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Book

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JOINING AND EXITING THE VALUE CHAIN OF MULTINATIONALS AND THE PERFORMANCE OF SUPPLIERS: EVIDENCE FROM INTER-FIRM TRANSACTION DATA

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Joining and exiting the value chain of multinationals and the performance of suppliers: evidence from inter-firm transaction data

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Abstract

This paper investigates the productivity effects for domestic suppliers from joining and exiting the value chains of multinational enterprises (MNEs). The vast majority of prior literature has relied on sector-level input-output tables in estimating the effects of vertical linkages of FDI. Instead, our econometric analysis of the creation and destruction of backward linkages of MNEs is based on information on firm-to-firm transactions recorded in the valued added tax declarations data. Treatment analysis based on propensity score matching and panel data from Estonia suggests that starting to supply multinationals initially boosts the value added per employee of domestic firms, including effects on the scale of production and the capital-labour ratio. These first linkages to MNEs do not affect the total factor productivity (TFP) of domestic firms, suggesting that TFP effects take time to materialise. We further find that there are limits to the wider diffusion of the effects of linkages to MNEs. We find no significant positive effects on the second-tier suppliers: the positive effects are limited to the first-tier suppliers with direct links to MNEs. One novel result is the evidence that the productivity of suppliers does not fall, on average, after decreasing or ending supplier relationships with MNE customers.

Keywords: FDI, supplier upgrading, global value chains, vertical spillovers, backward linkages

JEL Classification codes: F14, F23, F61

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1. INTRODUCTION

There have been many studies since Caves (1974) on whether the activities of multinational enterprises (MNEs) are associated with improved performance in local domestic owned firms and how. It is well known that there is mixed evidence about the horizontal effects (incl. spillovers) of MNEs on domestic owned firms within the same sector. The empirical evidence often suggests that the 'spillover' effects are more likely to take place through backward linkages to suppliers of MNEs (Javorcik 2004, Javorcik et al. 2018; for literature reviews on spillovers see Bhaumik et al. 2018, Demena and Bergeijk 2017, Rojec and Knell 2018, Havránek and Iršová 2011). Yet, the estimates of backward linkage effects to suppliers of MNEs are not fully conclusive, with results that range from strong positive to insignificant and in some limited cases even negative estimates, depending on the methods applied and the country and context of the study (e.g. Havránek and Iršová 2011, Rojec and Knell 2018).

Typically, these studies are strongly limited due to the fact that they do not observe the creation or termination of actual vertical linkages between firms in the supply chain and instead are forced to proxy the vertical linkages by using the input-output coefficients from sector-level input-output (I-O) tables (see Javorcik 2004, Javorcik et al. 2018, among others), most often even at the rather aggregated 2-digit sector level. This has severely limited both the accuracy of the measurement of firm-level MNE linkages and deeper analysis of the mechanisms for how these effects work (see recent discussion in Keller 2021). Recent evidence using firm-to-firm transaction-level data from Costa Rica (Alfaro-Ureña et al. 2020) shows that sector-level aggregate information on backward linkages from MNEs to local firms predicts less than one per cent of the actual firm-level linkages of foreign-owned firms and their local suppliers. This finding renders the standard input-output tables-based indicators the most imperfect proxies for MNE linkages. It also calls for a substantial re-assessment of the vertical 'spillover' effects literature, instead of input-output tables to be based on the use of firm-to-firm transactions data.

Our paper contributes to the literature on the effects of multinational firms and global value chains (see also recent literature review by Antràs and Chor 2021) by being one of the early papers to study the effects of formation and, to the best of our knowledge, a first to study the effects of the termination of firm-to-firm transaction linkages with MNEs on the productivity of their local supplier firms. A recent study directly related to ours is by Alfaro-Ureña et al. (2020). It makes use of an event study approach, which is a rare exception that applies firm-to-firm transaction data (from Costa Rica) and additionally survey data. They find that becoming a first-time supplier for multinationals has strong positive effects, including effects on employment and productivity in domestic firms (e.g., due to better reputation and improved managerial practices). Another directly related paper is by Carballo et al. (2021) based on data from Uruguay, using VAT declaration data to determine linkages between firms. It shows that selling inputs to an MNE is associated with a higher probability that a domestic firm starts to export and to export especially to the home country of the MNE or to the countries of other affiliates of the same MNE.

In this paper, we go beyond the study of supply chain linkages in general or 'first-tier' linkages between the domestic supplier and its multinational customer. We also explore the effects of exiting MNE networks (ending the supplier relationship) as well as the wider effect of the presence of the multinational firms in the network of companies and the limits of their beneficial effects in their local supply chain. This latter effect involves indirect FDI linkage effects on the productivity of second-tier suppliers. These are local firms supplying their goods and services to these local companies that directly supply the multinational firm(s) located in the host

country (Estonia in this case). The second-tier linkages to MNEs are most frequent in our data. It is of significant interest to observe the extent to which they function or not as significant channels of the effects of FDI. However, the more substantial novelty compared to prior literature is in studying the effects of ending the supplier relationship with MNEs based on firm-to-firm transaction data. Some relevant literature has focused on the effects of divestment; that is, if the foreign owned firm is taken over by local owners (Javorcik and Poelhekke 2017), but there appears to be a dearth of related econometric and representative analysis on how ending the backward linkages affects the local firms. Building on the analogy with the expected effects of divestments on former foreign-owned affiliates (Javorcik and Poelhekke 2017), one could similarly, in the case of ending backward linkages in the supply chain, expect a drop in labour and total factor productivity in the former supplier of MNEs. This would be the case if the backward linkage to an MNE entails not only a one-time transfer of knowledge, but rather a continuous flow of knowledge from the focal MNE to its suppliers. So far, little is known about the timing of the spillover/backward linkage benefits of FDI and how persistent these are. Further, the standard input-output table-based analysis of backward linkages would not enable an investigation of this issue in detail.

In addition to the direct supplier linkage effects, indirect learning mechanisms through second-tier supplier effects could also be potentially important, even though the majority of the firm-level benefit due to supplier linkages is expected to take place due to the immediate trading relationships between the local supplier and the multinational buyer. Differences in the ranking of the effects are expected because some particular mechanisms that may drive local first-tier suppliers to learn from multinationals – like multinationals sharing blueprints of products, visits of the supplier to the multinational to learn about the use of production input or the requirements by the multinational from the supplier to conduct audits and upgrade the quality of production (Alfaro-Ureña et al. 2020, Alcacer and Oxley 2013, Javorcik et al. 2008, Iacovone et al. 2015) – are not expected to be as important in the case of the second-tier suppliers. In addition, there are likely substantial differences in bargaining power and value-added content of production in the case of first and second-tier suppliers, which may also matter for the extent of learning and upgrading effects.

Our analysis of the effects of supplying goods or services to MNEs is to an extent also related to the literature on the indirect internationalisation of firms (Johanson and Vahlne 1977, 2009; Dhyne et al. 2021; Bai et al. 2017) and learning-by-exporting (Atkin et al. 2017; Clerides et al. 1998; Blalock and Gertler 2004; van Biesebroeck 2005; De Loecker 2007). Exporting or supplying local multinationals have similarities in their expected effects both due to the scale effect/demand effect, as well as due to learning from superior knowledge from abroad. There are some reasons why the effects could potentially be even larger in the case of supplying local foreign multinationals compared to exporting. For example, the links with sources of superior knowledge are likely to be stronger and more persistent in the case of joining the value chain of MNEs and due to the geographic proximity of the supplier and the source of learning – the foreign-owned affiliate in the host economy (e.g. Alfaro-Ureña 2020). However, past empirical studies on different modes of exporting (Bai et al. 2017) rather suggest that direct exporting can be associated with higher performance benefits than indirect exporting (e.g. through intermediates such as MNEs).

Our analysis is based on matched data of firm-level performance indicators (from the business registry of Estonia) with administrative data on firm-to-firm client-supplier linkages based on a VAT declarations dataset from Estonia's Tax and Customs Office (VAT declaration data is from 2015–2019, business registry data also covers the years from 1995 to 2019). The VAT declarations cover the universe of firms registered in Estonia, both foreign-owned and domestic

owned firms, for transactions larger than the threshold of 1,000 euros (more details are provided in the section on data). Our analysis covers firms in the manufacturing sector.

There is only a limited number of studies using similar detailed data of supplier networks in addition to the already mentioned Alfaro-Ureña et al. (2020) and Carballo et al. (2021) studies. Examples include Dhyne et al. (2021) using data from Belgium to analyse the characteristics and positions of firms in the buyer-supplier networks. Demir et al. (2021) using VAT declaration data from Turkey document the matching of firms in buyer-supplier networks, where skill-intensive buyers tend to buy inputs from similarly skill-intensive suppliers. Bernard et al. (2019) apply detailed data on supplier-buyer networks to show the effects of the extension of high-speed train links in Japan on the number of supply chain links of firms, thereby underlining the importance of personal meetings in these relationships. Finally, Jäkel (2021) investigates how export credit guarantees have direct and spillover effects in supply chains using transaction-level data from Denmark.

Our descriptive evidence and treatment analysis with propensity score matching (PSM) suggest that starting for the first time to supply multinationals substantially boosts labour productivity but not necessarily the total factor productivity (TFP) of the supplying domestic firms in the early stages. There are also clear limits to the diffusion of the effects. The addition of subsequent linkages to MNEs adds to productivity growth, but these additional effects on TFP are of comparable size to supplier linkages to exporters or domestic owned firms. Based on data from firms in the manufacturing sector, we further find no significant positive effects on the second-tier suppliers, with the strong positive effects limited to first-tier suppliers with direct links to MNEs. Surprisingly, completely ending or decreasing supplier linkages to MNE customers does not lead to a fall in TFP.

2. PRIOR LITERATURE ON BACKWARD LINKAGES FROM MNEs

While there have been rather mixed results on the horizontal effects of MNEs on domestic owned firms within the same sector (e.g. Aitken and Harrison 1999), there is more evidence suggesting likely backward linkage effects from multinationals on firms supplying MNEs (Javorcik 2004, Javorcik et al. 2018; for literature reviews on spillovers, see Bhaumik et al. 2018, Demena and Bergeijk 2017; Rojec and Knell 2018, Havránek and Iršová 2011, Keller 2021). While there are abundant studies investigating vertical linkages from MNEs, these have not focused on the effects of ending the supplier relationship to MNEs, and pay little attention to the issue of timing or the persistence of the linkage effects.

The theoretical reasoning of these expected positive effects of MNEs on domestic firms in the host economy of the investment, both for horizontal and vertical linkage effects, traditionally starts from the eclectic paradigm of Dunning: that MNEs must have some form of ownership advantage (firm-specific advantage) to cover its 'liability of foreignness' abroad (Dunning 1981). These ownership advantages come in the form of intangibles such as superior technology (Caves 1996) and management practices and market knowledge, and this knowledge may spill over to local firms in the host economy through spillover effects (Blomström and Kokko 1998, Caves 1996, Görg and Greenaway 2004, Görg and Strobl 2001). The knowledge spillover effect can work through mechanisms, such as the movement of employees and managers between firms (Fosfuri et al. 2001, Glass and Saggi 2002), agglomeration economies due to demonstration or reverse engineering type effects that, even if limited at first, can lead to further

learning-by-doing effects in the domestic firms (Bhaumik et al. 2018, Blomström and Kokko 1998, Görg and Greenaway 2004). The backward linkage effects on local suppliers may, for example, occur when MNEs give them assistance on technical and managerial issues.[2]

Some earlier evidence using data from Estonia, the country of our study, suggests significant spillovers of FDI. Vahter (2011) uses firm level data from 1990s and 2000s and finds positive association between FDI share in a sector in Estonia and firms' innovation indicators (i.e. horizontal spillovers). Masso and Vahter (2019) find based on employer-employee level data that hiring employees with experience from foreign-owned firms is associated with an increase in the total factor productivity, higher export propensity and breadth of export markets and products of domestic owned firms in Estonia.

The difference between the mixed findings in the literature on horizontal effects for domestic competitors of MNEs and more optimistic estimates about the backward linkage effects of MNEs has been traditionally argued to be due to the lack of negative competition/crowding out effects in the case of supply chain effects (e.g. Javorcik 2004, Bhaumik et al. 2018). The negative effects of tougher competition due to the entry of MNEs may balance positive knowledge externalities in the case of horizontal effects within the same sector (Aitken and Harrison 1999). Furthermore, MNEs have a strong incentive to try to limit knowledge transfer to their competitors but can have incentives to help develop their suppliers' capabilities in order to gain from improved quality or lower input costs (Javorcik 2004, Blalock and Gertler 2008).

The most cited paper on the vertical spillover effects of FDI with analysis of vertical effects on suppliers and buyers that became a standard in the literature (see Rojec and Knell 2018) is by Javorcik (2004). She uses a Lithuanian firm-level panel dataset and applies aggregate 2-digit sector based I-O tables to proxy the variables on spillover effects on the suppliers (backward spillovers) and clients (forward spillovers) of MNEs. She finds significant effects of FDI specifically on the TFP of firms in supplying sectors. Similar significant effects have been found from MNE presence on the economic complexity level of the products of firms in supplying sectors, again with supplier links defined based on I-O tables (Javorcik et al. 2018).

However, one needs to be cautious in interpreting these I-O table-based results because the aggregate sector-level I-O tables may not reflect the input-output relationships for the majority share of firms in these sectors (Keller 2021). The recent study by Alfaro-Ureña et al. (2020) shows that the variables on aggregate sector-level backward linkages predict only an infinitesimal share of the actual buyer-supplier linkages with MNEs. Furthermore, Keller and Yeaple (2009) have shown earlier that spillover estimates in the same sector are greatly affected by measurement, varying greatly depending on whether one investigates only the 'spillover' effects of firms in their one 'main activity' sector in the econometric analysis (as has been a common standard in the literature) or allows firms to have effects in their other main business line sectors as well.[3]

[2] We note that the pure externality effects of FDI are often bundled together in econometric analyses with other effects. Often authors find it difficult to distinguish the pure spillover/knowledge externality effect (by definition a positive effect) from other effects, such as changes in competition due to the entry of MNEs or from the effects that work through market-based transactions (licensing of technology, training and technology sharing contracts), which may matter a lot in the host economy but do not fit well under the term 'externalities'.

[3] Our focus in this paper on data on firm-to-firm linkages enables us to cover also the vertical linkages of the firm in the case of business lines other than the main line. Estonia's Business Registry includes firm level data on turnover by industry codes (for each firm for up to 28 different 4-digit NACE industry codes) for 2011–2019. We observe that on average firms with positive sales, 74% report sales just in one industry, 16% in two industries, 5.6% in 3 industries. On average firms with positive sales have sales in 1.43 industries. The average share of the

Some earlier papers, such as Javorcik and Spatareanu (2009), Godart and Görg (2013) as well as Gorodnichenko et al. (2014) have used firm-level survey data to measure the presence of supply chain linkages with MNEs, using these as indicators of vertical spillovers of FDI. Their approach, however, is not based on transaction-level data, linking each MNE and domestic firm, and has not investigated the effect of the termination of linkages.

Two notable exceptions to the dominant I-O table-based analysis of vertical linkages from MNEs in their host economy are by Alfaro-Ureña et al. (2020) and Carballo et al. (2021). Alfaro-Ureña et al. (2020) apply inter-firm transaction-based data from the VAT database from Costa Rica and show based on an event study methodology that the local firms benefit in terms of performance from backward linkages from MNEs active in Costa Rica. They find that domestic firms have 26% higher employment and 4–9% higher TFP four years after supplying their first MNE client. There is also significant sales growth, which largely is due to the firm's selection into supplying larger buyers and into more stable buyer-supplier relationships.[4] Another related paper by Carballo et al. (2021) uses VAT declaration data to determine linkages between firms in Uruguay. It finds that selling a firm's goods to MNEs is associated with a higher probability that this domestic supplier starts to export itself.

We complement these analyses in our paper in particular by analysing the exit of domestic firms from supply linkages with MNE(s). In addition, we distinguish between entry into supplier relationship and the effects specifically on productivity in the case of 'second-tier' suppliers of MNEs. The second-tier suppliers are local firms supplying their goods and services to other local firms (first-tier suppliers) that directly sell goods or services to the multinational firm(s). Indirect effects on second-tier suppliers further in the supply chain could be potentially important, even though most of the benefit due to the supplier linkages is expected to occur due to the immediate trading relationships between the local supplier and the multinational buyer (see e.g. theoretical model in Pack and Saggi 2001). Differences in the ranking of the effects are expected because some particular mechanisms that may drive local first-tier suppliers to learn from multinationals – like multinationals sharing blueprints of products, having more face-to-face interactions including continuous collaboration and, for example, regular visits of the supplier to the multinational to learn about the use of the production input and to improve the standards at the supplying firm (Alfaro-Ureña et al. 2020, Alcacer and Oxley 2013, Javorcik et al. 2008, Iacovone et al. 2015) – are not expected to be as significant in the case of the second-tier suppliers.

Further, the bargaining power of firms within the value chains of MNEs and their location in production networks (Gereffi 1999, Dedrick et al. 2010, Mudambi 2008, Rungi and Del Prete 2018) can affect the upgrading potential in MNE networks. The bargaining power among suppliers of MNEs is likely to be lower for the 2nd or 3rd tier suppliers compared to the first-tier ones. For example, Pavlinek and Ženka (2011, p. 564) point out, based on their study in Czechia, that: "*Compared to the position of assemblers, global suppliers and Tier 1 suppliers in automotive production networks, the position of particularly small Tier 2 and Tier 3 local suppliers is generally weak, unless they possess unique technologies or highly specialized*

most important industry in sales is 94.7%. Multiple industries are more important among large firms: there firms with one industry account just for 42% of sales and 60% of employees. Therefore, accounting for multiple main lines of business matters in the case of large firms.

[4] Alfaro-Ureña et al. (2020) focus on information from 24,370 domestic firms in Costa Rica that have median yearly revenues over their studied period of at least 50,000 USD. Our analysis in the case of Estonian data is based on a full population of firms, covering the full population both in the case of foreign and domestic owned firms.

capabilities. This increasing power polarization in automotive industry production networks negatively influences the upgrading potential for small domestic SME suppliers,…"

The distribution of the value added throughout the value chain is traditionally represented by the standard 'smiling curve' (Everatt et al. 1999) or the 'smile of value creation' (Mudambi 2008). Due to the complementarities between the intangibles of the supplier and buyer and the higher own absorptive capacity (Cohen and Levinthal 1989), the learning potential from links to the MNE network may be larger at firms supplying the MNEs with the various inputs and services that are located towards the left and right-hand end of the smile curve (such as R&D intensive inputs, design, marketing, after sales services, etc.) compared to more mundane assembly type activities or less knowledge intensive and more standardised inputs. The suppliers located in the left and right-hand tails of the smile curve have stronger bargaining power and appropriate the key part of the value added created among the suppliers of lead firms in the global value chain (e.g. Jacobides et al. 2006, Dedrick et al. 2010, Miroudut and Cadestin 2017). The second-tier suppliers, compared to first-tier, are on average more likely to supply more generic inputs (incl. base materials and labour-intensive inputs); therefore, with lower learning potential, as well as tougher competition suppressing their profits and more danger of replacement by competitors in the MNE's value chain.

Despite these considerations, there may still be potential spillover effects in the form of knowledge transfer for second-tier suppliers of MNEs. Importantly, the fixed investments needed for entering a 2nd-tier supplier relationship (e.g. required sunk investments in upgrading productivity to be accepted as a supplier in the MNE value chain), compared to first-tier suppliers, are likely to be significantly lower. This means that firms with lower initial productivity compared to first-tier suppliers can become second-tier suppliers. Even if the overall within-firm productivity effect of this tier 2 link to MNEs is much smaller than the linkage effect for tier 1 firms, then given the much larger number of tier 2 firms, their total aggregate effect could potentially be highly important for the host economy.

3. DATA

The most important dataset for our analysis is based on the Estonian Tax and Customs Office value added tax declarations (KMD); in particular, the appendix of the latter (KMD INF) recording transactions between firms. Part A of KMD INF includes information about the invoices issued and part B, information about the invoices received in transactions with legal entities, registered self-employed and government entities (excluding transactions with private individuals) that are subject to value added tax. The tax declarations are submitted on a monthly basis, but the data that we use has been aggregated to annual frequency for the analysis, as firm performance indicators are available on an annual basis. Our transaction-based data covers the years 2015–2019 and enables the treatment analysis of the effects of firm-to-firm transaction linkage formations on firm economic performance.

The KMD INF has to be submitted if a single invoice or the sum of invoices in the taxation period (month) without the value added tax per one transaction partner is at least 1,000 euros (for further details, see Maksu- ja Tolliamet 2021). As the reporting is subject to such a low threshold, the coverage of declarations is nearly universally representative with respect to all of the relevant firm-to-firm transactions in the economy. We have calculated the ratio of the sum of the total number of transactions from the value added tax declarations data to the total amount of turnover (sales) for the Estonian market; the latter is calculated as a ratio of the total turnover

from the business registry minus exports of services and goods. The ratio in the studied company groups is close to 1.

The firm-level financial data that we use is from the Estonian Business Registry, including annual financial statements (profit and loss statements, balance sheets, cash flow statements) for the population of firms from 1995 to 2019, thereby also allowing us to observe demographic indicators, such as entry and exit. Therefore, for the purposes of linkage formation, we are able to distinguish, for example, when the local firm starts to supply an MNE, and also whether the latter is a new firm in the Estonian market or had established itself there already previously before the formation of the particular transaction linkage.

From the Estonian Business Registry data, we have calculated the indicators of the key firm-level outcome variable in our study – productivity. Labour productivity has been measured either as value added per employee (value added being hereby measured as the difference between the firm's turnover and intermediate inputs) or turnover per employee (the latter variable is considered because value added cannot be calculated as a subset for approximately 25% of the companies). Total factor productivity (TFP) has been initially estimated based on the Levinsohn-Petrin method (Levinsohn and Petrin 2003) that accounts for the endogeneity of production inputs and is currently one standard approach in the literature for TFP estimation. Second, we estimate TFP using the system-GMM (generalised method of moments) approach. Both are by now standard approaches in the analysis of TFP. The estimation of TFP is in both cases based on estimating the production function separately by each 2-digit NACE rev. 2 industry classification sector (i.e. allowing the parameters of the production function to differ across the industries).

A key variable in our study is the dummy for foreign ownership of the firm. This variable is then used to identify linkages between local foreign-owned firms with local domestic owned suppliers. The ownership variable is taken from the Estonian Business Registry data. In order to fill gaps in the ownership data series, we have also used data on company ownership status with information from another dataset, the Statistical Profile of Enterprises. Through the study, we consider the firm as foreign-owned if it is majority foreign-owned, given that there are very few firms with the foreign ownership share in the range of 0 to 50%.

The Estonian Tax and Customs Office value added tax declarations data includes the transactions with other firms within Estonia. In order to further consider the exporting status of firms, we use the detailed firm-country-product level export data from Statistics Estonia (based on customs declarations) and the detailed services exports data from Eesti Pank (central bank of Estonia). The latter may be important, as multinational companies are typically exporting companies and there might also be knowledge spillovers from exporters, especially given past evidence on learning-by-exporting (Benkovskis et al. 2020 show this for Estonia and Latvia), where its effects might also spread to the non-exporters supplying the exporters.

4. METHODOLOGY

We use propensity score matching to analyse the effects of the formation and termination of supplier ties. The treatment in that case is the formation or termination of a sales tie between the domestic seller and its foreign-owned (multinational) customer in Estonia. This means that we focus on binary treatment analyses. In the case of establishing a supplying linkage as a

treatment, the pool of control units is based on the local firms that never supply a multinational in the studied period (2015–2019) (similar to the approach by Alfaro-Ureña et al. 2020). In the case of the termination of a supply linkage as a treatment, the pool of control units is based on firms that were continuously supplying a multinational or multinationals throughout the studied period.

The purpose of the propensity score matching will be to construct a 'statistical twin' for the treated firm. This means constructing a control group that is as similar as possible in terms of its relevant pre-treatment (observed) characteristics to the treatment group. The propensity score in PSM is calculated by estimating the probit model for the probability of i) the propensity of tie formation or ii) the propensity of tie termination. The probit model is used to summarise the information from various factors affecting the domestic owned firm to start to supply an MNE or terminate the supplier relationship with an MNE(s). The list of control variables in PSM include in both cases relatively standard firm-level pre-treatment proxies and determinants of firm performance. These are log of labour productivity (value added per employee), firm size measure (log of number of employees), firm size squared, firm age, firm age squared, the interaction term of firm age and firm size, regional dummy for Northern Estonia (the capital Tallinn and the surrounding Harjumaa county), as well as industry dummies at 2-digit NACE level. All the firm-level explanatory variables are measured at year *t-1* before the establishment of the transaction linkage at year *t* (or before the termination of the particular transaction linkage). The effect is then measured on firm performance indicators (productivity) as well as employment, sales and capital-labour ratio at time *t*, *t+1* as well as *t+2.*

Our baseline matching algorithm is the nearest neighbour matching with two neighbours. After estimating the propensity score, as the measure of the average treatment effect on the treated (hereinafter ATT) has been calculated, using the following formula:

$$ATT_{PSM} = \overline{\Delta\ \pi_{t+s}^{treated}} - \overline{\Delta\ \pi_{t+s}^{control}},$$

The first term in the right-hand side of the ATT equation is the average growth of the outcome variable (denoted as π), labour productivity or total factor productivity. The second term is at the same time the weighted average of the growth of the outcome variable (productivity) for the counterfactuals (other domestic firms with similar pre-treatment *t-1* characteristics but without the created transaction tie during the period 2015–2019). The symbol *s* denotes the period over which the growth of the outcome variable has been calculated; for example, for $s = 1$, $\Delta\pi_{t+1} = \pi_{t+1} - \pi_t$.

We consider various binary treatment indicators. We study establishing a sizeable supplier linkage with an MNE for the first time as one treatment (with sales to it in the first year of the linkage accounting for at least 20% of the total sales of the supplying domestic firm). Next, we investigate the establishing of any new supply linkages with MNEs; that is, we include here in the treatment group those firms that were trading with an MNE already before. We would expect significant effects especially in the case of sizeable linkages and stronger effects in the case of first linkages to MNEs. As a next step, we perform a similar treatment analysis in the case of the creation of second-tier supplying linkage to MNEs. Here the treatment variable is a dummy variable for the creation of a first-time second-tier supply link with MNEs and or a dummy indicating the creation of any second-tier supply link to MNEs (i.e. potentially the firm could have already other existing second-tier links to MNEs). Finally, we perform propensity score matching analysis, where the treatment is the termination of supply linkages to MNEs. In

this case, the pool of control firms consists of those that had supplier relationships with MNEs throughout the studied period 2015–2019.

Naturally, for these treatment indicators, even if a positive estimated effect of a tie creation is detected and in addition to other potential econometric concerns, one may question whether the effect of the creation of the tie on the supplier's performance is specifically due to the transaction partner being a multinational company or some other factors. Some other characteristics of the partner company may affect the results, such as their level of productivity, technology, firm size, and other measurers of internationalisation, such as exporting. Therefore, to consider that, we look at some alternative treatments for comparison. In particular, we consider similar treatment variables in all cases with multinational status being replaced with exporting status. Second, we consider whether supplying to additional domestic customers has similar effects as supplying to MNEs or exporters.

5. DESCRIPTIVE EVIDENCE

Table A1 in Annex 1 presents the values of some key descriptive statistics for the domestic firms in our study. As we can see, these firms are generally fairly small and young (mean age 2 years), as the dataset covers the population of firms in manufacturing. We observe, as expected, that foreign-owned firms exhibit significantly higher labour productivity and TFP than domestic owned firms (the mean of the log of TFP for manufacturing firms is 9.919 in the case of foreign-owned firms and 9.211 in the case of domestic owned firms). The links between domestic and foreign-owned firms are substantial. While domestic owned firms (in manufacturing) have on average 11.9 domestic customers, the corresponding number of foreign-owned customers of these same firms is 1.4 over the period 2015–2019. The share of domestic firms that report having additional foreign-owned customer(s) after a year is 18.6 per cent. On average, in a year 6.3 per cent of domestic firms establish a supply link with their very first MNE customer.

The second-tier linkages are an important indirect connection between local firms and MNEs (see Tables A1 and A2 in Annex 1). Even in the absence of the first-tier linkages, very many firms supply domestic companies that are then supplying multinational companies. Forty-three per cent of domestic firms have new second-tier supply relationship(s) in a given year with foreign-owned firms. The number of second-tier foreign-owned customer links is on average 119.5. However, we note that the wide extent of such linkages affects also their expected effects. We would expect a strong effect if there is a large scale second-tier relationship linking a local firm to an MNE (e.g. in the following analysis we use 20% of sales as a threshold for this), and not necessarily if there is just one second-tier link added. Furthermore, the wide extent of the second-tier links suggests that completely dropping all second-tier relationships with MNEs is rare. Such dropping of second-tier links rather predicts imminent firm exit rather than the intention to replace links to MNEs with links to domestic firms.

Table A2 in Annex 1 provides a further look into the firm-to-firm transaction data. For the purposes of this analysis, the data has been aggregated to the level of the firm-pair (firms trading with each other) and the year. As expected, the number of transaction partners (firms) varies a lot with the firm size (Table A2 in Annex 1) – firms with less than 10 employees have on average 8.1 customers, whereas firms with more than 250 employees have 180 customers.

Concerning supply chain linkages, the average domestic company in the manufacturing sector supplies to 1.2 foreign-owned firms. Most of the customers are located in different 2-digit NACE industries to that of the supplying domestic company, respectively 1.1 in another 2-digit industry and 0.1 in the same industry. The sales to MNEs among domestic firms comprise a much higher share (ca 10%) than one might infer from the number of MNE-local supplier links (on average domestically owned firms have 1.2 MNE customers, see Table A2).

We further observe from our dataset that the share of sales to MNEs (with a mean value of 17%) is fairly evenly spread from zero to one with a rather high standard deviation. We observe that the distributions spike at around 10% and 100%, meaning that there is also a non-negligible share of local firms that trade only with the MNEs.

The descriptive regression analysis below (see Table 1) indicates the key factors that encourage companies to trade with one another, once other covariates are accounted for. We look (as in Martyanova 2019) at two different aspects of such relationships – tie persistence (probability that the tie present at time t is there also at time t+1), and tie creation (that a tie not exiting at time t is created at time t+1). For the latter, as there is a large number of potential cooperation partners, we have created a random set among potential ties, and looked at which of these potential ties were actually formed in the next period. In addition, we also look at how the characteristics of the partnering company, like size and productivity, affect the value of their annual transactions.

The regression results in Table 1 show that either side of the transaction being a foreign firm (i denoting the supplier and j the buyer) positively affects the probability of a transaction linkage on a pair of firms. Yet if both sides are foreign-owned companies, that significantly reduces the presence of such linkage; that is, we see no tendency that foreign-owned companies trade particularly with one another. The importance of the other key variable, productivity, is more complicated. We can observe that the two trading companies being more different in terms of productivity is associated with their propensity to trade with one another; that could also indicate potential for productivity spillovers. If the average productivity of the actual transaction partners is higher, that contributes positively to the tie formation, but negatively to tie persistence.

Higher labour productivity is associated in the case of both supplier and buyer with higher tie formation and lower tie persistence, indicating this being consistent with the narrative that the higher productivity companies also experiment more with suppliers (i.e. look for new suppliers but are also ready to change existing suppliers for new ones). The same story seems to hold when the average labour productivity of the exiting transaction partners (customers or suppliers) is higher – such companies are more likely to form new ties, but also to finish existing transaction ties. The interaction term between the productivity of the company and the average productivity of its transaction partners (respectively buyers or suppliers) is negative – that indicates that the higher productivity of the company increasing the probability of tie me formation is less important in case it already has high productivity suppliers or buyers. All that indicates that the characteristics of the partner companies are important for the formation and persistence of transaction ties, further motivating to study whether such linkages are associated with knowledge transfer.

Table 1. Regression analysis on the formation and persistence of transaction ties (based on sample of manufacturing firms)

Dep. Var	Tie persistence	Tie formation
	0.119	-0.005
Foreign owner (dummy), firm i	(0.004)***	-0.004
	0.122	0.026
Foreign owner (dummy), firm j	(0.004)***	(0.004)***
	-0.254	-0.043
Foreign owner (dummy), firm i and j	(0.006)***	(0.006)***
	-0.574	0.567
Log of value added per employee, firm i	(0.032)***	(0.031)***
	-0.187	0.298
Log of value added per employee, firm j	(0.021)***	(0.021)***
	0.021	-0.013
Firm size, firm j	(0.001)***	(0.001)***
	-0.006	0.007
Firm size, firm i	(0.001)***	(0.001)***
	0.128	0.097
Distance in log prod. between firm i and j	(0.002)***	(0.002)***
	-0.217	0.275
Average log prod. of actually partnering firms j (-1)	(0.021)***	(0.020)***
	-0.54	0.55
Average log prod. of actually partnering firms i (-1)	(0.030)***	(0.029)***
	0.02	-0.026
Average log prod. of actually partnering firms j (-1) ×log prod. firm i	(0.002)***	(0.002)***
	0.053	-0.056
Average log prod. of actually partnering firms i (-1) ×log prod. firm j	(0.003)***	(0.003)***
Number of observations	176134	176134
Adjusted R-squared	0.414	0.347
Industry and location dummies	Yes	Yes

Note. Robust standard errors in parentheses. *Significant at 10%; **significant at 5%; ***significant at 1%. Period: 2015–2019.

In the following descriptive statistics, we investigate how the presence of supplier-client links with multinational companies is correlated with the productivity of domestic owned suppliers. The Kernel density graphs (see Figure 1) show clearly that the domestic owned firms with foreign-owned transaction partners have a productivity distribution that dominates over that of the domestic owned firms without such partners. In addition, those firms with two or more foreign-owned transaction partners also have a productivity distribution that dominates over that of those domestic companies with just one foreign-owned partner. The right-hand panel in

Figure 1 looks at the same issue by allocating domestic companies to three groups according to the number of their 2nd-tier foreign-owned customers – less than 10, 10–100, more than 100. Clearly, having more 2nd-tier foreign-owned customers is correlated with higher productivity. All the differences in distributions are also statistically significant as shown by the value of the Kolmogorov-Smirnov test statistics.

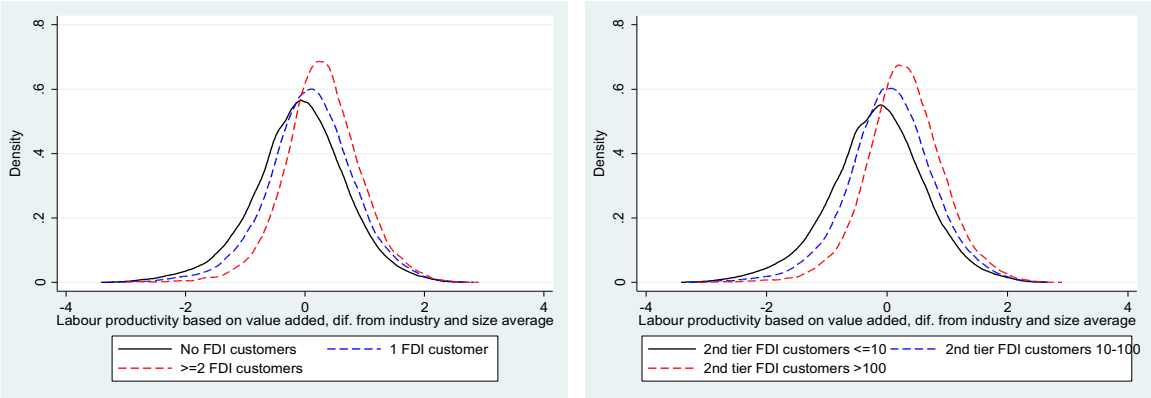

Figure 1. Kernel density plots of productivity distribution of domestic owned firms, by presence of linkages to foreign owned firms

Note. Calculations from the firm-level data merged with inter-company transactions information. The variables studied are the deviation of the labour productivity (value added per employee) from the average for 2-digit industry labour productivity and the size of the firm. Period: 2015–2019.

In Figure 2, we study whether after controlling for the standard determinants of firm productivity (size, age, etc.), any of the indicators of transactions with foreign partners have explanatory power in simple regression models with firm productivity as a dependent variable. We report both the estimates with OLS and firm fixed effects. We see clearly that higher numbers of multinational customers is correlated with higher productivity in both manufacturing and services, and this 'effect' is clearly larger than that of having more domestic owned clients. We note that this difference is smaller in the case of the fixed effects model.

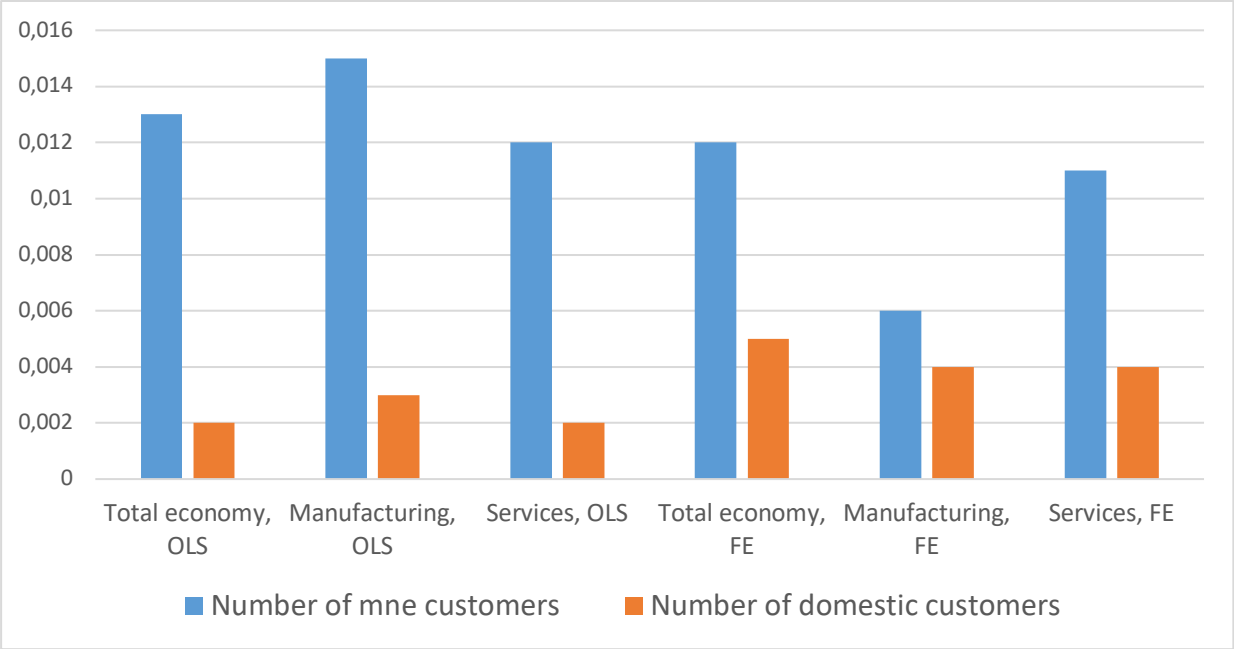

Figure 2. The estimated regression coefficients of the 'number of MNE and domestic customers' variables from the labour productivity regressions (log of labour productivity as dependent variable)

Note. The figure reports the estimated regression coefficients of the number of the customers, the other explanatory variables included exporting status (dummy), firm size (linear and squared terms), firm age (linear and squared terms), firm size and age interaction term, 5 region dummies. FE- fixed effects regression. Period: 2015–2019. Sample of domestic owned firms.

6. RESULTS

We next provide an overview of the results of the propensity score matching analysis. We present the results below on the basis of the different treatment years (*t, t+1, t+2*), measures of productivity (labour productivity and two measures of TFP), and different measures of treatment. In Annex 2, we report the quality of matching for a subset of these (Table A3). Generally, the differences of key pre-treatment variables between the treatment and the matched control group in various specifications of PSM were not significant after PSM, suggesting that matching has created a suitable control group in terms of the observed key pre-treatment characteristics of firms.

The results in Table 2 below indicate that, in the case of the manufacturing sector, establishing a supply link with a foreign-owned buyer in Estonia leads to higher labour productivity (value added per employee) in domestic owned firms.[5] Adding new foreign-owned customer(s) to the set of clients increases the labour productivity of the firm by about 0.062 log-points by the second year after the formation of the buyer-client linkage. Yet, it seems that what matters here especially is the effect of the first MNE customer. The effects on labour productivity in the case of that treatment are statistically significant and also quantitatively larger (0.13 log-point

[5] For comparison, descriptive statistics based on unmatched sample showing average productivity and performance dynamics after creation and terminating of supplier linkages(s) to foreign owned firms are shown in Annex 3 in Figure A1.

increase by the second year after the creation of the supply link). Such results are further confirmed based on a subset of tie-creations to new multinational firms that previously were not active in Estonia. Unexpectedly, we do not observe that the productivity effects require the first foreign-owned customer to constitute a dominating share of the sales of the local supplier; in other words, we do not observe the effects if more than 20 per cent of the sales of the domestic owned firm goes to one foreign-owned firm (see row 1 in Table 2).

Surprisingly, the effects of the first links to MNEs by domestic suppliers appear to be limited to labour productivity, and are not statistically significant in the case of TFP (estimated using the Levinsohn-Petrin method or the GMM approach). This suggests a likely specific channel of upgrading of suppliers from these first linkages that has less to do with transfers of organisational practices and more with increases in the scale of production or creating stronger incentives for further investments in capital inputs, raising the firm's capital-labour ratio in production.

We further observe evidence in Table 3 that suggests that subsequent linkages added to the very first links to MNE clients also have effects on TFP (in Table 2, see the estimated effect of 'New MNE customers' compared to 'First MNE customer'). The effects of these additional linkages go beyond scale effects and effects on the capital-labour ratio for the supplier. This is likely to reflect that the effects on TFP may take longer to materialise. There may be a need for the development of complementary assets/resources by the domestic firms themselves to benefit significantly from the transferred external knowledge from the MNEs. However, as a surprising result, we observe that the TFP effects of new supplier-client linkages are not specific to the linkages to foreign-owned firms only. Similar effects of new linkages to clients occur (see Table 3) due to linkages to exporters and, surprisingly, even to other domestic firms in general. In conclusion, the key distinctive vertical effect related to FDI appears in the case of a firm's first supply linkages to foreign-owned firms and is especially related to scale effects or effects on the capital-labour ratio.

The estimated performance effects of adding linkages to 2nd-tier foreign buyer(s) are not statistically significant. This stark difference from first-tier effects is not surprising, given the much lower extent of the expected knowledge transfer to the 2nd-tier supplier – less bargaining power in the MNE's value chains, their activities being concentrated more in standardised and less knowledge intensive goods or services that offer less potential for upgrading and can have substantially less complementarities with the knowledge available from MNEs. The lack of this type of effect means that the benefits of FDI on domestic owned firms in the host economy of FDI requires direct interactions between firms. There are clear limits to the spread of productivity enhancing knowledge in MNE value chains beyond the most directly and strongly involved local partners (first-tier suppliers), despite the fact that a large share of domestic firms are in fact second-tier suppliers to MNEs.[6]

[6] Concerning the timing of effects in Table 2 and 3, for comparison, the qualitative survey evidence by Alfaro-Ureña et al. (2020) from Costa-Rica is also relevant here. They have argued that the positive effects on productivity might need to occur fast for the supply linkage to be continued, as the multinational companies expect a very steep learning curve and rapid building of capabilities from the local suppliers. This is further confirmed in the study by Javorcik et al. (2008) of the soap and detergent sector and WalMart's entry in Mexico.

Table 2. ATT effects of creation of supply chain links on productivity of domestic owned firms in manufacturing industry

Treatment variable (0/1)	Log labour productivity			Log TFP (Levinsohn-Petrin)			Log TFP (GMM)		
	t	t+1	t+2	t	t+1	t+2	t	t+1	t+2
First MNE customer >=20% of sales (dummy)	.047	.192	.084	-.058	.07	-.038	-.109	.092	.006
First exporting buyer at least 20% share of sales (dummy)	.136	-.112	-.185	.176	-.084	-.113	.198	-.032	-.091
First 2nd-tier foreign buyer at least 20% share of sales (dummy)	.178	-.189	-.001	-.067	-.421	-.282	.288	-.055	.076
First MNE customer (dummy)	.112*	.148**	.130**	.057	.095	.076	.028	.101	.104
New MNE customers (dummy)	.012	.064**	.062**	.054	.109***	.105**	.018	.091	.097
New exporting customers (dummy)	.073**	.044	.065**	.071*	.043	.065*	.071	.042	.067
New domestic customer (dummy)	.082***	.04	.045	.129***	.097**	.105***	.015	-.009	-.004

Notes. Results of PSM. *Significant at 10%; **significant at 5%; ***significant at 1%. t - year of treatment. ATT- average treatment effect on the treated. Labour productivity is measured as value added per employee. Period: 2015-2019.

Table 3. ATT effects of creation of supply chain links on capital intensity, sales and number of employees of domestic owned firms in manufacturing industry

Treatment variable (0/1)	Log capital intensity			Log turnover			Log no. of employees		
	t	t+1	t+2	t	t+1	t+2	t	t+1	t+2
First MNE customer >=20% of sales (dummy)	.272	.462*	.526**	.102	.287	.29	-.016	.012	.054
First exporting buyer at least 20% share of sales (dummy)	-.175	-.125	-.458	.484**	.275	.252	.123	.121	.162
First 2nd-tier foreign buyer at least 20% share of sales (dummy)	-.028	-.058	.236	-.333	-.576	-.397	-.086	-.024	-.144
First MNE customer (dummy)	-.127	-.023	.034	.287**	.407***	.387***	.041	.096	.126
New MNE customers (dummy)	-.039	.011	.066	.182***	.256***	.267***	.119**	.151***	.171***
New exporting customers (dummy)	.006	.057	.067	.185***	.198***	.217***	.041	.069	.083*
New domestic customer (dummy)	-.029	-.027	-.028	.238***	.257***	.26***	.12**	.165***	.181***

Notes. Results of PSM. *Significant at 10%; **significant at 5%; ***significant at 1%. t - year of treatment. ATT- average treatment effect on the treated. Period: 2015-2019.

Table 4. ATT effects of termination of supply chain linkages on productivity of domestic owned firms in the manufacturing industry

Treatment variable (0/1)	Log labour productivity			Log TFP (Levinsohn-Petrin)			Log TFP (GMM)		
	t	t+1	t+2	t	t+1	t+2	t	t+1	t+2
Decreased MNE customers (dummy)	.001	-.016	-.013	.025	.008	.009	-.042	-.042	-.038
Decreased exporting customers (dummy)	-.055*	.007	-.027	-.099**	-.044	-.071*	-.102	-.051	-.077
Fully dropped MNE customers (dummy)	-.016	-.008	.016	.026	.041	.061	.08	.118	.141
Fully dropped exporting customers (dummy)	-.067	-.132	-.135	-.123	-.183*	-.183*	-.093	-.201	-.239

Notes. Results of PSM. *Significant at 10%; **significant at 5%; ***significant at 1%. t - year of treatment. ATT- average treatment effect on the treated. Labour productivity is measured as value added per employee. Period: 2015-2019.

Table 5. ATT effects of termination of supply chain linkages on productivity of domestic owned firms in the manufacturing industry

Treatment variable (0/1)	Log capital intensity			Log turnover			Log no. of employees		
	t	t+1	t+2	t	t+1	t+2	t	t+1	t+2
Decreased MNE customers (dummy)	-.056	-.048	-.03	-.008	-.01	.005	-.013	-.007	-.011
Decreased exporting customers (dummy)	.05	.015	-.027	-.079	-.103	-.095	-.065	-.104**	-.093*
Fully dropped MNE customers (dummy)	-.012	-.047	-.073	-.112	-.113	-.12	-.06	-.05	-.103
Fully dropped exporting customers (dummy)	.108	-.106	-.237	-.293*	-.399**	-.432**	-.062	-.14	-.162

Notes. Results of PSM. *Significant at 10%; **significant at 5%; ***significant at 1%. t - year of treatment. ATT- average treatment effect on the treated. Period: 2015-2019.

Finally, our results on the termination of an MNE's backward linkages is shown in Table 4 and 5. The complete termination of supplier linkages or decreasing the number of linkages to an MNE customer is, perhaps unexpectedly, not associated with a fall in the firm's labour productivity or TFP. This is quite different from the significant negative effect of decreasing the linkages to exporting clients (MNEs and locals) or dropping exporters from among the clients. The lack of negative effects on TFP from the termination of an MNE link may suggest that knowledge transfer through backward linkages is not necessarily persistent over time, but rather focused in the years after the creation of the supply linkage. Alternatively, this finding may indicate significant upgrading of these suppliers towards replacing indirect exports through MNEs with direct own sales abroad and may show their strong capabilities and flexibility to adjust to supply chain shocks.

As a robustness check, we applied two other matching approaches in addition to our baseline of the algorithm of nearest neighbour matching with two neighbours. These included the nearest neighbour matching with 5 neighbours and the Kernel matching. The choice of the particular matching algorithm had little effect on the quantitative results, and almost none on the qualitative ones (i.e. the sign and statistical significance of the estimates).

As another robustness check, we considered whether the positive effects of tie creation might reflect simultaneous positive effects of knowledge transfer via labour mobility (i.e. that these domestic firms have hired an employee who had previously worked in the multinational company). Hereby, we focused on the mobility of high-wage employees, defined as those belonging to the upper 10% of the wage distribution. Such high-wage employees are hereby used as a proxy for managers and professionals who may transfer useful knowledge when moving to new employer. We note that we cannot identify professionals and managers directly due to the absence of the occupational data on the longitudinal data bases. To account for the possible effects of labour mobility, we have removed domestic firms that hired an employee from multinational firms from the group of treatment companies (domestic companies with new or first multinational customers). The productivity Kernel distributions of the two groups of companies (with and without new managers) practically overlap and the difference being statistically insignificant (although the productivity is marginally lower for companies without new managers from multinationals).

Additional regression analysis, following the event-study design, indicated that the estimated coefficients are somewhat lower when controlling for employee mobility. That is, labour productivity as value added per employee one year after tie creation is 0.131 log-points higher in the case of not controlling for employee mobility and 0.115 log points higher in the case of excluding firms simultaneously hiring the employee with work experience in a MNE (and for total sales, the numbers were respectively a 0.381 log-point and 0.34 log-point increase). In conclusion, while accounting for employee mobility somewhat reduces the associations between tie creation and firm performance measures, the differences between estimates are relatively small.

7. CONCLUSIONS

Unlike the vast majority of prior literature that has relied on sector-level input-output tables in estimating the effects of vertical linkages of FDI, our econometric analysis of the backward linkages from MNEs is based on information on firm-to-firm transactions recorded in the value added tax declarations data. The first key novel aspect of this paper is that, in addition to the effects of the formation of immediate trading linkages between supplying domestic firms (first-tier suppliers) and their multinational customers, we also investigate the effects of the termination of supplier linkages to foreign-owned firms. The second novelty is the analysis of the effects of the formation of wider second-tier supply linkages of domestic firms with multinationals.

Treatment analysis with propensity score matching using panel data of manufacturing firms from Estonia suggests that starting to trade with multinationals initially boosts the labour productivity of the domestic firms supplying MNEs, through scale effects or effects on capital intensity, but with no significant initial effects on TFP. In the case of the first buyer-supplier relationships, the effects of supplying an MNE are statistically significant and large, whereas the similar effects of supplying the first domestic customer are not statistically significant. As a novel aspect, we observe that the termination of this MNE linkage has no significant adverse effect on the firm's labour productivity. This aspect of the termination of linkages has not been investigated in prior related analyses, and would not be possible to investigate with conventional sector-level input-output coefficients data. The lack of effects on TFP from terminating the MNE link may suggest that knowledge transfer through backward linkages is not necessarily persistent over time, but rather focused to the time closer to the creation of the supply linkage. Alternatively, this result may indicate significant upgrading of these suppliers towards direct own sales abroad and show their strong capabilities and flexibility to adjust to supply chain shocks.

We further observe that there are, as expected, limits to the backward linkages of FDI. We find, based on firms in the manufacturing sector, no significant positive effects on the second-tier suppliers, with strong positive effects thus limited to the first-tier suppliers with direct links to MNEs. The results in our study stress the importance of integrating the local subsidiaries of MNEs in the supply chains in the local economy and point to the need for direct interactions with local firms for the diffusion of beneficial effects of FDI in the host economies.

As an extension of our study, it would be also useful to investigate the types of upgrading effects that work through links to MNEs or successful exporters in greater depth. To that end, the econometric analysis of the creation and termination of supplier links would benefit from an additional survey-level investigation into the mechanisms of the effects, and how domestic firms adjust to exiting from an MNE's network. The effects are also likely to differ considerably by type of goods, capabilities of the firm, location in the value chain, bargaining power and the extent of relationship-specific investments in the supplier-client tier of firms. Finally, analysis of long-term effects is limited by the relatively short period available in our dataset (2015–2019). Due to data limitations the paper does not cover effects that may materialise more than 3 years after the creation of the linkage to the MNE(s).

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Annex 1

Table A1. Descriptive statistics of the variables used in the analysis

	Total economy, all firms		Manufacturing. domestic firms		Manufacturing, foreign firms	
Variable name	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Firm age	2.020	0.886	2.274	0.761	2.360	0.775
Firm age squared	4.864	3.180	5.751	3.090	6.170	3.164
All exporters (goods and services)	0.050	0.218	0.180	0.385	0.597	0.491
Change on no. of MNE customers	-0.292	2.765	-0.087	1.363	-0.078	1.949
First 2nd-tier MNE customer (dummy)	0.010	0.100	0.030	0.172	0.020	0.139
First MNE customer (dummy)	0.014	0.117	0.064	0.244	0.044	0.205
First MNE customer that is new MNE (dummy)	0.021	0.144	0.041	0.198	0.077	0.267
Northern Estonia	0.577	0.494	0.500	0.500	0.627	0.484
Central Estonia	0.076	0.265	0.096	0.294	0.079	0.270
North-Eastern Estonia	0.037	0.190	0.056	0.229	0.050	0.217
Western Estonia	0.102	0.303	0.114	0.318	0.097	0.297
Southern Estonia (dummy)	0.208	0.406	0.235	0.424	0.146	0.354
Log labour productivity	10.774	0.987	10.750	0.894	11.186	0.903
Log LPV	10.022	0.830	9.949	0.753	10.308	0.714
Log TFP	8.979	1.008	9.211	0.925	9.919	0.878
New 2nd-tier MNE customers (dummy)	0.324	0.468	0.430	0.495	0.434	0.496
New MNE customers (dummy)	0.150	0.358	0.186	0.389	0.250	0.433
Shares of sales to MNE customers	0.137	0.274	0.144	0.260	0.258	0.332
Shares of sales to MNE customers in the different 2-dig. Ind	0.121	0.257	0.130	0.247	0.222	0.309
Shares of sales to MNE customers in the same 2-dig. Ind	0.016	0.104	0.015	0.089	0.036	0.149
Importance of 2nd-tier for sales at tier 1	0.129	0.176	0.161	0.169	0.239	0.228
Firm size	0.992	1.061	1.460	1.214	2.624	1.283
Firm size × Firm age	2.334	2.887	3.706	3.491	6.691	4.034
Firm size squared	2.109	3.483	3.606	4.573	8.531	6.484
No. of domestic customers	6.865	44.213	11.864	24.689	15.161	39.565
No. of 2nd-tier MNE customers	82.972	320.797	119.454	282.358	197.491	361.061
No. of MNE customers	0.879	4.318	1.477	3.605	2.702	5.004
No. of MNE customers squared	19.420	959.827	15.173	128.407	32.322	158.138
No. of MNE customers in the different 2-digit industry	0.799	4.066	1.350	3.422	2.443	4.806
No. of MNE customers in the same 2-digit industry	0.080	0.490	0.126	0.517	0.259	0.808
Labour share of foreign firms in 3-digit industry	3.659	5.703	6.373	6.852	6.873	7.659

Note. Calculations from the data of value added tax declarations merged with the Estonian Business Registry.

Table A2. Number of transaction partners among various groups of companies

Group of companies	No. of customers			No. of 2-dig. industries with customers	No of. MNE customers		Shares of sales to MNE customers	No. of 2nd-tier MNE customers	Share of 2nd tier in sales at tier 1	No. of suppliers		
	All	MNE custo-mers	Domestic customers		In the same 2-dig. ind.	In the different 2-dig. ind.				All	MNE	Domestic
0-9 employees	8.1	0.8	6.2	3.9	0.1	0.7	0.1	75.7	0.2	7.4	1.2	5.9
0-49 employees	11.6	1.1	8.8	4.7	0.1	1.0	0.1	107.8	0.2	10.5	1.7	8.3
50-249 employees	160.2	14.4	121.5	18.8	1.2	13.3	0.2	1121.4	0.2	103.3	16.8	81.2
>250 employees	180.0	16.3	136.3	19.7	1.2	15.1	0.2	1255.4	0.2	124.4	19.8	97.9
Age 1-2 years	5.0	0.5	3.9	2.8	0.0	0.4	0.1	43.4	0.2	5.9	0.9	4.7
Age 3-5 years	7.0	0.6	5.4	3.6	0.1	0.6	0.1	62.7	0.2	7.8	1.2	6.2
Age >=6 years	17.7	1.7	13.4	5.5	0.1	1.6	0.1	154.9	0.2	14.7	2.4	11.6
All exporters	49.3	4.1	31.2	7.9	0.4	3.8	0.2	350.7	0.1	31.8	4.2	20.8
Non-exporter	8.8	0.7	5.3	3.3	0.1	0.6	0.1	62.9	0.1	6.7	0.9	4.5
Goods exporter	72.4	5.1	47.1	9.7	0.5	4.6	0.2	431.9	0.1	45.9	6.5	29.7
Services exporter	47.5	4.4	30.0	7.4	0.3	4.1	0.2	369.7	0.1	29.0	3.6	19.4
Domestic owner	12.6	1.2	9.5	4.7	0.1	1.1	0.1	110.7	0.2	11.5	1.8	9.2
Foreign owner	51.7	5.8	40.0	8.0	0.6	5.3	0.3	428.8	0.2	28.8	5.2	22.0
Services	18.5	1.9	14.5	6.7	0.2	1.7	0.2	150.7	0.2	21.7	4.0	16.8
Manufacturing	16.1	1.6	12.4	4.9	0.2	1.5	0.1	150.7	0.2	11.3	1.8	9.0
Total economy	13.9	1.1	8.6	3.9	0.1	1.0	0.1	99.6	0.1	9.5	1.2	6.3

Note. Calculations from the data of value added tax declarations merged with the Estonian Business Registry. The figures on the multinational and domestic companies need not always add up to the statistics on all companies because the ownership information is missing for some companies.

* The importance of second-tier for sales at tier 1 has been calculated in two steps. First, we calculated for the first-tier suppliers their share of sales to the foreign customers. Then, for the second-tier suppliers, we calculated the weighted average of that indicator calculated at the 1st step by using as weights the amounts of sales from second-tier to first-tier suppliers.

Annex 2

Table A3. Balancing property test after matching. Treatment establishes first-time supplier link with an MNE with more than 20% of sales going to this MNE

Variable name	Sample	Mean for treated group	Mean for control group	t-test	p-value of t-test
Log TFP (t-1)	Unmatched	9.0168	8.9445	0.64	0.52
	Matched	9.0517	9.1788	-0.77	0.442
Log capital (t-1)	Unmatched	10.36	10.047	1.38	0.168
	Matched	10.352	10.287	0.2	0.844
Log labour productivity (t-1)	Unmatched	9.8956	9.7466	1.57	0.117
	Matched	9.8825	9.9292	-0.34	0.735
Firm size (t-1)	Unmatched	1.468	1.3013	1.21	0.227
	Matched	1.4934	1.5164	-0.11	0.915
Firm size squared (t-1)	Unmatched	3.5957	2.6674	2.02	0.043
	Matched	3.6576	3.4895	0.22	0.828
Firm age (t-1)	Unmatched	2.3686	2.2683	0.99	0.323
	Matched	2.3905	2.3577	0.23	0.82
Firm age squared (t-1)	Unmatched	6.1759	5.6921	1.2	0.232
	Matched	6.2616	6.1888	0.13	0.898
Firm size (-1) × Firm age (-1)	Unmatched	3.7264	3.1971	1.34	0.181
	Matched	3.7906	3.9302	-0.22	0.823
Northern Estonia (dummy)	Unmatched	0.37288	0.33966	0.51	0.609
	Matched	0.37931	0.39655	-0.19	0.85

Note. Calculations from the data of value added tax declarations merged with the Estonian Business Registry, sample of manufacturing firms. *t-1* denotes the pre-treatment period.

Annex 3

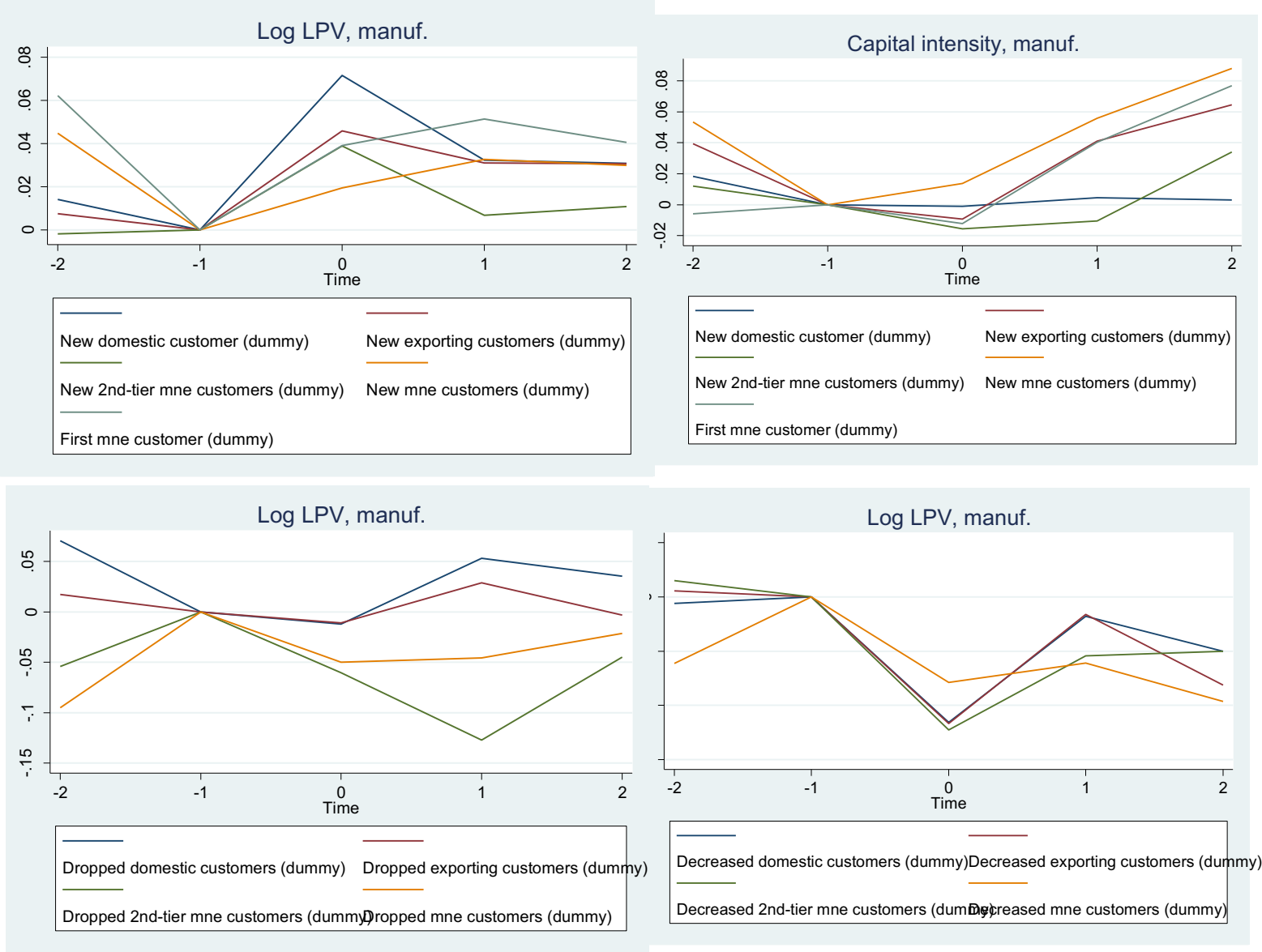

Figure A1. Changes in labour productivity and capital intensity before and after the creation and discontinuation of transaction linkages, based on unmatched sample

Note. Time t=0 in the figures denotes the year when the particular transaction linkage is created or discontinued. The indicators presented in the graphs are calculated so that in the case of the specific outcome variables, logged values are subtracted from the corresponding value in year $t = -1$ (i.e., the percentage change from year $t = -1$). After that, the difference is calculated from the values of the treated companies (those that created or discontinued the particular link) and the untreated companies. Therefore, the indicator is effectively a difference-in-difference estimate, but without controlling for the other confounders in the treatment and control groups.

The upper part of Figure A1 shows the dynamics of the domestic firms' indicators of firm performance before and after creating transaction linkages with different types of firms (e.g., foreign-owned companies, exporting firms, etc.). The lower part of Figure A1 describes the dynamics of these indicators before and after discontinuing the transaction linkages with the

same types of firms. Time *t=- 1* denotes in all figures the year preceding the particular event (linkage creation or destruction), and the variables are normalised to zero in that year.

The solid lines in Figure A1 indicate the differences in the logged values of the particular variable (e.g., labour productivity) in a year, in the case of a particular category of firms, from its value at time *t=- 1* (the last year before the treatment). After that, differences from the values of the treated and untreated firms are calculated, starting from the year of treatment (*t=0* in Figure A1). From the upper-left part of the graph, we can infer that labour productivity increases, on average, after establishing the transaction with either a domestic owned, foreign-owned, or exporting firm. Therefore, a general finding is that adding new clients is on average associated with productivity improvements. However, we note that there is heterogeneity in these effects: these increases are the fastest by *t+2* and *t+3* periods if the firm starts to trade for the very first time with a multinational (foreign-owned) firm. Such increases in the case of a first-time supplier link to a multinational can also be seen in the case of TFP (not reported to save space). Yet, we note that the statistical significance of this finding varies: it is not consistent across the various measures of TFP (Levinsohn-Petrin vs GMM base of TFP).

The upper right part of Figure A1 shows that establishing the transaction linkage is related to other effects on labour productivity than those functioning through TFP. There is solid growth in capital intensity among the domestic companies that start supplying their very first foreign-owned customer (light-green line) or simply new foreign-owned customer (yellow line). We also looked at the dynamics of the share of employees with higher education as an indicator of the skills level of the companies' workforce. However, this indicator showed rather limited dynamics over time, with no significant correlation with change in supplier status. The two lower panels in Figure A1 look at what happens if there is a discontinuance of trade linkages with some of the firms (lower left) or with all the companies of the particular group (lower right). In most cases, we see a decrease in labour productivity, especially if the domestic company stops selling to one or all of its prior multinational clients. These statistics, in Figure A1, of course do not account for the non-random selection into treatment: that the treated and control group might have shown different dynamics even in the absence of treatment. However, these graphs provide general descriptive evidence that for a domestic firm, starting a supplier relationship in general and a supplier relationship with foreign-owned firms may be associated with effects on performance indicators.

KOKKUVÕTE

Hargmaiste ettevõtete väärtusahelatega liitumise ja neist lahkumise mõju kodumaiste tarnijate tootlikkusele: tulemused ettevõtete-vaheliste tehingute andmete põhjal

Käesolev uurimus käsitleb hargmaiste ettevõtete väärtusahelatega liitumise ja neist lahkumise mõju kodumaiste tarnijate tootlikkusele. Valdav osa senisest selle-teemalisest kirjandusest on kasutanud sektoritaseme sisend-väljund tabelite andmeid otseste välisinvesteeringute vertikaalsete seoste uurimiseks, s.t. kuivõrd välisosalusega ettevõtetele toomissisendite tarnimine kodumaiste ettevõtete poolt aitab tõsta viimaste tootlikkust. Erinevalt sisend-väljundtabeleid kasutanud kirjandusest uurib meie ökonomeertiline analüüs välisosalusega ettevõtetele tarnimise alustamist ja selle lõpetamist kasutades ettevõtete-vaheliste tehingute andmeid Eesti käibemaksu deklaratsioonidest. Viimaseid kombineeritakse Äriregistri paneelandmetega tuvastavamaks tarnijasideme loomise mõju tarnija tootlikkusele kasutades tõenäosusliku sobitamise meetodit, kus sideme loonud ettevõttetele konstrueeritakse kontrollgrupp kodumaistest ettevõtetest, mis ei hakanud hargmaiste ettevõtete tarnijateks.

Tulemused näitavad, et hargmaistele ettevõtetele tarnimise alustamine suurendab kodumaise tarnija tööjõu tootlikkust (lisandväärtust töötaja kohta), seda tänu positiivsele mõjule käibele ning kapitali ja tööjõu suhtele. Esimesed tarnijaseosed hargmaiste ettevõtetega ei mõjuta kodumaiste ettevõtete tootmistegurite kogutootlikkust, kuivõrd viimasele positiivse mõju avaldumine nõuab enam aega. Tulemused näitasid ka, et hargmaistele ettevõtetele tarnimise positiivsed mõjud on eelkõige piiratud vahetute tarnijatega ning ei ilmne positiivseid mõjusid nö teist järku tarnijatele (hargmaiste ettevõtete tarnijate tarnijatele). Samuti on uueks tulemuseks, et kodumaiste tarnijate tootlikkus ei lange kui tarnijasidemed hargmaiste ettevõtetega vähenevad või lõppevad sootuks. Meie uurimistöö tulemused rõhutavad hargmaiste ettevõtete kohalike haruettevõtete sihtriigi tarneahelatesse integreerumise tähtsust ning osundavad sellele, et otseste välisinvesteeringute positiivsete välisefektide laiemaks levimiseks sihtriigi majanduses on vajalik välisosalusega ettevõtete vahetu vastastikmõju kohalike ettevõtetega.