	0.549*** (0.000)	0.212 (0.721)	0.402*** (0.000)	0.181 (0.856)	0.412*** (0.000)	0.000 (0.998)
<i>Size</i>	1.834*** (0.000)	0.020 (0.858)	1.880*** (0.000)	-0.032 (0.788)	1.833*** (0.000)	0.029 (0.806)
<i>Sizesq</i>	10.639*** (0.000)	0.151 (0.853)	11.734*** (0.000)	-0.076 (0.933)	11.222*** (0.000)	0.752 (0.397)
<i>Age</i>	-0.017 (0.688)	0.061 (0.209)	-0.036 (0.425)	-0.080 (0.105)	-0.033 (0.481)	-0.045 (0.369)
<i>Agesq</i>	-0.030 (0.850)	0.317* (0.090)	-0.175 (0.324)	-0.233 (0.225)	-0.166 (0.357)	-0.084 (0.665)
<i>Capital Intensity</i>	0.297*** (0.002)	0.179* (0.072)	0.312*** (0.004)	0.085 (0.459)	0.280** (0.012)	0.271 (0.119)

Table of Balancing Test

<i>Segments in Manufacturing Sector (Med-high-tech Firms)</i>						
	<i>Lead: 0 year</i>		<i>Lead: 1 year</i>		<i>Lead: 2 years</i>	
	<i>Unmatched</i>	<i>Matched</i>	<i>Unmatched</i>	<i>Matched</i>	<i>Unmatched</i>	<i>Matched</i>
<i>lprod</i>	0.502*** (0.000)	0.103 (0.106)	0.412*** (0.000)	0.105 (0.319)	0.388*** (0.000)	0.122 (0.227)
<i>Size</i>	1.395*** (0.000)	-0.025 (0.645)	1.381*** (0.000)	-0.034 (0.610)	1.386*** (0.000)	-0.030 (0.646)
<i>Sizesq</i>	7.722*** (0.000)	-0.272 (0.469)	7.422*** (0.000)	-0.509 (0.238)	7.490*** (0.000)	-0.497 (0.283)
<i>Age</i>	0.053** (0.015)	0.047 (0.082)	0.019 (0.490)	0.057* (0.097)	0.029 (0.291)	0.087 (0.106)
<i>Agesq</i>	0.232*** (0.007)	0.211* (0.096)	0.116 (0.270)	0.281* (0.082)	0.147 (0.167)	0.103* (0.086)
<i>Capital Intensity</i>	0.296*** (0.000)	-0.025 (0.646)	0.205*** (0.000)	-0.778 (0.246)	0.197*** (0.001)	-0.101 (0.129)

Table of Balancing Test

	<i>Segments in Manufacturing Sector (Med-low-tech Firms)</i>					
	<i>Lead: 0 year</i>		<i>Lead: 1 year</i>		<i>Lead: 2 years</i>	
	<i>Unmatched</i>	<i>Matched</i>	<i>Unmatched</i>	<i>Matched</i>	<i>Unmatched</i>	<i>Matched</i>
<i>lprod</i>	0.541*** (0.000)	0.084 (0.128)	0.571*** (0.000)	0.040 (0.362)	0.604*** (0.000)	0.134 (0.103)
<i>Size</i>	1.101*** (0.000)	-0.070 (0.178)	1.148*** (0.000)	-0.025 (0.664)	1.150*** (0.000)	-0.100* (0.093)
<i>Sizesq</i>	5.268*** (0.000)	-0.720 (0.224)	5.406*** (0.000)	-0.383 (0.266)	5.421*** (0.000)	-0.784 (0.230)
<i>Age</i>	0.024 (0.226)	0.018 (0.491)	0.028 (0.239)	0.012 (0.704)	0.060** (0.029)	0.016 (0.619)
<i>Agesq</i>	0.117 (0.118)	0.088 (0.375)	0.153* (0.084)	0.064 (0.594)	0.241*** (0.008)	0.086 (0.481)
<i>Capital Intensity</i>	0.543*** (0.000)	0.126 (0.137)	0.590*** (0.000)	0.121 (0.189)	0.631*** (0.000)	0.169 (0.125)

<i>Table of Balancing Test</i>						
<i>Segments in Manufacturing Sector (Low-tech Firms)</i>						
	<i>Lead: 0 year</i>		<i>Lead: 1 year</i>		<i>Lead: 2 years</i>	
	<i>Unmatched</i>	<i>Matched</i>	<i>Unmatched</i>	<i>Matched</i>	<i>Unmatched</i>	<i>Matched</i>
<i>lprod</i>	0.521*** (0.000)	0.055 (0.536)	0.455*** (0.000)	0.032 (0.284)	0.453*** (0.000)	0.010 (0.737)
<i>Size</i>	1.456*** (0.000)	-0.021 (0.530)	1.366*** (0.000)	-0.021 (0.586)	1.359*** (0.000)	-0.002 (0.964)
<i>Sizesq</i>	7.938*** (0.000)	-0.179 (0.438)	7.300*** (0.000)	-0.205 (0.439)	7.331*** (0.000)	-0.044 (0.873)
<i>Age</i>	0.135*** (0.000)	0.017 (0.280)	0.096*** (0.000)	-0.012 (0.522)	0.098*** (0.000)	-0.001 (0.976)
<i>Agesq</i>	0.477*** (0.000)	0.077 (0.211)	0.306*** (0.000)	-0.057 (0.439)	0.316*** (0.000)	-0.016 (0.830)
<i>Capital Intensity</i>	0.458*** (0.000)	0.029 (0.452)	0.356*** (0.000)	0.021 (0.639)	0.364*** (0.000)	0.047 (0.325)

P-value is shown in the in the parentheses

* Statistical significance at 0.1 level ** Statistical significance at 0.05 level *** Statistical significance at 0.01 level

Appendix F. Balancing Test in Services Sector

	<i>Segments in Services Sector (Overall Sample)</i>					
	<i>Lead: 0 year</i>		<i>Lead: 1 year</i>		<i>Lead: 2 years</i>	
	<i>Unmatched</i>	<i>Matched</i>	<i>Unmatched</i>	<i>Matched</i>	<i>Unmatched</i>	<i>Matched</i>
<i>lprod</i>	0.882*** (0.000)	0.009 (0.889)	0.919*** (0.000)	0.001 (0.931)	0.933*** (0.000)	0.000 (0.999)
<i>Size</i>	0.674*** (0.000)	-0.049 (0.776)	0.678*** (0.000)	0.001 (0.964)	0.689*** (0.000)	0.001 (0.981)
<i>Sizesq</i>	2.830*** (0.000)	-0.058 (0.683)	2.915*** (0.000)	-0.002 (0.979)	3.000*** (0.000)	-0.044 (0.602)
<i>Age</i>	-0.095*** (0.000)	-0.003 (0.636)	-0.074*** (0.000)	0.011 (0.167)	-0.049*** (0.000)	-0.006 (0.467)
<i>Agesq</i>	-0.344*** (0.000)	-0.012 (0.614)	-0.264*** (0.000)	0.030 (0.314)	-0.171*** (0.000)	0.017 (0.587)
<i>Capital Intensity</i>	0.240*** (0.000)	-0.056 (0.091)	0.165*** (0.000)	-0.083 (0.088)	0.166*** (0.000)	-0.073 (0.101)

Table of Balancing Test

Segments in Services Sector (Knowledge-intensive Firms)

	<i>Lead: 0 year</i>		<i>Lead: 1 year</i>		<i>Lead: 2 years</i>	
	<i>Unmatched</i>	<i>Matched</i>	<i>Unmatched</i>	<i>Matched</i>	<i>Unmatched</i>	<i>Matched</i>
<i>lprod</i>	0.645*** (0.000)	0.046 (0.117)	0.635*** (0.000)	0.039* (0.099)	0.631*** (0.000)	0.044 (0.124)
<i>Size</i>	0.990*** (0.000)	-0.028 (0.236)	1.070*** (0.000)	-0.034 (0.270)	1.095*** (0.000)	-0.018 (0.582)
<i>Sizesq</i>	3.715*** (0.000)	-0.028 (0.817)	4.124*** (0.000)	0.031 (0.846)	4.294*** (0.000)	0.180 (0.288)
<i>Age</i>	-0.114*** (0.000)	-0.004 (0.788)	-0.061*** (0.000)	0.018 (0.294)	-0.023* (0.063)	0.0037* (0.051)
<i>Agesq</i>	-0.357*** (0.000)	-0.019 (0.674)	-0.159*** (0.000)	0.065 (0.283)	-0.027 (0.554)	0.128* (0.077)
<i>Capital Intensity</i>	0.042* (0.051)	-0.033 (0.314)	-0.139*** (0.000)	-0.036 (0.389)	-0.172*** (0.000)	0.072 (0.104)

Table of Balancing Test

<i>Segments in Services Sector (Low Knowledge-intensive Firms)</i>						
	<i>Lead: 0 year</i>		<i>Lead: 1 year</i>		<i>Lead: 2 years</i>	
	<i>Unmatched</i>	<i>Matched</i>	<i>Unmatched</i>	<i>Matched</i>	<i>Unmatched</i>	<i>Matched</i>
<i>lprod</i>	0.958*** (0.000)	0.027 (0.571)	0.995*** (0.000)	0.006 (0.745)	1.011*** (0.000)	0.010 (0.597)
<i>Size</i>	0.552*** (0.000)	-0.015 (0.278)	0.551*** (0.000)	-0.009 (0.572)	0.560*** (0.000)	0.002 (0.925)
<i>Sizesq</i>	2.490*** (0.000)	-0.118 (0.100)	2.527*** (0.000)	-0.069 (0.426)	2.595*** (0.000)	-0.082 (0.385)
<i>Age</i>	-0.090*** (0.000)	0.009 (0.230)	-0.080*** (0.000)	0.001 (0.934)	-0.058*** (0.000)	0.016* (0.095)
<i>Agesq</i>	-0.346*** (0.000)	0.043 (0.121)	-0.303*** (0.000)	-0.013 (0.706)	-0.222*** (0.000)	0.046 (0.182)
<i>Capital Intensity</i>	0.303*** (0.000)	-0.045 (0.222)	0.247*** (0.000)	-0.061 (0.228)	0.255*** (0.000)	-0.095 (0.121)

P-value is shown in the in the parentheses

* Statistical significance at 0.1 level ** Statistical significance at 0.05 level *** Statistical significance at 0.01 level

Zusammenfassung

Välismaiste Otseinvesteeringute ja Tööjõu Tootlikkuse Suhte Analüüs Eesti ettevõtete andmete abil

Antud uurimus uurib välisomand mõju kohalike ettevõtete tööviljakusele. Kasutades Eesti Äriregistrist ettevõtte taseme paneelandmeid perioodist 1995–2021, on selle uuringu peamised uurimisküsimused järgmised. Kas välisomandus on positiivses seosestööviljakusega Eesti ettevõtetes? Kas antud seos esineb erinevatel ajaperioodidel? Kui suurel määral see seos varieerub erinevate sektorite lõikes? Kas välisomandusel on tööviljakusele viivitusega mõju? Uurimuse uuenduslikkus seisneb välisinvesteeringute ja tootlikkuse seose uurimises, kasutades selleks pikaajalisi andmeid ja analüüsides uuritavat seost erinevate ajaperioodide ja erinevate sektorite — töötleva tööstuse ja teenindussektori — lõikes. Rakendades vähimruutude meetodit, standardset fikseeritud efektiga mudelit ja tõenäosusliku sobitamise meetodit (PSM) lähima naabri sobitamisega, näitavad tulemused selgelt positiivset seost välisomanduse ja ettevõtte tööviljakuse vahel. Lisaks leitakse töös, ettöövilkuse ja välisinvesteeringute seos ei pruugi ilmnedda koheselt vaid võib võtta aega.

Märksõnad: tootlikkus, välismaine otseinvesteering, kalduvuse skoori sobitamine.

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Runkang Ma

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