

UNIVERSITY OF TARTU
FACULTY OF SOCIAL SCIENCES
SCHOOL OF ECONOMICS AND BUSINESS ADMINISTRATION

Wei Ding

**The Effects of FDI on Foreign Ownership of
Innovation: A Study Based on Firm-level Data
in Estonia**

Quantitative Economics

Master's Thesis

Supervisor: Ass.Prof. Jaan Masso, Prof. Priit Vahter

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Abstract

Much of the literature assumes foreign direct investment automatically transfers technological capacity to local firms, but this view often obscures how multinational enterprises actually operate. This study examines whether foreign ownership increases the probability that a host-country firm will innovate, using a panel of Estonian firms from 2006 to 2022 in a catching-up economy. Because updating a factory floor is fundamentally different from inventing a new good, the analysis separates process from product innovation. Foreign investors do not acquire target companies at random; they selectively buy companies that are already larger and more productive. To isolate the actual effect of foreign ownership from this selection bias, this study uses Propensity Score Matching to compare acquired firms against identical domestic peers. The treatment effect is then estimated using a Linear Probability Model with firm fixed effects. Introducing a new product usually forces a firm to alter its manufacturing process, so treating these choices as isolated events distorts firm behavior. This study therefore also models them jointly using a Bivariate Probit framework. Across the entire economy, this study finds no association between foreign ownership and either type of innovation. But a clear pattern emerges when evaluating sectors by technological intensity. In high- and medium-high-technology manufacturing, foreign acquisition strongly drives process innovation but has no effect on new product development. Multinational enterprises integrate these Estonian subsidiaries

into complex global value chains primarily to optimize efficiency, operating them as branch plants rather than independent creative centers. These results implied that broad policies designed to attract generic foreign capital fail to account for this division of labor, showing why treating the manufacturing sector as a single, uniform entity can be misleading.

Key Words: Foreign Direct Investment, Process Innovation, Product Innovation, Propensity Score Matching, Sectoral Heterogeneity, Estonia.

**OTSESTE VÄLISINVESTEERINGUTE JA INNOVATSIOONI
HETEROGEENSUSE VAHELINE SEOS: TOENDID EESTI
ETTEVÕTETE TASANDI ANDMETE PÕHJAL**

Magistritöö

Wei Ding

Lühikokkuvõte

Suur osa teaduskirjandusest eeldab, et otsesed välisinvesteeringud kannavad tehnoloogilise võimekuse automaatselt üle kohalikele ettevõtetele, kuid see üldistav käsitlus varjutab sageli rahvusvaheliste ettevõtete tegelikku toimimist. Käesolev uurimus analüüsib, kas välisosalus suurendab asukohariigi ettevõtte innovatsioonitõenäosust, kasutades Eesti kui järelejõudva majandusega riigi ettevõtete paneelandmestikku aastatest 2006–2022. Kuna tootmisüksuse kaasajastamine erineb fundamentaalselt uue toote väljatöötamisest, eristatakse analüüsis protsessi- ja tooteinnovatsiooni. Välisinvestorid ei omanda sihtettevõtteid juhuslikult; nad ostavad selektiivselt ettevõtteid, mis on juba varasemalt suuremad ja tootlikumad. Välisosaluse tegeliku seose

eraldamiseks antud valikunihkest rakendatakse käesolevas uuringus tõenäosusskooride sobitamist (Propensity Score Matching), et võrrelda omandatud ettevõtteid identsete kodumaiste võrdlusettevõtetega. Seejärel hinnatakse efekti ettevõtte püsiefektidega lineaarse tõenäosusmudeli (Linear Probability Model) abil. Uue toote juurutamine sunnib ettevõtet tavaliselt muutma ka oma tootmisprotsessi, mistõttu annab nende valikute käsitlemine eraldiseisvate sündmustena ettevõtte käitumisest moonutatud pildi. Seetõttu modelleeritakse neid uuringus ka ühiselt, kasutades bivariaatset probit-mudelit (Bivariate Probit).

Kogu majanduse lõikes ei tuvasta uuring seost välisosaluse ja kummagi innovatsioonitüübi vahel. Küll aga ilmneb selge seaduspärasus, kui hinnata sektoreid nende tehnoloogilise intensiivsuse alusel. Kõrg ja keskmiskõrgtehnoloogilises töötlevas tööstuses ergutab välisomandamine tugevalt protsessiinnovatsiooni, kuid ei avalda olulist seost uute toodete arendamisele. Rahvusvahelised ettevõtted integreerivad nimetatud Eesti tütaretevõtted keerukatesse globaalsetesse väärtusahelatesse eelkõige efektiivsuse optimeerimiseks, opereerides neid pigem tütarتهastena kui iseseisvate loomekeskustena. Üldise väliskapitali kaasamiseks kavandatud laiahaardelised poliitikad ei võta seda tööjaotust arvesse, mis tõestab, miks töötleva tööstuse käsitlemine ühtse ja homogeense tervikuna võib olla eksitav.

Märksõnad: otsesed välisinvesteeringud, protsessiinnovatsioon, tooteinnovatsioon, tõenäosusskooride sobitamine, valdkondlik heterogeensus, Eesti.

1 Introduction

Foreign Direct Investment (FDI) serves as a critical engine of economic integration and modernization for small open economies. For Estonia, a digitally advanced European Union member state, FDI has been a primary driver of capital accumulation and productivity growth since its restoration of independence (Vahter and Masso, 2007). However, while the volume of investment has been substantial locally, the broader academic literature demonstrates that the qualitative impact of foreign ownership on domestic innovation capabilities remains a subject of intense debate (e.g., Aitken and Harrison, 1999; Javorcik, 2004). Does foreign capital actively transfer knowledge and foster the creation of new products, or does it merely integrate Estonian firms into global value chains as efficient production units with limited creative mandates?

The theoretical promise of FDI lies in its potential for technology transfer and positive direct effects on affiliates. According to the ownership advantages in Dunning's OLI paradigm (Dunning, 1980; Dunning, 2000), multinational enterprises (MNEs) bring superior technology and advanced operational processes that should, in theory, boost the innovation performance of their subsidiaries and domestic partners. Yet, empirical evidence from the Baltic states and the broader Central and Eastern European (CEE) region suggests a more complex reality. Existing literature indicates that FDI in these transition economies often has a strong "efficiency-seeking" component (e.g., Bevan and Estrin, 2004; Sass and Fifekova, 2011), driven by the optimization of production costs rather than the development of new products or technologies.

This distinction creates a critical gap in the existing literature. A considerable strand of early research (e.g., Damijan et al., 2003; Stiebale and Reize, 2011) relies on R&D expenditure as the sole proxy for innovation. This approach risks underestimating the true extent of innovation in economies like Estonia, where firms may engage in significant process innovation (improving how things are made) with-

out formal R&D departments or large budgets for product innovation (creating new goods) (Masso and Tiwari, 2024). Furthermore, early research often utilized cross-sectional data or short panel, which fail to capture the long-term dynamic adjustments of firms following ownership changes.

To address these limitations, this thesis employs a rigorous longitudinal approach. We construct a comprehensive firm-level panel dataset combining the Community Innovation Survey (CIS) and the Estonian Business Registry, covering the extensive period of 2006 to 2022. This 17-year timeframe allows us to observe firm dynamics across multiple economic cycles, offering a distinct methodological advantage over previous studies. By utilizing a Linear Probability Model (LPM) with Firm Fixed Effects, complemented by Propensity Score Matching (PSM), we control for unobserved firm heterogeneity and selection bias to more rigorously examine the relationship associated with foreign ownership.

The primary objective of this study is to disentangle the heterogeneous effects of FDI on different types of innovation and provide nuanced policy implications for moving the Estonian economy up the global value chain. Specifically, we test the hypothesis that foreign ownership in Estonia is strongly associated with process innovation—consistent with efficiency-seeking integration into global value chains—while having a neutral or lesser relationship with product innovation. This expectation is rooted in the strategic behavior of Multinational Enterprises (MNEs). The literature suggests that while MNEs readily transfer operational technologies to improve subsidiary efficiency, they often centralize core research and development (R&D) and new product design at their headquarters to protect intellectual property and avoid duplicating efforts (Cantwell and Mudambi, 2005). Consequently, an acquired domestic firm may experience the "branch plant" syndrome (Stiebale and Reize, 2011), where its indigenous creative mandate is stripped, relegating it to a pure production role.

The remainder of this thesis is structured as follows. Section 2 reviews the theo-

retical framework of the OLI paradigm and the empirical literature regarding FDI and innovation heterogeneity. Section 3 describes the CIS and Business Registry dataset, variable construction, and the empirical strategy, including the Fixed Effects and Propensity Score Matching models. Section 4 presents and discusses the main empirical findings. Finally, Section 5 concludes with a summary of the key results and their corresponding policy implications.

Note: I hereby declare that I used AI (Gemini) as a guide for debugging the data processing section of the paper (PSM part and Biprobit part); and that I also used AI (Gemini) for some English grammar guidance during the paper's processing to make the expression more academic. My prompt: Correct all grammatical, spelling, and punctuation errors. Ensure the syntax is completely flawless. Identify overly brief, fragmented, or disjointed sentences. Synthesize and combine them into cohesive, well-structured complex sentences. The goal is to significantly improve the logical flow and increase the information density without altering my original meaning.

2 Literature Review

2.1 Theoretical Framework: The OLI Paradigm and Innovation

The theoretical nexus between FDI and innovation is fundamentally rooted in Dunning's Eclectic Paradigm, often referred to as the OLI framework (Dunning, 1980; Dunning, 2000). This paradigm posits that Multinational Enterprises (MNEs) invest abroad to exploit three distinct types of advantages: Ownership, Location, and Internalization.

Ownership advantages refer to the superior proprietary assets that MNEs possess, such as advanced technological patents, sophisticated managerial skills, and organizational know-how. These unique assets enable MNEs to successfully compete in foreign markets against established local firms. Location advantages encompass the specific characteristics of the host country that make it an attractive investment destination, including factor endowments, market size, institutional quality, and geographic proximity to other markets. For Estonia, location advantages are particularly relevant: as a small, digitally advanced European Union member state with proximity to Nordic markets and access to EU institutions, Estonia offers both cost advantages relative to Western Europe and technological infrastructure advantages relative to other transition economies. These location characteristics have historically attracted efficiency-seeking FDI, particularly from Nordic investors seeking to integrate Estonian firms into regional value chains (Vahter and Masso, 2007).

Internalization advantages explain why MNEs choose to execute these activities internally through FDI rather than relying on external market transactions such as licensing. By internalizing operations, MNEs protect their intellectual property from imitation and maintain tight control over product quality and operational standards. To understand the direct impact of foreign acquisition on a domestic firm's innovation capabilities, the Ownership and Internalization advantages are

particularly relevant, as they determine both what knowledge is transferred and how tightly the parent company controls the subsidiary's strategic mandate.

Ownership advantages dictate that MNEs possess superior proprietary assets, which can range from advanced technological patents to sophisticated managerial skills and organizational know-how. These unique assets enable them to successfully compete in foreign markets against local firms that are already established. When an MNE enters a host country like Estonia by acquiring a local firm, it theoretically transfers these superior assets directly to its new subsidiary. This direct injection of knowledge, capital, and technology serves as a primary driver for upgrading the affiliate's internal operations and capabilities.

Furthermore, Internalization advantages explain why MNEs choose to execute these activities internally through FDI rather than relying on external market transactions, such as licensing their technology to independent firms. By internalizing operations, MNEs protect their intellectual property from imitation and maintain tight control over product quality. However, the extent to which actual innovation activities are decentralized to the newly acquired subsidiary heavily depends on the strategic mandate set by the parent company (Cantwell and Mudambi, 2005). If the parent company restricts the subsidiary to a purely operational role, the anticipated boost in creative output may not materialize.

2.2 Mechanisms of Impact: Direct Effects on Affiliates

Rather than focusing on indirect spillovers to domestic competitors or suppliers (e.g., Aitken and Harrison, 1999; Javorcik, 2004), this study specifically examines the direct effects of foreign ownership on the innovation performance of the acquired affiliates themselves. The literature identifies two contrasting mechanisms regarding how foreign acquisition reshapes the innovative trajectory of a target firm: competence-creating direct transfers and the centralization of innovation, often conceptualized as the "branch plant" syndrome.

In the first scenario, foreign parent companies directly transfer advanced proprietary technologies, organizational know-how, and financial capital to their subsidiaries. This competence-creating mandate significantly boosts the affiliate's internal innovation capabilities. Under these conditions, the subsidiary may be granted a creative mandate to develop new products or adapt existing ones for both the local and global markets (Cantwell and Mudambi, 2005). Such direct knowledge transfers and resource injections are expected to lead to a measurable increase in the subsidiary's overall innovation output, encompassing both product and process advancements.

Conversely, a foreign acquisition does not automatically guarantee an increase in innovation at the subsidiary level. When evaluating the impact of FDI on local innovation, it is critical to disaggregate innovation into distinct typologies. According to the subsidiary mandate literature (Cantwell and Mudambi, 2005; Jindra, Giroud, and Scott-Kennel, 2009), multinational enterprises often concentrate core Research and Development (R&D) and complex product design within their headquarters to protect intellectual property. In such configurations—often conceptualized as the "branch plant" syndrome—MNEs primarily transfer advanced capital equipment and lean manufacturing techniques to local affiliates to optimize production efficiency. Consequently, while longitudinal observations might show a significant increase in the subsidiary's production capabilities—reflecting process innovation—its own indigenous capacity for new product development may simultaneously stagnate or remain relatively isolated (Stiebale and Reize, 2011).

2.3 The "Efficiency-Seeking" Reality and Sectoral Heterogeneity

The context of the host economy is paramount in understanding the impact of FDI. In Central and Eastern Europe (CEE), and specifically in the Baltic states, FDI has historically been characterized as efficiency-seeking rather than market-seeking or

asset-seeking (e.g., Bevan and Estrin, 2004; Sass and Fifekova, 2011). This means that multinational enterprises primarily integrate Estonian firms into Global Value Chains (GVCs) to optimize production costs and leverage local efficiencies. In this capacity, the parent company frequently transfers advanced process technologies to ensure strict quality and efficiency standards are met. However, the mandate for creating entirely new products is rarely transferred to these subsidiaries, often relegating them to a production-focused role within the broader corporate network. Furthermore, this dynamic exhibits significant sectoral heterogeneity, which must be carefully accounted for in empirical analyses. The magnitude of technology transfer via FDI is not uniform across the economy but is fundamentally constrained by the host firm's sector and intrinsic absorptive capacity (Cohen and Levinthal, 1990). In technology-intensive manufacturing sectors (e.g., high- and medium-high technology), integrating a local affiliate into a complex Global Value Chain (GVC) mandates strict standardization and continuous upgrading of production processes (Benkovskis et al., 2020). Therefore, FDI in these advanced sectors is theoretically more likely to trigger immediate process innovations. In contrast, foreign investments in low-technology, labor-intensive sectors are often purely cost-arbitrage seeking, exploiting existing cheap labor without the strategic need to upgrade legacy production processes. Consequently, analyzing the manufacturing sector as a homogeneous group risks obscuring these precise sector-specific mechanisms.

2.4 Heterogeneity of Innovation: Product vs. Process

A critical gap in much of the existing empirical literature is the failure to adequately distinguish between different types of innovation outcomes. Product innovation involves the introduction of a good or service that is either entirely new to the market or significantly improved compared to existing offerings. This type of innovation is traditionally linked to market-seeking strategies, requiring high R&D intensity and

a clear mandate for new product development from the parent company. On the other hand, process innovation encompasses the implementation of a new or significantly improved production or delivery method (OECD/Eurostat, 2018). This is much more closely aligned with the efficiency-seeking strategies prevalent in the Baltic region, where the focus is on optimizing existing operations rather than inventing new goods. Given Estonia’s position as a small open economy, pooling these distinct types of innovation into a single aggregate variable may severely mask the true, heterogeneous relationship between foreign ownership and firm upgrading.

Importantly, while these two types of innovation represent distinct strategic outcomes, they are rarely mutually exclusive in practice. There is a strong theoretical and empirical basis to suggest that product and process innovations are often interrelated and jointly determined by the firm. For instance, the introduction of a novel product may inherently necessitate the adoption of new manufacturing processes, just as a significant upgrade in process technology might enable the firm to launch improved services or goods. Recognizing this strategic complementarity is vital for empirical modeling. Treating these innovation decisions as independent, isolated events ignores their underlying correlation. Consequently, modeling them jointly—an approach we operationalize via a bivariate probit model—provides a more accurate and comprehensive reflection of how foreign-owned affiliates structure their overall innovation portfolios.

2.5 Addressing Selection Bias

While early empirical literature examining FDI in transition economies often relied on cross-sectional data or relatively short panels (e.g., Damijan et al., 2003), which struggle to adequately control for unobserved firm heterogeneity, modern economic research increasingly emphasizes the necessity of longitudinal approaches. However, existing firm-level studies in the CEE region have largely examined product and process innovation separately, without systematically modelling their joint response

to foreign acquisition.

A persistent methodological challenge in the FDI-innovation literature is the endogeneity arising from non-random foreign acquisitions. Theoretical frameworks and empirical evidence consistently show that MNEs engage in "cherry-picking," deliberately targeting domestic firms that are already larger, older, or more productive (Aitken and Harrison, 1999; Guadalupe, Kuzmina, and Thomas, 2012). If this selection bias is not rigorously addressed, standard linear estimations may falsely attribute a firm's superior innovation performance to foreign ownership rather than its pre-existing advantageous characteristics. Consequently, recent literature emphasizes the necessity of utilizing rigorous matching techniques to construct valid counterfactuals and isolate the true treatment effect of FDI.

This thesis addresses these empirical challenges by constructing a 17-year panel dataset (2006–2022). Using a Linear Probability Model paired with Propensity Score Matching (PSM), this study mitigates the established selection bias and controls for observable pre-treatment firm characteristics. Because product and process decisions naturally overlap, estimating them jointly through a Bivariate Probit model provides a cleaner, more precise picture of how foreign ownership actually shapes firm-level innovation.

3 Data and Methodology

3.1 Data Description

This study employs a comprehensive firm-level panel dataset covering the period from 2006 to 2022. The dataset is constructed by merging two primary sources:

Community Innovation Survey (CIS) serves as the primary source for innovation variables. The CIS is the standard data source for innovation studies in the EU, following the guidelines of the Oslo Manual (OECD/Eurostat, 2018). Crucially, our dataset incorporates multiple sequential waves of the CIS spanning the 2006–2022 period. A specific methodological feature of the CIS is its temporal structure: rather than capturing data for a single isolated year, each survey wave requires firms to report their innovation activities over a three-year reference period (e.g., from year t to $t + 2$). While merging these successive waves provides a comprehensive mapping of firms’ innovation behavior, this three-year window inherently introduces a temporal mismatch with standard annual financial data, a methodological issue we will explicitly address in our empirical strategy.

Estonian Business Registry provides longitudinal financial data, including ownership structure (FDI), sales, employment, and industry classification codes (NACE Rev. 2).

The resulting panel is unbalanced. This happens by design. The Community Innovation Survey comprehensively tracks all large companies, but only pulls random samples of smaller firms in each wave. Small firms cycle in and out of the dataset. Still, the 17-year timeframe provides enough within-firm variation—especially around changes in foreign ownership and innovation behavior—to estimate panel data models effectively.

3.2 Variables

3.2.1 Dependent Variables: Innovation Performance

A growing body of literature relies on R&D expenditure as a proxy for innovation. However, this measure has well-documented limitations. First, firm-level R&D spending often exhibits severe zero-inflation, particularly in catching-up economies where much innovation is informal, ad-hoc, or not captured by standard accounting metrics (Masso and Tiwari, 2024). Second, R&D expenditure is a financial input, not a direct measure of whether a firm actually introduced a new product or improved a production process. Non-linear estimators (e.g., Tobit) can address zero-inflation statistically, but they do not resolve the conceptual mismatch between input and outcome.

Therefore, this study uses two binary indicators directly capturing innovation outcomes, following the definitions in the Oslo Manual (OECD/Eurostat, 2018). Process Innovation equals 1 if the firm introduced a new or significantly improved production process, distribution method, or supporting activity during the period, and 0 otherwise. Product Innovation equals 1 if the firm successfully launched a new or significantly improved good or service to the market, and 0 otherwise.

3.2.2 Independent Variable: Foreign Ownership

Foreign Direct Investment, our primary explanatory variable is a dummy variable indicating foreign ownership. Based on the standard classification in the Estonian Business Registry data, it takes the value of 1 if a foreign entity owns at least 50% of the firm's equity (majority ownership), and 0 for domestically owned firms.

The choice of the 50% threshold warrants careful consideration, as it represents a conceptual boundary in how foreign ownership relates to subsidiary behavior. According to the OLI paradigm discussed in our theoretical framework, majority ownership grants the foreign investor significant control over strategic decisions,

including capital allocation, technology adoption, and R&D priorities. This distinction matters because the mechanisms through which FDI influences innovation depend on the parent company's ability to exercise control over subsidiary operations and to impose strategic mandates (Dunning, 2000; Cantwell and Mudambi, 2005). A 50% threshold captures this qualitatively different relationship compared to minority foreign shareholding, where influence operates through more indirect channels rather than direct hierarchical control.

The literature on FDI and innovation has employed various measurement approaches, each with different implications. One alternative would be to use the continuous percentage of foreign equity ownership, ranging from 0 to 100%. This approach could capture the intensity of foreign control and potentially reveal non-linear effects. However, this approach faces practical constraints in our context. The Estonian Business Registry provides reliable information on majority versus minority ownership classifications, but detailed ownership percentages are less consistently recorded, particularly for firms with complex ownership structures or multiple foreign investors. Moreover, the relationship between ownership share and actual control is not necessarily linear. We adopt the binary majority ownership indicator because it aligns with standard practice in the FDI literature.

Another possible approach would involve including firms with minority foreign ownership as a separate category or analyzing them alongside majority-owned affiliates. This would allow examination of whether non-controlling foreign investment influences subsidiary innovation. However, minority foreign investors typically lack the strategic control necessary to impose the operational mandates described in our theoretical framework. The mechanisms through which FDI influences innovation—direct technology transfer, process upgrading, and the imposition of efficiency-seeking mandates—presume hierarchical control by the parent company. The existing literature, including studies by Aitken and Javorcik (Aitken and Harrison, 1999; Javorcik, 2004), consistently focuses on majority-owned affiliates as the primary unit of analysis, precisely because minority stakes operate through

different channels such as knowledge spillovers rather than direct transfers. Including minority ownership would increase the treated sample size but at the cost of conflating two fundamentally different types of foreign involvement.

A more granular approach might distinguish between acquisitions, where a foreign investor takes over an existing domestic firm, and greenfield investment, where a foreign investor establishes a new subsidiary from scratch. A more granular approach might distinguish between acquisitions and greenfield investments, as these represent different entry modes. However, the Estonian Business Registry does not consistently distinguish between these types across the full panel. Our empirical strategy focuses on the treatment effect of the ownership change event itself, which is most naturally captured through a binary indicator. The Estonian Business Registry does not consistently distinguish between acquisition and greenfield FDI in a way that would allow reliable classification across the full 17-year panel. This distinction remains a valuable avenue for future research with access to more detailed transaction data.

One could also consider disaggregating foreign ownership by the source country or region of the foreign investor, examining whether innovation effects vary by the technological sophistication or institutional proximity of the investor's origin. In the Baltic context, for example, Nordic investors might operate under different strategic logics than investors from other regions, reflecting the integration of these economies into Nordic-dominated global value chains (Bevan and Estrin, 2004; Sass and Fifekova, 2011). However, such refinement would substantially reduce sample sizes within each sub-category, particularly problematic given that our high-technology manufacturing sub-sample already comprises only 1,558 observations. Source country effects would also conflate multiple mechanisms, introducing additional complexity to the interpretation.

We adopt the binary majority ownership indicator for several reasons. First, it aligns with our theoretical framework, which emphasizes the control mechanisms

through which the "branch plant" syndrome and efficiency-seeking FDI operate (Stiebale and Reize, 2011). Second, the 50% threshold aligns with the majority ownership definition used in prior FDI studies (Guadalupe, Kuzmina, and Thomas, 2012), facilitating comparison with existing work. Third, the Estonian Business Registry provides consistent and reliable information on majority versus minority ownership across our 17-year panel, reducing measurement error. Fourth, this approach is standard in the FDI literature and allows our results to be directly comparable with existing work on FDI and innovation (Guadalupe, Kuzmina, and Thomas, 2012). Fifth, the binary treatment indicator suits our propensity score matching strategy, which requires a clear definition of the treatment event.

It should be noted that our FDI measure captures the stock of foreign ownership at a given point in time, not the flow of new FDI. This means we observe whether a firm is foreign-owned in a particular year, but we do not distinguish between firms that were newly acquired in that year and firms that have been foreign-owned for multiple years. To address this limitation and establish clearer temporal precedence, we employ a lagged specification in which we measure foreign ownership in year $t-1$, strictly prior to the innovation observation window. This approach mitigates reverse causality concerns. However, it does not fully distinguish between the effects of recent acquisitions versus long-standing foreign ownership, a distinction that could be explored in future research with more granular transaction-level data.

3.2.3 Control Variables

Before specifying our control variables, it is important to situate our analysis within the broader framework of the knowledge production function (KPF), which is central to innovation economics. The knowledge production function describes how firms convert innovation inputs (such as R&D expenditure and human capital) into innovation outputs (such as product and process innovations), which in turn affect firm productivity and performance (Griffith, Harrison, and Van Reenen, 2006;

Crépon, Duguet, and Mairesse, 1998). This framework is typically operationalized through the CDM model, a three-stage structural model that links R&D investment decisions, then innovation output (product and process innovations), last is productivity effects.

Our empirical analysis focuses specifically on stage 2 of this framework the relationship between firm characteristics (including foreign ownership) and the probability of achieving innovation outputs (product and process innovations). We do not model R&D expenditure as an explicit input variable, nor do we examine productivity as an output. Rather, we examine how foreign ownership, as an external factor affecting firm capabilities and strategic mandates, influences the firm's propensity to introduce new products or improved production processes.

In this context, FDI can affect the knowledge production function through several mechanisms. First, foreign parent companies may directly transfer advanced technologies and operational know-how to their subsidiaries, enhancing their capacity to innovate. Second, foreign ownership may alter the subsidiary's strategic mandate within the multinational enterprise's global value chain, potentially restricting or expanding its innovation activities. Third, foreign acquisition may improve the subsidiary's absorptive capacity—its ability to recognize, assimilate, and apply new knowledge (Cohen and Levinthal, 1990)—thereby affecting its propensity to innovate. Our control variables are selected to capture firm characteristics that influence this knowledge production process, while avoiding the inclusion of variables that may themselves be direct outcomes of the FDI treatment.

We control for time-varying firm characteristics that may influence innovation. Firm size is measured as the natural logarithm of the number of employees. We include this variable to account for the Schumpeterian hypothesis, which posits that larger firms may have structural advantages in undertaking innovation. However, the mechanism through which firm size influences innovation in catching-up economies like Estonia may differ from that in advanced economies. Rather than

assuming that larger firms necessarily benefit from economies of scale in formal R&D spending, we recognize that in the Estonian context, much innovation occurs through informal channels, process improvements, and technology adoption that do not require substantial R&D expenditure (Masso and Tiwari, 2024). Larger firms may simply have greater organizational capacity and resources to implement both product and process innovations, regardless of whether these innovations are formally documented as R&D activities. Firm size is measured as the natural logarithm of the number of employees. Since foreign-targeted firms may differ in size, controlling for this variable is essential to isolate the true FDI effect.

Labor productivity is measured as the natural logarithm of value added per employee, serving as a proxy for the firm's absorptive capacity. The absorptive capacity concept, introduced by Cohen (Cohen and Levinthal, 1990), suggests that a firm's ability to benefit from external knowledge and technology depends on its existing stock of knowledge and capabilities. Higher labor productivity may indicate a firm's greater capacity to recognize, assimilate, and apply new technologies and innovations. However, as labor productivity can also be a direct outcome of foreign acquisition, including it may introduce a "bad control" problem. Therefore, to ensure the robustness of our baseline results and avoid masking the true impact of FDI, our empirical estimations will be conducted and reported both with and without productivity as a control variable.

Capital intensity is measured as fixed assets per employee. This variable captures the degree to which a firm relies on physical capital in its production process. Capital-intensive firms may have different innovation patterns compared to labor-intensive firms, as they may be more likely to engage in process innovation to optimize their capital utilization. Additionally, capital intensity may reflect the technological sophistication of the firm's production facilities, which could influence both the need for and capacity to innovate.

Firm age, measured in years since establishment, is included as an additional con-

trol variable. Younger firms may exhibit greater agility and flexibility in adopting novel practices and technologies compared to older, more established firms with entrenched organizational routines. Conversely, older firms may have accumulated more experience and organizational knowledge that could facilitate innovation. The relationship between firm age and innovation is thus potentially non-linear, and including this variable allows us to account for lifecycle effects in firm innovation behavior.

One could also consider controlling for innovation expenditures as a measure of innovation inputs, following the logic of knowledge production functions commonly used in the innovation literature. This approach would allow us to examine whether foreign ownership influences the efficiency with which firms convert innovation inputs into innovation outputs. However, as noted in Section 3.2.1, R&D expenditure data in the Estonian context exhibits severe zero-inflation and inconsistent reporting, particularly for firms engaged in non-formal innovation activities. Moreover, innovation expenditures (including R&D, external knowledge acquisition, and innovation-related training) may themselves be directly altered by foreign acquisition, as parent companies control subsidiary budgets for these activities, introducing endogeneity concerns. Including innovation expenditures as a control variable would therefore risk introducing additional endogeneity concerns. For these reasons, we focus on firm characteristics that are less likely to be directly altered by the FDI event itself, while acknowledging that the relationship between innovation inputs and outputs remains an important avenue for future research.

3.3 Empirical Strategy

3.3.1 The Fixed Effects Model

To explore the relationship between FDI and innovation, we employ a Linear Probability Model (LPM) with Fixed Effects as our baseline specification. While Logit

or Probit models are often used for binary outcomes, the LPM is preferred in panel data settings because it allows for a straightforward interpretation of coefficients and facilitates the inclusion of high-dimensional fixed effects without the incidental parameter problem.

The baseline regression equation is specified as follows:

$$\begin{aligned} Innovation_{it} = & \beta_0 + \beta_1 FDI_{it} + \beta_2 Size_{it} + \beta_3 Prod_{it} + \beta_4 CapInt_{it} \\ & + \beta_5 ImportShare_{it} + \beta_6 ExportShare_{it} + \alpha_i + \delta_t + \varepsilon_{it} \end{aligned} \quad (1)$$

Where:

- $Innovation_{it}$ represents either $Process_{it}$ or $Product_{it}$ (binary indicators of innovation outcomes).
- FDI_{it} is the binary indicator of foreign ownership (1 if $\geq 50\%$ foreign ownership, 0 otherwise).
- $Size_{it}$ is the natural logarithm of firm employment.
- $Prod_{it}$ is labor productivity (natural logarithm of value added per employee).
- $CapInt_{it}$ is capital intensity (natural logarithm of fixed assets per employee).
- $ImportShare_{it}$ and $ExportShare_{it}$ are continuous measures of import and export intensity relative to total turnover.
- β_0 is the constant term.
- β_1 through β_6 are the coefficients to be estimated.
- α_i denotes firm fixed effects, controlling for time-invariant unobserved heterogeneity.
- δ_t denotes year fixed effects, controlling for common macroeconomic shocks.
- ε_{it} is the idiosyncratic error term.

3.3.2 Temporal Structure and Lagged Effects

We acknowledge that innovation is not instantaneous and that ownership changes require time to materialize. Furthermore, it is crucial to account for the specific temporal structure of the Community Innovation Survey (CIS). As the CIS captures innovation activities over a three-year reference period (from year t to $t+2$), we must adjust our explanatory variables accordingly to establish a proper temporal sequence.

The temporal structure of successive CIS waves introduces a particular challenge for panel estimation. Because each survey wave covers a three-year window and successive waves overlap in their reference periods, a firm's innovation outcome in one CIS wave may partially overlap with the reference period of the subsequent wave. For example, a firm surveyed in the wave covering years 2008-2010 and again in the wave covering years 2010-2012 will have years 2010 and 2011 in common.

When overlapping years occur and innovation values differ between waves, we use the observation from the closest CIS wave to the outcome period to minimize measurement error. This means that for overlapping years, we prioritize the wave whose reference period is temporally closest to the innovation measurement window.

In cases where a firm appears in multiple overlapping CIS waves, we include all available observations in our panel estimation, as the fixed effects specification with firm-level clustering naturally accounts for the within-firm correlation across overlapping periods.

To address this issue, we adopt the following approach. When successive CIS waves overlap, we treat the ownership status measured at the beginning of each reference period (year $t-1$) as the relevant explanatory variable for that wave's innovation outcome. This ensures that the foreign ownership measure strictly precedes the entire three-year innovation observation window, minimizing concerns about reverse causality. In cases where a firm appears in multiple overlapping CIS waves, we include all available observations in our panel estimation, as the fixed effects speci-

fication with firm-level clustering naturally accounts for the within-firm correlation across overlapping periods. The fixed effects estimator absorbs time-invariant firm characteristics and, combined with year fixed effects, controls for common macroeconomic shocks that may affect multiple overlapping waves.

To align with this structure, we estimate a specification using lagged FDI. Specifically, we measure foreign ownership in year $t-1$, strictly prior to the innovation observation window:

$$\text{Innovation}_{i,(t \text{ to } t+2)} = \beta_1 \text{FDI}_{i,t-1} + X_{i,t-1} \beta + \alpha_i + \delta_t + \varepsilon_{it}$$

While utilizing a lagged structure does not perfectly solve all reverse causality issues, it mitigates potential simultaneity concerns by ensuring that the ownership status explicitly precedes the measured innovation outcomes. The inclusion of firm fixed effects (α_i) further controls for time-invariant unobserved heterogeneity that might affect both the likelihood of foreign acquisition and innovation propensity.

3.3.3 Sectoral Heterogeneity

Given the structural differences between sectors, we will perform subsample analyses for Manufacturing and Services separately. We hypothesize that the association between FDI and process innovation will be significantly more pronounced within the manufacturing sector. Conversely, drawing upon our earlier literature review, we expect the relationship between foreign ownership and product innovation to be stronger within the services sector (Blind and Jungmittag, 2004). Service-oriented affiliates, particularly in knowledge-intensive branches, rely heavily on localized human capital and customized market demand, making them more likely to retain or receive a mandate for direct product and service development (Miozzo and Miles, 2002; Tether, 2005).

This expectation is firmly grounded in the nature of "efficiency-seeking" FDI in

the Baltic region. Manufacturing subsidiaries in Estonia are frequently integrated into production networks where the primary strategic mandate is to execute standardized production tasks efficiently and at lower costs (Vahter and Masso, 2007). This objective naturally drives Process Innovation—such as upgrading machinery, improving logistics, or optimizing production lines. On the other hand, the mandate for creating new goods (Product Innovation) often remains centralized at the MNE’s headquarters (Cantwell and Mudambi, 2005), severely limiting the subsidiary’s role in product development. Analyzing these sectors separately is crucial to capture these distinct mechanisms.

3.3.4 Joint Estimation: Bivariate Probit Model

As discussed in the literature review (Section 2.4), product and process innovations are often jointly determined by the firm, with strong theoretical and empirical evidence suggesting that these two types of innovation are interrelated and jointly determined (Martinez-Ros, 1999; Miravete and Pernías, 2006). Treating these two binary outcomes as completely independent in separate regression equations ignores their underlying strategic complementarity. To account for this, we extend our baseline framework by estimating a Bivariate Probit (Biprobit) model. This methodological choice aligns with established empirical innovation literature (Martinez-Ros, 1999; Miravete and Pernías, 2006), which demonstrates that estimating these outcomes jointly is essential to capture the simultaneous nature of technological decisions. This approach allows the error terms of the product and process innovation equations to be correlated. The correlation between error terms reflects the possibility that unobserved firm-level characteristics—such as managerial quality, organizational culture, or strategic orientation—may simultaneously influence both innovation types. By estimating these equations jointly, we can capture the extent to which firms’ product and process innovation decisions are shaped by these common underlying factors, rather than treating them as completely in-

dependent strategic choices.

3.3.5 Addressing Selection Bias: Propensity Score Matching (PSM)

Finally, recognizing that fixed effects alone may not fully account for selection bias—specifically, the endogeneity concern that foreign investors might "cherry-pick" domestic firms that are already highly productive—we utilize a Propensity Score Matching (PSM) approach as a core component of our empirical strategy. The implementation of this matching procedure involves two steps. First, we will estimate the probability of a domestic company becoming foreign-owned (the propensity score) using a probit model based on pre-acquisition observable characteristics, such as firm size, labor productivity, and sector classification. Second, we will match these treated (acquired) firms with a control group of highly similar domestic firms that were not acquired. By comparing the innovation trajectories across these carefully matched groups, we can more rigorously isolate the relationship associated with the FDI event itself.

An important methodological consideration concerns the timing of control variables in our PSM procedure. We measure all control variables (firm size, labor productivity, capital intensity, age, export and import shares) in year t —the same year in which we observe the foreign ownership status and the beginning of the CIS innovation reference period $[t, t+2]$.

This contemporaneous timing of controls and treatment is justified for several reasons. First, in observational studies of firm acquisitions, the precise timing of ownership change within a calendar year is often difficult to pinpoint. Using year- t characteristics ensures that we capture the firm's state at the moment closest to the ownership transition. Second, this approach is standard in the FDI literature, where researchers typically match firms based on characteristics measured in the year of acquisition (Guadalupe, Kuzmina, and Thomas, 2012). Third, our fixed effects specification in the LPM absorbs time-invariant firm heterogeneity, further

mitigating concerns about pre-treatment imbalances.

We acknowledge that a potential limitation is that year- t characteristics may already partially reflect early-year effects of foreign acquisition if the acquisition occurred in the first months of year t . However, we note that foreign and domestic firms show substantial observable differences in characteristics, suggesting that selection effects dominate any immediate post-acquisition effects; also our PSM results remain consistent with the baseline LPM estimates, which use lagged FDI (year $t-1$), indicating robustness to alternative timing specifications; and the inclusion of year fixed effects controls for any common macroeconomic shocks that might affect all firms similarly in year t .

Therefore, while we recognize the timing of controls as a methodological consideration, we are confident that it does not substantially bias our treatment effect estimates.

4 Empirical Results

4.1 Descriptive Statistics

Table 1 presents the summary statistics for the core variables used in our empirical estimations. The integrated dataset spans from 2006 to 2022. The initial merged dataset, based on the CIS sampling frame, encompasses over 64,000 firm-year observations. For the innovation outcome variables derived from the CIS, we have approximately 20,331 firm-year observations with valid responses to innovation questions.

An important clarification regarding trade variables is warranted. In earlier data processing stages, export and import participation were captured as binary indicators (0 or 1) based on specific survey questions, which suffered from extensive missing data and non-response. The current dataset employs continuous measures of export share and import share, calculated as the proportion of exports and imports relative to total turnover. These continuous measures are available across the full 64,000 firm-year observations, substantially improving data completeness compared to the earlier binary approach. Export share has a mean of 0.163 with a standard deviation of 0.303, while import share has a mean of 0.141 with a standard deviation of 0.249, indicating considerable variation in firms' participation in international trade.

As shown in Table 1, approximately 30.2% of firm-year observations engaged in product innovation over the analyzed period, while 35.5% reported process innovation. Foreign-owned enterprises constitute approximately 16.0% of total observations, providing a substantial subsample for evaluating FDI effects. The inclusion of import share and export share as continuous variables represents a methodological improvement that allows us to capture the intensity of firms' global value chain participation, though trade flows alone provide only a partial measure of GVC positioning.

Table 1: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Product Innovation (<i>innoproduct</i>)	20,331	0.302	0.459	0	1
Process Innovation (<i>innoprocess</i>)	20,331	0.355	0.478	0	1
Foreign Ownership (<i>foreign</i>)	64,782	0.160	0.366	0	1
Import Share (<i>import_share</i>)	64,782	0.141	0.249	0	1
Export Share (<i>export_share</i>)	64,782	0.163	0.303	0	1
Firm Size ln (<i>ln_tarv</i>)	40,722	3.208	1.225	0	9.859
Labor Productivity ln (<i>ln_lpq</i>)	46,881	11.358	1.191	-0.199	18.732
Capital Intensity ln (<i>ln_cap_int</i>)	39,567	9.534	1.814	-2.345	18.263
Age (<i>ageyears</i>)	53,709	12.916	8.138	1	33

As noted by Benkovskis et al. (Benkovskis et al., 2020), measuring GVC participation through trade flows alone may not capture the full complexity of value chain positioning. More refined measures based on product-level trade data and input-output structures would provide additional insights into whether firms are integrated into high-value or low-value segments of global value chains. Nonetheless, export and import intensity serve as useful proxies for firms' engagement in international production networks.

Before advancing to regression analysis, it is important to examine whether foreign-owned affiliates systematically differ from domestic firms. Table 2 reports mean comparison tests between domestic and foreign-owned enterprises across core firm characteristics. The results strongly indicate the presence of selection bias, or "cherry-picking" behavior by multinational enterprises. Foreign-invested firms in Estonia are significantly larger in size and exhibit substantially higher labor productivity compared to their domestic counterparts, both significant at the 1% level. Notably, foreign-acquired firms are also slightly younger and marginally less capital-intensive, suggesting a preference for dynamic, high-efficiency targets. Additionally, foreign-owned firms have significantly higher import shares (0.297 versus 0.111 for domestic firms), indicating deeper integration into global value chains. Additionally, foreign-owned firms have significantly higher import shares (0.297 versus 0.111 for domestic firms), suggesting deeper integration into international production net-

works.

Table 2: Mean Differences by Ownership Status

Variable	Domestic (<i>foreign</i> =0)	Foreign (<i>foreign</i> =1)	Difference
Firm Size ln	3.081	3.657	0.576***
Labor Productivity ln	11.281	11.673	-0.392***
Capital Intensity ln	9.544	9.497	0.047**
Age (years)	13.052	12.338	0.714***
Import Share	0.111	0.297	-0.186***

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.2 Baseline Regression and Sectoral Heterogeneity

To rigorously isolate the relationship between foreign ownership and innovation propensity, we present baseline estimates using a Linear Probability Model (LPM). We estimate models controlling for key firm-level characteristics—size, labor productivity, import share, export share, capital intensity, and age—alongside time and industry fixed effects to absorb macroeconomic shocks and sector-specific unobserved heterogeneity.

Table 3 presents results including labor productivity as a control variable, while Table 4 presents the same specifications excluding labor productivity. This dual presentation addresses the "bad control" problem discussed in Section 3.2.3. Labor productivity can itself be a direct outcome of foreign acquisition, as parent companies may upgrade subsidiary operations and efficiency. Including productivity as a control variable risks masking the true impact of FDI on innovation. Comparing results across both specifications allows us to assess the sensitivity of our findings to this methodological choice. As shown in the tables, removing labor productivity generally increases the magnitude of the foreign ownership coefficients, particularly for product innovation in the full sample (from 0.011 to 0.016) and for process innovation in high-technology sectors (from 0.056 to 0.062). This pattern is

consistent with the hypothesis that labor productivity partially mediates the FDI effect on innovation. The import share coefficient becomes statistically significant for product innovation when productivity is excluded (0.041**, Table 4), suggesting that import-intensive firms are more likely to introduce new products, though this relationship may operate partly through productivity improvements.

We classify manufacturing industries by technological intensity using the OECD classification based on NACE Rev. 2 codes. High and Medium-High Technology sectors include industries such as chemicals, machinery, electrical equipment, and transport equipment. Low and Medium-Low Technology sectors include textiles, basic metals, and other traditional manufacturing.

Table 3: Baseline LPM Estimates for Innovation Propensity (Including Labor Productivity)

Variable	(1) Product Full Sample	(2) Process Full Sample	(3) Process High/Med-High Tech	(4) Process Low/Med-Low Tech
Foreign Ownership	0.011 (0.011)	0.006 (0.012)	0.056** (0.028)	-0.014 (0.020)
Import Share	0.028 (0.020)	-0.024 (0.020)	-0.048 (0.051)	0.001 (0.033)
Export Share	-0.001 (0.016)	-0.024 (0.016)	0.028 (0.036)	-0.050** (0.024)
Labor Prod. (ln)	0.021*** (0.005)	0.033*** (0.005)	0.046*** (0.014)	0.060*** (0.012)
Firm Size (ln)	0.062*** (0.005)	0.090*** (0.004)	0.100*** (0.012)	0.086*** (0.008)
Capital Int. (ln)	0.021*** (0.003)	0.037*** (0.003)	0.034*** (0.009)	0.051*** (0.006)
Firm Age	-0.002** (0.001)	-0.003*** (0.001)	-0.004* (0.002)	-0.005*** (0.001)
Year Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	No	No
Observations	10,152	10,152	1,558	3,498
R^2	0.0989	0.1153	0.1393	0.1592

Note: Robust standard errors are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

In the full sample estimations (Columns 1 and 2 of Table 3), the coefficient for

Table 4: Baseline LPM Estimates for Innovation Propensity (Excluding Labor Productivity)

Variable	(1) Product Full Sample	(2) Process Full Sample	(3) Process High/Med-High Tech	(4) Process Low/Med-Low Tech
Foreign Ownership	0.016 (0.011)	0.013 (0.011)	0.062** (0.028)	0.000 (0.019)
Import Share	0.041** (0.019)	-0.001 (0.020)	-0.024 (0.051)	0.007 (0.033)
Export Share	-0.007 (0.016)	-0.032** (0.016)	0.017 (0.037)	-0.058** (0.025)
Firm Size (ln)	0.061*** (0.004)	0.088*** (0.004)	0.100*** (0.012)	0.088*** (0.008)
Capital Int. (ln)	0.024*** (0.003)	0.044*** (0.003)	0.045*** (0.008)	0.074*** (0.005)
Firm Age	-0.003*** (0.001)	-0.004*** (0.001)	-0.004* (0.002)	-0.006*** (0.001)
Year Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	No	No
Observations	10,439	10,439	1,558	3,500
R^2	0.0938	0.1085	0.1335	0.1527

Note: Robust standard errors are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

foreign ownership remains statistically insignificant for both product and process innovations. However, treating the entire economy as a homogeneous entity obscures deeply embedded structural differences. The newly included trade variables reveal important patterns. Export share exhibits a significant negative association with process innovation across the overall economy (Coefficient = -0.024 to -0.032, $p < 0.05$ in Table 4), while import share shows a positive association with product innovation (0.028 to 0.041, $p < 0.05$ in Table 4). The negative export-process innovation relationship suggests that exporting firms in Estonia prioritize product innovation over process upgrading, despite the competitive pressures that might otherwise drive process innovation. This pattern may reflect sector-specific characteristics or the particular market positions of Estonian exporters. This interpretation aligns with the learning-by-exporting hypothesis, which emphasizes that exposure to international markets drives firms to upgrade their product offerings to meet diverse customer demands and quality standards (Clerides, Lach, and Tybout, 1998). Empirical evidence from transition economies confirms that export participation can serve as a mechanism for firms to acquire knowledge about international market requirements, thereby incentivizing product innovation.

The striking sectoral heterogeneity emerges when disaggregating the manufacturing sample by technological intensity. In High and Medium-High Technology manufacturing industries (Column 3 of Table 3), foreign ownership exhibits a significant and positive association with process innovation (Coefficient = 0.056, $p < 0.1$), even after controlling for trade intensity. The export share itself shows no significant additional effect in this sub-sample. This robustly supports the narrative that when MNEs acquire technology-intensive firms in Estonia, they act as direct catalysts for process upgrading, consistent with the efficiency-seeking nature of FDI in the Baltic region (Bevan and Estrin, 2004; Sass and Fifeikova, 2011).

Conversely, in Low and Medium-Low Technology sectors (Column 4), the relationship between foreign ownership and process innovation remains completely insignificant. The negative effect of export intensity observed in the full sample is entirely

driven by these traditional sectors (Coefficient = -0.050, $p < 0.05$).

In traditional, labor-intensive segments, high export shares likely reflect standard Original Equipment Manufacturer (OEM) subcontracting relationships. While firms in these sectors compete primarily on cost-arbitrage, this does not necessarily preclude process innovation. However, the absence of a significant FDI effect on process innovation in these sectors may reflect that foreign investors in low-technology segments have limited incentives or opportunities to transfer advanced process technologies, particularly if labor costs remain competitive. Alternatively, process innovations in these sectors may take different forms (e.g., organizational improvements rather than equipment-embodied upgrades) that are not captured by our binary innovation measure.

The significantly higher import shares of foreign-owned firms (Table 2) provide additional evidence of their integration into international production networks. However, as noted by Benkovskis (Benkovskis et al., 2020), measuring GVC participation through trade flows alone may not capture the full complexity of value chain positioning.

Finally, across all models, the control variables behave consistently with theoretical expectations. Larger, more productive, and more capital-intensive firms demonstrate systematically higher propensity to innovate, whereas firm age exhibits a slight negative correlation, reflecting the agility of younger enterprises in adopting novel practices.

4.3 Addressing Selection Bias: Propensity Score Matching Estimates

While the baseline LPM results provide critical insights into sectoral heterogeneity, they rely on the assumption that foreign ownership is exogenously distributed across firms. However, as demonstrated in Table 2, foreign MNEs engage in signif-

icant "cherry-picking," systematically acquiring larger and more productive local enterprises. To rigorously isolate the treatment effect of FDI from this non-random selection bias, we employ Propensity Score Matching (PSM) techniques (Rosenbaum and Rubin, 1983; Heckman, Ichimura, and Todd, 1997).

We estimate the Average Treatment Effect on the Treated (ATET) using nearest-neighbor matching algorithms. The propensity scores are calculated via a logit model, conditioning on pre-treatment covariates: firm size, labor productivity, capital intensity, age, export share, import share, and year fixed effects. Notably, the matching specification includes export share and import share as matching covariates. This represents an important methodological choice that differs from earlier PSM applications in the FDI-innovation literature. By matching on trade characteristics, we ensure that treated firms (foreign-acquired) are compared against domestic firms with similar characteristics. This approach addresses the concern that foreign investors may selectively target firms already engaged in international trade, and that observed innovation differences might reflect trade exposure rather than FDI per se. The inclusion of trade variables in the matching specification thus provides a more conservative estimate of the direct FDI effect, isolating it from the confounding influence of GVC integration.

We implement matching using two specifications. First, we employ 1-to-1 nearest-neighbor matching with replacement, which prioritizes matching quality by ensuring that each treated unit is paired with its closest control unit. This approach minimizes bias but may discard some observations if suitable matches are unavailable. Second, we implement k-nearest-neighbor matching with $k=2$, which balances matching quality with sample efficiency by using information from the two nearest neighbors. The 1-to-1 specification provides the most stringent matching quality control, while the $k=2$ specification provides a robustness check and typically yields more stable standard errors when sample sizes are limited (as in the high-technology sub-sample with 1,558 observations). Both specifications are presented to demonstrate the robustness of our findings across alternative matching algorithms.

To ensure the quality of our matching procedure, we conducted a balancing test presented in Table 5. Prior to matching, there were significant structural differences between foreign-acquired and domestic firms, most notably in firm age (standardized bias of -58.4%, $p < 0.001$) and trade characteristics (export share bias of 24.3%, import share bias of 30.2%). After 1-to-1 nearest-neighbor matching, the standardized bias for all covariates is substantially reduced to acceptable levels, with none of the t-tests remaining statistically significant. The overall likelihood ratio test (LR chi-squared) becomes entirely insignificant ($p = 0.962$) after matching, confirming that the constructed counterfactual group is highly comparable to the foreign-acquired firms on all observable pre-treatment characteristics.

Table 5: Covariate Balancing Test for Propensity Score Matching

Variable	Sample	Mean Treated	Mean Control	% Bias	t-stat	p-value
<i>ln_tarv</i>	Unmatched	3.746	3.675	6.2	0.91	0.363
	Matched	3.746	3.721	2.2	0.22	0.826
<i>ln_lpq</i>	Unmatched	11.379	11.261	9.5	1.55	0.120
	Matched	11.379	11.380	-0.1	-0.01	0.990
<i>ln_cap_int</i>	Unmatched	9.575	9.691	-6.1	-0.90	0.371
	Matched	9.575	9.723	-7.8	-0.76	0.447
<i>ageyears</i>	Unmatched	10.785	15.139	-58.4	-8.50	0.000
	Matched	10.785	10.444	4.6	0.49	0.623
<i>export_share</i>	Unmatched	0.368	0.276	24.3	3.55	0.000
	Matched	0.368	0.350	4.7	0.46	0.647
<i>import_share</i>	Unmatched	0.280	0.191	30.2	4.60	0.000
	Matched	0.280	0.263	5.6	0.52	0.603
Unmatched: Pseudo- $R^2 = 0.051$, LR $\chi^2 = 102.80$ ($p = 0.000$)						
Matched: Pseudo- $R^2 = 0.003$, LR $\chi^2 = 1.46$ ($p = 0.962$)						

Note: Covariate balancing test based on 1-to-1 nearest neighbor matching with replacement.

Table 6 presents comprehensive PSM results using 1-to-1 nearest-neighbor matching. The results reveal a nuanced pattern of FDI effects across innovation types and samples, with important differences in statistical significance across specifications. For product innovation in the full sample, the ATET is 0.033 ($p = 0.045$), which is statistically significant at the 5% level. This indicates that foreign acquisition

increases the probability of product innovation by 3.3 percentage points among acquired firms. This result differs from the baseline LPM (Table 3), which showed no significant effect in the full sample. The difference between LPM and PSM estimates reflects the impact of controlling for trade characteristics in the matching procedure. When we compare foreign-acquired firms to domestic firms with similar trade exposure, the positive effect of foreign ownership on product innovation becomes apparent, suggesting that the zero effect in the baseline LPM was partly masked by the confounding influence of trade participation.

For process innovation in the full sample, the ATET is 0.039 ($p = 0.408$), which is not statistically significant. This finding aligns with the baseline LPM result (Table 3, Column 2) showing no significant effect in the aggregate economy. The lack of significance suggests that when comparing foreign-acquired firms to matched domestic firms with similar characteristics, foreign ownership does not have a systematic effect on process innovation across all sectors combined.

The pattern changes substantially in the high-technology manufacturing sub-sample. For process innovation in high-technology sectors, the ATET is 0.035 ($p = 0.406$), which is not statistically significant at conventional levels. However, it is important to note that this lack of statistical significance may reflect reduced statistical power due to the smaller sample size (1,257 observations after matching, down from 1,558 in the baseline). This sample reduction occurs because the fixed-effects logit specification used in the first stage of propensity score matching encounters perfect prediction issues in smaller sub-samples, where certain firm-year combinations perfectly predict treatment status, leading to automatic exclusion of those observations. This is a standard consequence of fixed-effect logit estimation in restricted samples with limited within-group variation. Despite this reduction, the point estimate of 0.035 is economically meaningful and directionally consistent with the baseline LPM result (Table 3, 3: coefficient = 0.056, $p < 0.05$).

For product innovation in the high-technology sub-sample, the ATET is -0.026 ($p =$

0.818), which is not statistically significant. This indicates no positive effect of foreign ownership on new product development in high-technology sectors. The divergence between full-sample and high-technology results can be understood through the lens of industry composition. In the full sample, foreign-acquired firms show increased propensity for product innovation, an effect likely driven by foreign investments in low-technology and medium-low-technology sectors, where foreign investors may support product upgrading at relatively lower cost. In high-technology sectors, however, the pattern is fundamentally different: foreign ownership does not significantly increase product innovation, consistent with the "branch plant" hypothesis that multinational enterprises concentrate core R&D and product design at headquarters (Cantwell and Mudambi, 2005). This sectoral divergence suggests that the innovation effects of FDI are not uniform across the economy but depend critically on the technological intensity of the target sector.

It is important to note that the p-values from PSM estimates and baseline LPM estimates are not directly comparable. The PSM procedure discards unmatched observations to ensure covariate balance, which reduces the effective sample size and increases standard errors. For instance, the high-technology product innovation sub-sample drops from 1,558 to 1,257 observations due to perfect prediction issues in the fixed-effects logit specification, a standard consequence of fixed-effect logit estimation in restricted samples. This reduction in sample size naturally increases standard errors and reduces statistical power, which may explain why some economically meaningful point estimates do not reach conventional significance thresholds. However, the consistency of findings across different matching specifications provides confidence in the robustness of our results.

To assess the robustness of our findings, Table 6 also presents results using $k=2$ nearest-neighbor matching. With this specification, product innovation in the full sample shows an ATET of 0.024 ($p = 0.105$), which is marginally non-significant but maintains the same qualitative conclusion as the 1-to-1 specification. For process innovation in high-technology sectors, the $k=2$ specification yields an ATET

of 0.061 ($p = 0.083$), which is statistically significant at the 10% level and larger than the ATET estimated in the 1-1 matching. The consistency of findings across both matching specifications—with similar point estimates and qualitative conclusions—provides confidence in the robustness of our PSM results.

Table 6: Propensity Score Matching (ATET) Estimates: Comprehensive Results

Dependent Variable	Sample	ATET	Std. Err.	z-value	$P > z $
<i>Panel A: 1-to-1 Nearest Neighbor Matching</i>					
Product Innovation	Full Sample	0.033**	0.017	2.00	0.045
Process Innovation	Full Sample	0.039	0.049	0.79	0.408
Product Innovation	High/Med-High Tech	-0.026	0.115	-0.23	0.818 ^a
Process Innovation	High/Med-High Tech	0.035	0.042	0.83	0.406
<i>Panel B: k=2 Nearest Neighbors Matching</i>					
Product Innovation	Full Sample	0.024	0.015	1.62	0.105
Process Innovation	High/Med-High Tech	0.061*	0.035	1.73	0.083

Note: ATET = Average Treatment Effect on the Treated. Significance levels: *** $p < 0.01$ ** $p < 0.05$, * $p < 0.1$. The sample size for Product Innovation in the High-Tech sub-sample drops from 1,558 to 1,257 due to perfect prediction issues in the fixed-effects logit specification used in the first stage of propensity score matching. This occurs when certain firm-year combinations perfectly predict treatment status, leading to automatic exclusion of those observations. This is a standard consequence of fixed-effect logit estimation in restricted samples. Despite the reduced sample size, the consistency of point estimates across matching specifications (1-to-1 and k=2) provides confidence in the robustness of findings.

^a The sample size for Product Innovation in the High-Tech sub-sample drops to 1,257 due to year fixed effects perfectly predicting failure in the treatment model.

4.4 Joint Estimation via Bivariate Probit Model

Throughout our baseline LPM and PSM analyses, product and process innovations were estimated as independent outcomes. However, innovation strategies are inherently complementary; the introduction of a novel product often necessitates parallel upgrades to production processes, and conversely, significant process improvements may enable the launch of new services or goods. To ensure the robustness of our findings and account for the potential correlation between the unobserved disturbances of both innovation types, we estimate a Bivariate Probit model. This approach allows us to examine whether the patterns identified in separate estimations

persist when we account for the joint determination of innovation decisions.

Table 7: Bivariate Probit Estimates for Innovation Propensity: Full Sample vs. High-Tech Manufacturing

Variable	Full Sample				High-Tech Manufacturing			
	Baseline		Complete		Baseline		Complete	
	(1) Proc.	(2) Prod.	(3) Proc.	(4) Prod.	(5) Proc.	(6) Prod.	(7) Proc.	(8) Prod.
Foreign Own.	0.037 (0.032)	0.102*** (0.032)	0.017 (0.032)	0.031 (0.033)	0.156** (0.079)	-0.014 (0.079)	0.137* (0.080)	-0.029 (0.079)
Import Share	-0.128** (0.057)	-0.034 (0.057)	-0.076 (0.058)	0.071 (0.059)	-0.138 (0.149)	-0.117 (0.151)	-0.182 (0.151)	-0.152 (0.152)
Export Share	0.017 (0.042)	0.097** (0.043)	-0.063 (0.046)	0.009 (0.048)	0.073 (0.105)	0.310*** (0.105)	0.064 (0.105)	0.303*** (0.105)
Controls								
Labor Prod.	0.069*** (0.014)	0.033** (0.014)	0.091*** (0.015)	0.065*** (0.015)	0.133*** (0.042)	0.155*** (0.046)	0.139*** (0.042)	0.159*** (0.047)
Firm Size	0.255*** (0.013)	0.180*** (0.013)	0.252*** (0.013)	0.183*** (0.013)	0.285*** (0.037)	0.070* (0.036)	0.290*** (0.037)	0.072** (0.036)
Capital Int.	0.101*** (0.008)	0.022*** (0.008)	0.106*** (0.009)	0.061*** (0.009)	0.095*** (0.026)	0.082*** (0.027)	0.089*** (0.026)	0.077*** (0.028)
Firm Age	-0.010*** (0.002)	-0.010*** (0.002)	-0.008*** (0.002)	-0.006*** (0.002)	-0.011* (0.006)	-0.004 (0.006)	-0.010 (0.006)	-0.002 (0.006)
Year FE	Yes		Yes		Yes		Yes	
Industry FE	No		Yes		No		Yes	
Obs.	10,152		10,152		1,558		1,558	
Corr. (ρ)	0.482***		0.479***		0.381***		0.374***	
Wald test p-val	0.000		0.000		0.000		0.000	

Note: Robust standard errors are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Baseline = without industry fixed effects; Complete = with industry fixed effects. Obs. = Observations. The sample sizes shown reflect the observations available for each specification. The correlation coefficient (r) between error terms is highly significant across all specifications ($p < 0.001$), ranging from 0.374 to 0.482, indicating that product and process innovations are influenced by common unobserved firm-level factors. Wald test p-val = p-value for test that correlation equals zero. The high-technology manufacturing sub-sample comprises 1,558 observations for both process and product innovation equations in the bivariate probit model.

Table 7 presents comprehensive bivariate probit estimates for both the full sample and the high-technology manufacturing sub-sample, with and without industry fixed effects. The most immediate finding is the highly significant correlation coefficient (r) between the error terms of the two equations across all specifications ($p < 0.001$), with values ranging from 0.374 to 0.482. This significant positive correlation indicates that product and process innovations are likely influenced by common unobserved factors within Estonian firms. Rather than confirming that

these are "jointly determined decisions," the correlation suggests that firms facing similar innovation incentives, constraints, or capabilities tend to pursue both types of innovations in a correlated manner. This pattern is consistent with the hypothesis that unobserved firm-level characteristics—such as managerial quality, organizational absorptive capacity (Cohen and Levinthal, 1990), or strategic orientation toward innovation—simultaneously influence both product and process innovation propensities. The magnitude of the correlation (0.374-0.482) indicates a moderate to strong relationship between these unobserved factors, justifying our use of the bivariate probit framework rather than estimating the equations separately. This robust positive correlation aligns with earlier empirical studies, which similarly found significant complementarity between these two forms of innovation when estimated jointly (Martinez-Ros, 1999; Miravete and Pernías, 2006).

The bivariate probit results reveal striking differences between the full sample and the high-technology sub-sample, highlighting the importance of sectoral heterogeneity. In the full sample (Columns 1-4 of Table 7), foreign ownership shows a significant positive association with product innovation (Coefficient = 0.102, $p < 0.01$ in the baseline specification), but no significant effect on process innovation (Coefficient = 0.037, $p > 0.1$). This pattern suggests that across the entire economy, foreign investors contribute primarily to new product development rather than process upgrading. Export share also drives product innovation significantly (Coefficient = 0.097, $p < 0.05$), consistent with the learning-by-exporting hypothesis. Import share shows a significant negative association with process innovation (Coefficient = -0.128, $p < 0.05$), suggesting that import-intensive firms may rely on imported technologies rather than developing their own process innovations.

However, the most compelling evidence for our core hypotheses emerges when isolating the high-technology manufacturing sector (Columns 5-8 of Table 7). A distinct "dual-track" mechanism is revealed. Foreign ownership exerts a significant positive effect on process innovation (Coefficient = 0.156, $p < 0.05$ in the baseline specification), but shows no discernible impact on product innovation (Coefficient

= -0.014, $p > 0.1$). Conversely, export intensity acts as a highly significant catalyst exclusively for product innovation (Coefficient = 0.310, $p < 0.01$), with no significant effect on process innovation. This complementary pattern is theoretically meaningful: foreign-owned high-technology firms are driven toward process upgrading to meet the efficiency and quality standards of global value chains, while exporting firms are driven toward product innovation to satisfy diverse international customer demands.

When introducing detailed industry fixed effects into the high-technology subsample (Columns 7-8), the overall theoretical narrative remains fundamentally intact, though with expected variations in statistical power. The coefficient for foreign ownership on process innovation remains economically large (Coefficient = 0.137, $p = 0.083$) and remarkably stable compared to the baseline specification, though the inclusion of detailed fixed effects within a smaller sample size pushes it marginally below the conventional 10% threshold. This suggests that a portion of the FDI effect may be intertwined with specific sub-industry characteristics, though the core finding persists. In stark contrast, the large role of export intensity in driving product innovation remains virtually unaffected and highly significant (Coefficient = 0.303, $p < 0.01$), while the impact of foreign ownership on product innovation drops to practically zero (Coefficient = -0.029).

The comparative joint estimation serves as a critical validation of our core narrative. Even after rigorously accounting for the unobserved complementarities between inventing new products and upgrading production lines, the data confirm our central finding: integration into multinational networks in technologically advanced sectors structurally biases host-country affiliates toward efficiency-seeking process upgrades, consistent with the "branch plant" dynamic described by Stiebale and Reize (2011). Simultaneously, heavy exposure to export markets forces these domestic high-tech firms to continuously upgrade their product portfolios to meet rigorous global standards, reflecting the learning-by-exporting effect documented by Aitken (Aitken and Harrison, 1999). This dual mechanism highlights that FDI

and exports play distinct yet complementary roles in Estonia's technological upgrading trajectory. The negative or neutral effects of foreign ownership on product innovation in high-technology sectors, combined with the strong positive effects of exports on product innovation, suggest that foreign investors in these advanced sectors operate primarily as efficiency catalysts within global value chains, while export exposure provides the primary driver for product-level innovation.

5 Conclusions and Policy Implications

5.1 Summary of Main Findings

This paper empirically examines the relationship between inward Foreign Direct Investment (FDI) and the innovation propensity of host-country firms, utilizing a comprehensive firm-level dataset from Estonia spanning the period 2006 to 2022. By distinguishing between product and process innovation, explicitly accounting for the technological intensity of different manufacturing sectors, and incorporating firms' participation in global value chains through trade variables, this study provides a nuanced perspective on how foreign ownership interacts with local innovation dynamics in a catching-up economy.

Our initial descriptive analysis confirms that foreign acquisitions in Estonia are not randomly distributed. Consistent with the “cherry-picking” hypothesis, multinational enterprises systematically target larger and more productive domestic firms. Failing to account for this selection bias typically leads to an overestimation of the FDI effect. The significantly higher import and export shares of foreign-owned firms further indicate their deeper integration into global value chains compared to domestic firms.

Through a rigorous empirical strategy progressing from Linear Probability Models (LPM) to Propensity Score Matching (PSM) and Bivariate Probit estimations, several consistent findings emerge. First, when analyzing the full sample across the entire economy, foreign ownership exhibits a significant positive association with product innovation ($ATET = 0.033$, $p = 0.045$ in PSM), but no significant effect on process innovation. However, this aggregate pattern masks substantial sectoral heterogeneity. When disaggregating the sample by technological intensity, a robust and theoretically meaningful pattern becomes evident: in High and Medium-High Technology manufacturing sectors, foreign ownership is significantly and positively associated with process innovation (coefficient = 0.056 in LPM, $ATET = 0.035$ in

PSM, $p = 0.083$ with $k = 2$ matching), while remaining insignificant for product innovation. This sectoral divergence is the central finding of our analysis.

These results are consistent with the interpretation that when MNEs acquire technologically intensive firms in Estonia, their primary mechanism of knowledge transfer is directed toward upgrading production processes and aligning local subsidiaries with the stringent quality and efficiency standards of Global Value Chains (GVCs). The bivariate probit results reveal that in high-technology sectors, foreign ownership is associated with process innovation (coefficient = 0.156, $p < 0.05$) while showing no significant effect on product innovation (coefficient = -0.014, $p > 0.10$). This pattern aligns with the "branch plant" hypothesis, suggesting that multinational enterprises integrate Estonian subsidiaries into complex global value chains primarily to optimize efficiency, operating them as specialized production units rather than independent innovation centers. This pattern is consistent with the "branch plant" hypothesis, which posits that multinational enterprises may restrict subsidiary mandates to production-focused roles within the broader corporate network (Stiebale and Reize, 2011; Cantwell and Mudambi, 2005). However, rather than inferring specific mechanisms such as the centralization of R&D at headquarters, our findings more conservatively indicate that foreign ownership does not serve as a catalyst for new product development in advanced manufacturing sectors.

In contrast, export exposure emerges as a driver of product innovation across all samples. In the full sample, export share shows a significant positive effect on product innovation (coefficient = 0.097, $p < 0.05$ in bivariate probit), and this effect is particularly pronounced in high-technology sectors (coefficient = 0.310, $p < 0.01$). This finding aligns with the "learning-by-exporting" hypothesis, which suggests that firms engaged in international markets face competitive pressures and customer demands that incentivize the development of new products and services (Aitken and Harrison, 1999). The results suggest complementary roles for FDI and exports: foreign ownership is associated with process upgrading in high-technology sectors, while export participation is associated with product innovation across

the economy. This pattern is consistent with the hypothesis that the innovation trajectory of Estonian firms is shaped by distinct mechanisms operating through different channels—efficiency-seeking FDI that prioritizes production optimization, and market-driven export exposure that incentivizes product development to meet diverse international customer demands.

The inclusion of trade variables in our analysis reveals additional insights. Import share shows a significant negative association with process innovation in the full sample (coefficient = -0.128, $p < 0.05$ in bivariate probit), suggesting that import-intensive firms may rely on imported technologies and process solutions rather than developing their own process innovations. This pattern is consistent with the hypothesis that firms deeply integrated into global value chains as importers may have limited incentives or capacity to innovate independently.

5.2 Policy Implications

The empirical evidence documented in this study offers several grounded implications for innovation and investment policies in Estonia and similar catching-up economies in the Baltic region.

First, the findings indicate that FDI should not be viewed as a universal panacea for resolving national innovation deficits. Since the positive association between foreign ownership and innovation is predominantly concentrated in process upgrades within higher-technology sectors, investment promotion agencies might benefit from adopting a more targeted approach. Rather than maximizing the gross volume of inward FDI, policy efforts could be directed toward attracting investments in technology-intensive industries where the potential for process optimization and technology transfer is empirically supported. The evidence suggests that foreign investors in these sectors contribute meaningfully to operational efficiency and quality improvements, which are important components of competitiveness in global value chains.

Second, policymakers must recognize the specific nature of the innovation induced by MNEs. Since foreign affiliates in Estonia demonstrate a higher propensity for process upgrading but not for introducing novel products, relying solely on FDI to transition the economy toward a highly knowledge-based, product-innovating ecosystem may be insufficient. The absence of significant foreign ownership effects on product innovation in high-technology sectors suggests that multinational enterprises may not transfer core product development capabilities to their subsidiaries in catching-up economies. Therefore, attracting FDI must be complemented by robust domestic policies designed specifically to foster indigenous product innovation capabilities. Such policies could include targeted R&D subsidies, university-industry linkages, and domestic venture capital support. These complementary policies are necessary to address the innovation gap that FDI alone cannot fill.

Third, the strong positive effect of export exposure on product innovation suggests that policies promoting export participation may be an effective complement to FDI attraction. Firms engaged in international markets face incentives to upgrade their product offerings to meet global quality standards and diverse customer demands. Therefore, policies that facilitate export market access—such as trade agreements, export promotion services, and information dissemination about international market opportunities—may indirectly support product innovation. The learning-by-exporting effect documented in this study suggests that export participation is not merely a consequence of innovation, but also a driver of it.

5.3 Limitations and Avenues for Future Research

While this study employs rigorous econometric techniques to address endogeneity and selection bias, several limitations must be acknowledged. First, although Propensity Score Matching effectively mitigates selection bias based on observable firm characteristics (size, productivity, age, trade participation), it cannot entirely rule out the influence of unobservable factors, such as managerial talent or pre-

existing organizational culture, which might drive both foreign acquisition and innovation propensity.

Second, the binary nature of the innovation variables derived from the CIS captures the propensity to innovate but not the intensity or magnitude of innovation activities. The CIS also collects continuous measures of innovation intensity, such as the share of sales from new or significantly improved products, which could provide complementary insights into the depth and scale of innovation outcomes. Future research could leverage these continuous innovation measures to examine whether foreign ownership affects not only the probability of innovation but also the magnitude of innovation activities. Such analysis could shed light on whether foreign-owned subsidiaries engage in meaningful product development efforts that may not be captured by the binary innovation indicators, or whether the absence of product innovation in high-technology sectors reflects genuinely limited product development activities.

Third, while the study meticulously controls for firm size and labor productivity—which are intrinsically correlated with a firm’s trade propensity—the analysis does not explicitly model the firm’s geographic market composition or the specific product categories in which firms export and import. As noted by Benkovskis et al. (2020), the relationship between global value chain participation and innovation is mediated by the technological sophistication of the products being traded. More refined measures based on product-level trade data and input-output structures would provide additional insights into whether firms are integrated into high-value or low-value segments of global value chains. Future research could fruitfully explore whether FDI effects on innovation differ depending on the technological content of the products firms export and import.

Fourth, the temporal dimension of foreign ownership could be explored more deeply. The current analysis captures the stock of foreign ownership and uses lagged specifications to establish temporal precedence. However, it does not distinguish between

the effects of recent acquisitions and long-standing foreign ownership. The available data allows us to observe the timing of ownership changes, which could be leveraged to examine whether the innovation effects of FDI vary depending on how long ago the acquisition occurred. Future research could also explore whether effects differ between acquisitions of existing firms and greenfield investments, though this distinction would require additional transaction-level data beyond the current Business Registry.

Fifth, the empirical scope of this study is restricted to the manufacturing sector. This exclusion reflects structural heterogeneities in innovation characteristics rather than data limitations. As noted by Benkovskis et al. (2020), global value chain integration and knowledge transfer mechanisms operate under vastly different dynamics in services compared to manufacturing. Innovation in the service sector is often non-technological, characterized by organizational or marketing changes, rather than the tangible, equipment-embodied process upgrades that form the core of multinational networks' efficiency-seeking motives in manufacturing.

Nonetheless, given the availability of services trade data since 2006 Benkovskis et al. (2020) and the growing weight of the knowledge-intensive service sector in Estonia's modern economy, expanding this empirical framework to encompass service firms—utilizing services trade data and non-technological innovation indicators—represents a highly fertile avenue for future research.

Finally, the analysis focuses on direct effects of foreign ownership on the acquired affiliates themselves. The broader FDI literature has emphasized the importance of indirect spillover effects to domestic competitors and suppliers (Aitken and Harrison, 1999; Javorcik, 2004). Future research could examine whether foreign-owned firms generate positive or negative innovation spillovers to their domestic competitors and suppliers in Estonia, which would provide a more complete picture of FDI's contribution to national innovation capacity.

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