International Fragmentation of Production and Firm Productivity: Evidence from Slovenian Manufacturing Firms

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Abstract

An increasing number of firms outsource peripheral functions in order to stay focused on their core capabilities. This paper contributes to a limited body of empirical research on the relationship between intermediate inputs offshoring and firm productivity. We use a unique firm-level panel data set of Slovenian manufacturing firms operating in the period 1994–2005 with a detailed accounting information and foreign trade data. Using propensity score matching techniques combined with the difference-in-differences approach, We analyze whether firms that start importing intermediate inputs become more productive. The results imply that new importers exhibit temporal boost in productivity growth and increase productivity level relative to non-importing control group over a medium term. In the first year, offshoring brings about a 20% increase in labour productivity and an equivalent growth of total factor productivity. Despite the short-lived year-on-year growth rates of productivity in excess of non-importers, cumulative gain in productivity of new importers after four years remains significant at around 37% for labour productivity and 35% for total factor productivity.

Keywords: intermediate inputs outsourcing, firm productivity, difference-in-differences matching.

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1 Introduction

Globally, fragmentation of production has become increasingly widespread in recent years as barriers to international trade and investment have decreased and as global competition has driven producers to cross national borders in order to lower costs. Improved legal and business environment, proliferation of internet and improvements in information and communications technology (ICT) have made the splitting of production processes and the coordination in the resulting activities possible. Particularly noteworthy was the spread of offshore outsourcing – international sourcing of intermediate goods and services based on contractual, arm's length relationship between a producer and an input provider.[1]

International fragmentation of production, especially offshore outsourcing of services, received a great deal of attention in public media. Strong media interest notwithstanding, there is relatively little empirical evidence on its economic impact. Because the debate has mainly been focused on job relocation aspect of offshoring, most of the existing research on the subject is primarily centred on labour market issues. There are numerous studies that assess the number of jobs to be moved to low-cost locations (e.g. Kirkegaard, 2004, 2005), the impact on the wages of different skill groups (e.g. Geishecker, 2006; Orberg Jensen et al., 2006), employment effect of international sourcing (e.g. Harrison & McMillan, 2006; Head & Ries, 2002), and changes in the price elasticity of labour demand as a consequence of enhanced internationalization of value chains (e.g. Paul & Siegel, 2001). The impact on productivity at firm-level, however, has received only little attention.

The goal of this paper is to test whether the use of imported intermediate goods increases firm productivity, using a firm-level data on Slovenian manufacturing firms from 1994-2005. The data features heterogeneity of foreign sourcing across firms and across time and allows me to identify firms that switched from purely domestic sourcing of inputs to offshoring. We use these firms to disentangle the causal effect of foreign sourcing on productivity growth from the parallel self-selection effect. Namely, previous studies and this one included have shown that importers are larger and more productive than non-importers even before they start importing inputs from abroad (e.g. Criscuolo and Leaver 2006; Kurz, 2006). Estimating the effect of imports would be straightforward if imports were randomly assigned to firms. In the absence of such randomized experiment, we need to deal with the difficulty that imports may depend on unobserved productivity, which leads to reverse causality problems. We cope with this endogeneity problem using the empirical methodology developed by Kasahara and Rodrigue (2008) in order to estimate firm level productivity more accurately. To identify the causal effect from importing intermediates to productivity growth, We test for the differential

[1] Following the broad definition of the term, outsourcing is defined as the acquisition of an input or a service from an unaffiliated company. On the other hand, offshoring is the sourcing of input goods or services from a foreign country (WTO (2008, p. 99))

effect of offshoring by applying non-parametric difference in differences matching techniques.

The rest of this paper is organized as follows: the next section describes the theoretical framework and overviews the existing empirical research. Section 3 sketches the empirical methodology while Section 4 describes the data set. Section 5 provides the results of the empirical estimations before the last section concludes.

2 Theory and empirical evidence

Existing models of productivity gains from importing emphasize two mechanisms (see Connolly, 2001; Keller, 2001; Rivera-Batiz & Romer, 1991). In the first mechanism, learning occurs through the incorporation of new intermediate products invented abroad in the local production chain. The use of foreign intermediate products conveys the embodied technological capability and R&D of the foreign producer. The second mechanism for learning from importing is exposure to foreign technology. An original design invented abroad is learned by domestic producers, for example, by reading a patent, reverse engineering a product, or licensing a technology. Learning the new design raises productivity by shifting out the firm's technological expertise. Using patent citations in French firms' patents, MacGarvie (2006) confirms such technology spillovers via imports. His results suggest that the inventions of importers are significantly more likely to be influenced by foreign technology than are the inventions of non-importing firms. Furthermore, importers' citations increase relative to similar firms after they start importing.

Similarly, Halpern, Koren and Szeidl (2006) use two mechanisms identified in theoretical work to explain the beneficial effects of trade at the level of the firm: access to a greater number of product varieties (as in Krugman (1979)) and importing more high-quality foreign inputs (e.g., Grossman and Helpman (1991)). In their model, producers use differentiated intermediate goods to produce a final good. Each intermediate good has a domestic as well as a foreign variety, and producers may choose to import the foreign variety in exchange for a fixed cost. The domestic and foreign varieties within each good are imperfect substitutes, and the foreign variety has a quality advantage. Firms differ both in the fixed cost of acquiring foreign varieties and in their productivity, and hence make different choices about the number of varieties they import. Hence the model exhibits cross-firm heterogeneity in both the number of imported varieties and the share of imports in intermediate inputs, an observation borne out by the data as well.

Görg, H., Hanley, A. & Strobl, E. (2008) identify three channels for productivity increase due to international outsourcing. In the short run, a firm engaging in international outsourcing has access to internationally traded inputs which may be available at lower costs or at higher quality than domestic substitutes. Therefore, increasing use of internationally traded inputs may result in

a direct boost in productivity for the firm, shifting its production function outward. Secondly, in the longer run, international outsourcing may affect productivity through the changes in factor shares. If the firm outsources some of the upstream production abroad there will be a reallocation of production in the firm towards more skill intensive downstream production. This, *ceteris paribus*, will lead to a rise in average labour productivity in the firm. Thirdly, there will be general equilibrium effects associated with the firm level outsourcing activity. International outsourcing changes the relative demand for factors of production in the domestic economy, which will affect relative factor prices in the economy.

Although much of the literature on international fragmentation of production is theoretical, looks at the relationship between outsourcing and wages, or measures the importance of outsourcing in the global economy, there is a growing body of empirical work on the relationship between international production sharing and productivity. Due to only recent emergence of available data that combine accounting information with the data on international trade flows at the firm-level, the empirical evidence on the level of firms has only recently begun to increase, yet the existing evidence is no less revealing.

Some of the earliest studies to estimate the effects of production sharing on firm productivity using micro-data include Görzig and Stephan (2002) and Girma and Görg (2004). Neither of them, however, distinguishes between domestic and international sourcing. Görzig and Stephan (2002) find that in the long run all three types of outsourcing activities have positive impact on return per employee, whereas in the short-run all but services outsourcing have a positive impact on productivity in a sample of about 43.000 German manufacturing firms. Girma and Görg (2004) examine the plant-level data including a sample of predominately larger establishments with more than 100 employees in the chemical, electronic, and mechanical and instrument engineering industries over the period 1980-1992. They found a positive correlation between outsourcing and labour productivity in level terms in chemicals and engineering sectors, while the first differences specifications only indicate a positive correlation within foreign-owned establishments in the engineering sector. Similarly, the level of TFP seems to respond to changes in the outsourcing intensity again in the chemical and engineering sectors, while the TFP growth appears to be correlated with outsourcing only in the engineering sector, particularly in foreign plats.

Görg, Hanley and Strobl (2008) use plant level data for the electronics industry in Ireland to examine the effect of international outsourcing of material and services inputs on labour productivity. In the pooled sample of firms, the authors find no significant impact of offshore outsourcing in either materials or services on productivity levels or growth. When they split the sample into upstream and downstream sector, the firms in the latter appear to increase the level and growth of labour productivity as they increase the intensity of international service outsourcing, but not in case of material outsourcing. In contrast, Görg and Hanley (2005) find a significant positive correlation between international outsourcing on TFP in the whole sample of firms, using the same dataset. In the low-export-intensity group of firms, only

material outsourcing appears to be significantly correlated with firm productivity levels, while high-export-intensive group exhibits no productivity gains from either type of international outsourcing. Görg, Hanley and Strobl (2004) conduct a study very similar to Görg, Hanley and Strobl (2008) but on a longer time period (1990-1998) and the whole manufacturing sector. Point estimates suggest that an increase in the outsourcing intensity by one percentage point leads to a 1.2 percent increase in productivity at the level of the plant. Splitting the sample further according to ownership status revealed that international outsourcing of materials exhibits productivity enhancing effects for domestic and foreign exporters, with a coefficient of similar magnitude, while there are no such effects of materials outsourcing for non-exporters.

Analyzing plant-level data for Indonesian manufacturing firms in the period 1988-1996, Blalock and Veloso (2007) present evidence that firms in industries supplying increasingly import-intensive sectors exhibit greater productivity growth than other firms. The results suggest that factory output increases approximately by 0.12% as the proportion of downstream materials imported rises by 1%. Learning from downstream imports is more pronounced in larger firms and firms in intermediate goods sectors as opposed to final goods sectors. Also using Indonesian manufacturing data from 1991-2001, Amiti and Konings (2007) study the effect of trade liberalization on plant productivity by disentangling the gains to those arising from lower output tariffs and those fostered by lower tariffs on intermediate inputs. The results are robust to many specifications and alternative productivity measures and show that a reduction of input tariffs has much larger effects on productivity growth than the decline of output tariffs.

A study by Van Biesebroeck (2008) evaluates five different productivity estimation techniques and investigates the effect of five channels as an engine of productivity growth: exporting output, importing materials, acquiring external technology, frequent capital investment, and high levels of human capital. In Colombia, import status is not associated with significant growth effect, probably because the sector studied, textiles, enable little scope for technological advances to be embedded in imported input. For Zimbabwe, the results suggest that importing inputs tends to be associated with higher productivity growth.

Employing a data set of 9,500 Brazilian manufacturers for the years 1986-1998, Muendler (2004) separates and analyzes three different mechanisms behind trade-induced productivity change: i) competitive push, which brings pressures to improve existing business processes in order to cope with the competitive shifts from lower inward trade barriers; ii) foreign input push, which allows firms to adopt new production methods by importing high-quality equipment and intermediate inputs; iii) competitive elimination, by which increased foreign competition induces exit of the least efficient firms which leads to higher average productivity. The evidence points in the direction of strong competitive push effects as a source of firm-level productivity change, while the effect from intermediate goods imports are found to be relatively unimportant.

Halpern, Koren and Szeidl (2006) examine the effects of imports on productivity at the firm level using a panel of large Hungarian exporters in the period 1992-2003. The results imply that an increase of imported intermediates from 0 to 100 percent of total intermediate inputs use increases firm productivity by an average of 14 percent. About two thirds of this effect comes from the imperfect substitution of domestic and foreign inputs, while the remaining third emanates from higher quality of foreign goods.

Kasahara and Rodrigue (2008) propose a novel estimation procedure through which they address the issue of simultaneous productivity shocks and decision to import inputs. The results demonstrate that imported intermediates improve a plant's productivity as it is found that by switching from being a non-importer to an importer of foreign intermediates a plant can immediately improve productivity. The estimates of the effect range from 12.9 to 16.1 percent, while the long term improvement of productivity is estimated to be on average 23.5 percent. They also find some evidence of a positive dynamic effect from the use of imported materials, the finding we aim to confirm and extend even further on the Slovenian manufacturing data.

Review of existing empirical literature at the plant/firm-level has shown that there is a strong evidence for the positive relationship between productivity and offshoring but none of the studies investigated the causality issue. Using the methodology explained in the following section, we aim to fill in this gap.

3 Methodology

To be able to explore the effect of foreign sourcing of intermediate inputs on productivity, we need a measure of it in the first place. Besides using value added per employee, we employ total factor productivity derived from production function estimation. However, any estimation approach dealing with production function estimation has to contend with some crucial endogeneity issues. First, part of the productivity shock (ω_{it}) is unobservable to the econometrician but known to a firm when choosing the amount of inputs. The identification problem arises because ω_{it} becomes integral part of the error term, while at the same time inputs are determined on the basis of the productivity shock. Next, there is a problem of self-selection due to endogenous exit of firms. Firms with larger capital stocks and positive imports of intermediate inputs can expect larger future returns for any given level of current productivity and will therefore continue in operation at lower realizations of productivity shocks. The self-selection process generated by exit behaviour therefore leads to attrition bias: negative bias on capital and import status coefficients. The third estimation problem, endogeneity of import status, is corrected by incorporating past import status as an additional state variable.

In order to manage the issues of simultaneity, self-selection, and endogeneity of import decision, we apply Kasahara and Rodrigue (2008) (KR hereafter) estimation framework that proposes a semi-parametric estimation of production function, building on Olley and Pakes (1996) and Levinsohn and Petrin (2003). In addition to current capital and productivity shock, import status (d_{it}) serves as an additional state variable. Furthermore, it is assumed that import status has a positive dynamic effect on productivity as proposed in my hypotheses.

Once the parameters of production function are estimated, we construct total factor productivity measures in the traditional way: $tfp_{it} = y_{it} - \hat{\beta}_L l_{it} - \hat{\beta}_K k_{it}$. This productivity measure is expressed in logarithmic terms, which means that time differentiation directly yields the growth rate of productivity. Estimated TFP is then used to test my hypothesis on whether the use of imported intermediate inputs leads to higher productivity growth. For that reason we use propensity score matching, a method used extensively in labour economics to evaluate the impact of different social programmes.[2]

The first step in the propensity score matching method is to estimate a probability to start importing. This is carried out by running a probit model with a dependent variable *D* equal to 1 if a firm started importing and zero otherwise on a set of the following observables:

$$\Pr(D_{it} = 1) = \Phi\left[h(\omega_{it-1}, rk_{it-1}, rl_{it-1}, ex_{it-1}, a_{it}, iFDI_{t-1}, oFDI_{t-1})\right]. \quad (1)$$

As a dependent variable we use an indicator for the *start* of importing intermediate inputs instead of a dummy that signifies the importing status. In the latter case, we would have to include a lagged import status among the regressors and would thus in fact estimate the probability to continue importing instead of the probability to start importing. Firms that import throughout the entire sample period are excluded from the analysis as they do not provide the necessary dynamics and are neither useful for the following matching stages. $\Phi(\cdot)$ is the normal cumulative distribution function, ω_{it-1}, rk_{it-1}, rl_{it-1} and ex_{it-1} are lagged productivity measure, relative capital, relative labour, and export status, respectively. a_{it} represents firm *i*'s age at time *t* while $iFDI_{t-1}$ and $oFDI_{t-1}$ denote foreign ownership and outward FDI status. Because firm age is known only for firms that entered the industry after 1994, we also include a left censoring dummy for the age as a regressor. This variable has value 1 if a firm was operational already in 1994 and is hence most probably older than (*t*-1994) years. Age variable is used to make sure that firms of similar age are matched and to proxy for unobserved ability, managerial experience, organizational knowledge, and survival probability.[3] we include export status since one can expect that having established business relationship with export markets helps firms in their pursuit of internationalization of production chain. We furthermore include a set of year and industry dummy variables to

[2] For matching techniques in general see Heckman et al. 1997 and 1998; for propensity score matching in particular refer to Rosenbaum and Rubin 1983 and 1984.

[3] It is a well established stylized fact that younger firms have a higher probability of exiting (Klette and Kortum 2004, pp. 990).

control for the common aggregate shocks and specific industry characteristics. We use a third order polynomial in the elements of *h* in order to improve the fit of the model. We denote the predicted probability to start importing, i.e. the propensity score, with P_{it}.

We match denovo importers with appropriate non-importing control firms within the same 2-digit NACE industries and in the same year. Consequently, we create a control group of similar firms from the same sector that are exposed to common temporal aggregate supply and demand shocks. The group of treated firms to be matched consists of only those firms that start importing intermediate inputs somewhere during the sample period and remain importers ever since. Potential control group consists only of non-importing firms so that the possibility of a denovo importer being matched with a forthcoming importer (i.e. an importer-to-become but not yet importing at the time of matching) is excluded. This way we make sure that subsequent import status changes in the matched control group/firm do not enter the estimation of the average effect. Matching is performed in the year in which a firm starts importing (τ_0) and the same control group/firm is used for comparison in all the other preceding and subsequent periods used (τ_{-2}, τ_{-1}, τ_1, τ_2, τ_3). To provide more confidence with the results, average treatment effect on the treated is estimated using several matching methods. Among traditional matching estimators, we use nearest neighbour matching within caliper and K-nearest neighbour matching within caliper. In addition, we also perform a more complex mahalanobis matching estimator. In order to make sure that matches are as similar in productivity levels as possible, mahalanobis matching allows me to fit the treated units with controls not only on propensity score but also on productivity level at the time of import decision (a year before import start).

Relatively long time dimension of my panel data enables me to track the effects of importing on firm performance several years after the foreign sourcing of intermediate inputs has begun. In addition, the post-programme effect is compared to the differences between prospective new importers and control firms in the years prior to import start by observing the average diff-in-diffs as defined by equation (2) from τ_{-2} to τ_3. This allows me to check the validity of matching procedure[4], structural shift between the pre- and post-transformation period, the size of the effect and its temporal persistence. The average treatment effect for a period *s* will be calculated according to the following expression, where weights W_{ij} and w_i depend on the specific matching estimator used:

$$\hat{\alpha}_s^{DID} = \sum_{i \in M} \left(\left(Y_{i\tau_s} - Y_{i\tau_{s-1}} \right) - \sum_{j \in C} W_{ij} \left(Y_{j\tau_s} - Y_{j\tau_{s-1}} \right) \right) w_i \text{ for } s = -2, -1, 0, 1, 2, 3. \qquad (2)$$

In case of *Y* denoting TFP, the value of $\hat{\alpha}_s$ describes by how many percentage points on average the growth rate of new importers ($i \in M$) *s* years after (prior to) the import initiation exceeded the growth rate of corresponding control non-importing firms ($j \in C$) from the same

[4] If the matching was correct, future importers would have to exhibit similar productivity growth rates as the matched control firms in the years just before the start of international fragmentation of production.

industry and in the same year. In other words, the value of the effect represents the extra productivity growth that can be attributed to firm's decision to procure intermediate inputs abroad.

In order to explore a different yet tightly related aspect of productivity effects of importing, we also observe how the decision of starting to import intermediate inputs impacts the productivity trajectory. Therefore, we estimate the average cumulative treatment effect or the productivity gain gathered over *S* years after the decision to start sourcing inputs abroad. The estimator $\hat{\alpha}_S^{CUM}$ is given by

$$\hat{\alpha}_S^{CUM} = \sum_{i \in M} \left(\left(Y_{i\tau_S} - Y_{i\tau_{-1}} \right) - \sum_{j \in C} W_{ij} \left(Y_{j\tau_S} - Y_{j\tau_{-1}} \right) \right) w_i \text{ for } S = 0, 1, 2, 3. \quad (3)$$

The above estimate calculates the average productivity gain since the period before the import initiation (*S*=-1). In other words, the estimate in (3) gives the productivity premium new importers have gathered over time. In reality, long-term above-average growth rates are uncommon, yet firms become and remain more productive than domestically oriented competitors with respect to their pre-internationalization productivity level, the pattern observed in several studies on the effect of starting to export (e.g. De Loecker 2007, Damijan and Kostevc 2006). To test whether new importers become more productive despite not growing significantly faster each year after the switch to foreign sourcing, we therefore estimate cumulative effects in addition to the effect on the year-to-year productivity growth.

Once the matching is completed and difference-in-differences values assigned to all the matched denovo importers for the periods $\tau_{-2} - \tau_3$, we estimate the following equation proposed by Damijan and Kostevc (2006):

$$\Delta_{it} = \beta_0 + \beta_1 y_{it-1} + \beta_2 r\kappa_{it-1} + \sum_{\tau=\tau_0}^{\tau_3} \beta_3 D_\tau + \sum \beta_4 X_{it} + \beta_5 \theta_t + \varepsilon_{it} , \quad (4)$$

where Δ represents the productivity growth differential between denovo importer and its control group and is defined as the difference between the productivity growth rate of an importer $\left(\omega_{it}^M - \omega_{it-1}^M\right)$ and a non-importing control firm/group $\left(\omega_{it}^C - \omega_{it-1}^C\right)$. Explanatory variables include the lagged productivity (y_{t-1}) and lagged relative capital intensity[5] ($r\kappa_{t-1}$) in terms of the difference between the treatment and control group. My interest lies in the values of coefficients β_3 which will reveal whether there are any productivity gains attributable to import status. Dummy variable D_{τ_s} equals 1 if firm *i* started importing $\tau \in [0,3]$ years ago and is set to zero otherwise. Positive and statistically significant values of the coefficients β_3 would confirm that international fragmentation of production chain brought about notably

[5] Relative firm-to-sector figures are derived by expressing the nominal values of firm's characteristics relative to the corresponding 3-digit NACE industry averages in the same year.

higher productivity growth rates of importers compared to the pre-outsourcing periods. The vector of variables in X includes the share of imported inputs in the total material costs (m), an indicator variable for firms with outward foreign direct investment ($oFDI$), and the foreign ownership dummy ($iFDI$). θ_t is time dummy that captures the temporal shocks common to all firms. We now turn to the description of the data used in the empirical part.

4 Data description

The data set is created by linking three different sources of firm-level data: financial statements collected by Agency of the Republic of Slovenia for Public Legal Records and Related Services (AJPES), information on FDI status provided by Bank of Slovenia, and trade data from Slovenian Customs Office. Financial statements include data from balance sheet and income statement for every firm in Slovenia and are collected annually, regardless of the establishment size and ownership. Reporting is obligatory for all the firms, so the resulting unbalanced panel includes information on exit and entry. Among other, this data source provides information on gross revenue, the number of workers employed, stock of fixed assets, value of exports, material costs, and labour costs. The period covered is from 1994 to 2005. FDI related information is provided by Bank of Slovenia through its annual mandatory survey of firms with foreign ownership and/or foreign direct investments abroad. Unfortunately, from otherwise rich survey data, only the indicators of inward and outward foreign direct investment were made available to me by Bank of Slovenia. The time span of this data source is 1994-2003 period. Trade data comes from Customs Office of the Republic of Slovenia and includes firm-level information on every import and export shipment of goods to and from Slovenia in the period 1994-2003. Among other, the information include the 6-digit TARIC code of the goods being shipped, the value in Slovene tolars and US dollars, country of origin and country of destination, physical quantity, and date of the dispatch. In classifying products into intermediate inputs, we use UN Comtrade classification of goods in SNA in the categories of BEC (Broad Economic Activities). However, we exclude Food and beverages, primary and processed categories (BEC codes 111 and 121, respectively), primary Fuels and lubricants category (BEC code 31), and primary Industrial supplies not elsewhere specified (BEC code 21). All value data are in Slovene tolars[6] and are deflated with corresponding 2-digit NACE industry producer price indices. In the empirical analysis only the data of firms larger or equal to 5 employees was used in order to partially clean the dataset from outliers. The other outliers were removed after the inspection of the most important variables (sales, employment and capital) industry by industry. Eventually, my database comprised of 4,197 manufacturing firms in the period 1994-2003, yielding 22,041 observations altogether.

[6] On 1st of January 2007, when euro was adopted in Slovenia, the conversion rate between Slovene tolars (SIT) and euro was 239,64 SIT/€.

5 Results

Table 1 reports descriptive statistics for variables in the period from 1994-2003. The comparison between continuous importers, switchers and non-importers reveals substantial differences between the three types of firms. The largest firms as indicated by sales, employment, and capital stock are firms that imported throughout the sample period. In addition, they have substantially higher labour productivity than the other two groups of firms. Non-importing firms, in contrast, are inferior in each of the selected performance measures, although the direction of causality is not clear from these simple descriptive statistics. On average, switchers are three to four times less import intensive than their continuously importing counterparts.

[Table 1 about here]

Table 2 provides a comparison between the three modes of input sourcing in terms of average relative values of firm characteristics with respect to the current average in the corresponding 3-digit NACE industries. Relative to the average firm in the same sector, domestic firms were only 30-40% as large in terms of employment and 20-30% of the average size in terms of total revenue. Non-importing firms are also around 20% less productive and 20-40% less capital intensive than an average firm in the same industry.

[Table 2 about here]

Relative productivity of domestic firms remained fairly constant in time while that of importers with outward FDI decreased by as much as 10 percentage points. The reason is that the growth of average labour productivity in offshore outsourcers was considerably higher than in the group of domestic sourcers and importers with outward FDI. However, since offshore outsourcers represent the majority of firms in Slovene manufacturing, their average relative productivity improved only marginally in the analysed time interval. In addition, the ordering of distinct groups of firms according to the discussed performance measures is consistent with the theoretical predictions in Antras and Helpman (2004).

Next, we turn to the quantitative aspects by exploring the relationship between the intensity of firms' involvement in foreign market sourcing and their performance. Table 3 reveals the association between the extent of foreign inputs sourcing and relevant firm characteristics in Slovene manufacturing firms. Contrary to export intensity (see Damijan & Kostevc, 2006 and Blalock & Gertler, 2004), higher intermediate inputs import intensity is associated with higher relative labour productivity. The same can be said for capital intensity and total revenue. Only in terms of size as measured by the number of employees, the most import intensive firms are dominated by firms with intermediate involvement in foreign input sourcing. Higher share of

foreign inputs in total material costs therefore appears to demand and/or cause higher productivity, capital intensity and size of importing firms.
[Table 3 about here]

The intensity of foreign input sourcing can either come about as a consequence of a larger number of imported varieties (extensive margin) or higher import values of existing range of imported varieties (intensive margin). If the former is at work, we should identify positive relationship between the number of imported varieties and productivity similar to the link between the extent of foreign sourcing and firm productivity. If each foreign intermediate input entails bearing some fixed cost, importing a broader range of inputs demands a firm to have higher productivity in order to cover all the fixed costs. Table 4 reveals that the productivity is uniformly increasing in the number of imported varieties of intermediate inputs.[7] Firms that import more than 100 varieties are on average almost 20% more productive than the average firm in a corresponding 3-digit industry, while the productivity of firms with more than ten inputs is only 2% above the average. Because of high collinearity between productivity and capital intensity, revenues and employment, the relationship between the latter three performance measures and the number of imported varieties exhibits the same robust pattern as with productivity.

[Table 4 about here]

Heterogeneity in importing behaviour is also reflected in the relationship between the number of import markets and firm characteristics (Table 5). As in the case of import intensity, relative productivity increases stepwise with the number of import markets. Firms that buy intermediates from more than 9 countries are on average 15% more productive than the average firm in the same narrowly defined industry. Except for minor irregularity in relative capital intensity, capital-labour ratio and the firm size as measured by the number of employees and total revenue increase monotonically with the number of import markets. Spreading the procurement network to a larger number and more distant countries entails higher fixed costs (because it requires establishing and maintaining costly business connections and other transaction costs) and thus demands higher productivity.

[Table 5 about here]

5.1 What happens to the firms that switch to foreign sourcing of intermediate inputs?

[7] Halpern, Koren, and Szeidl (2006) also find that the number of imported varieties is positively associated with firm productivity and size. In addition, they estimate that about two thirds of the increases in total factor productivity comes from the increased variety.

Up to this point, we have only analyzed static differences between importers of intermediate inputs and domestic firms. Although highly informative, the above findings do not establish any unambiguous causality from importing to various performance measures. In addition, importers are heterogeneous along many dimensions and differ not only from their domestically-oriented competitors but from their importing counterparts as well. To disentangle the effects of intermediate inputs importing from the self-selection effect, it is therefore not enough to compare the means of importers and non-importers but to focus on firms that switched from domestic to foreign input sourcing and impose even starker methodological restrictions. Having the privilege to work with firm-level longitudinal data, we can delve deeper into the dynamics of importing decision and its effect on various firm characteristics. This section turns its focus from static to dynamic analysis and from importers in general to new importers – firms that made a permanent change from domestic to foreign input sourcing sometime in the observed period 1994-2003. Despite bringing me one step closer to the evaluation of the true effects of importing, the following analysis will by no means provide definite and methodologically appropriate estimates. My aim in this section is to provide an idea of what is going on in new importers before, at and after the beginning of foreign sourcing. The reader has to bear in mind, however, that here we only compare new importers with the entire pool non-importers, disregarding important (prior) differences between the two groups of firms.

Productivity changes in new importers can be graphically represented by shifts in productivity distribution of firms in time. Figure 1a –1d hence represent the movements in distribution of the logarithm of value added per employee in 1994, 1998, and 2003. As a benchmark, we first present the evolution of productivity distribution for the whole sample of manufacturing firms, followed by the figures for non-importers and importers. These distributions can then be compared to the shifts in productivity distributions in new importers, where points of particular interest will be the position and shape of distribution functions.

[Figure 1 about here]

Figure 1a reveals that there has been a significant improvement in average productivity of Slovenian manufacturing firms as represented by stepwise shifts of productivity distributions in each of the three cross-section years. Alongside average productivity improvements, the changing shape of distribution functions reveals the reduction in the variance of productivity between firms as the distributions become more condensed. In the beginning of transition, market conditions allowed even relatively less productive firms to survive in the business, but as the environment became more competitive, less deviation from the average productivity was sustainable.

Figures 1b and 1c show that the initial distribution of non-importers was substantially more spread and had a lower mean than that of intermediate input importers. Next, while non-importers experienced a positive shift and concentration of productivity in the earlier stage of

transition period (1994-1998) and hardly any significant change from 1998 onwards, the group of importing firms increased their productivity substantially throughout the entire time interval. Third, the position of productivity distribution of importers was always to the right of the corresponding distribution of non-importers, while the productivity variance of importers remained lower than that of non-importers.

Finally, Figure 1d depicts the evolution of productivity distribution of new importers. Unlike Figures 1b and 1c, where only observations without and with positive imports are present, respectively, Figure 1d includes the observations of new importers regardless of their current import status. In other words, we include observations of new importers' productivity levels even before they actually started importing. The 1994 line therefore, by construction, shows the distribution of productivity levels of non-importing firms that will switch to importing anytime by 2003. On the other hand, by construction, the 2003 line shows importing firms that switched from domestic to foreign sourcing of intermediate inputs anytime in the 1995-2002 period. Compared to non-importers, new importers exhibit even stronger positive shifts in productivity distribution leading to the assumption that it was importing status that accelerated productivity growth in these firms. At the end of the period the shape of the distribution of new importers is almost identical to that of importers, while the distribution of non-importers remains more dispersed and positioned significantly to the left.

So far, we have presented some rather suggestive findings on the positive impact of intermediate inputs import initiation on firm productivity. In the remaining part of this section, we will inspect the effects of importing even more thoroughly by tracing the movement of various firm characteristics prior and after the starting year of foreign sourcing. New importers will be pooled and synchronized to the common technical timeline, so that year t will denote the first year of importing, t+1 the year after and so forth. Various performance indicators will then be observed for the group of new importers and averaged together. Figures 2a–2g present the progress of eight performance measures in 917 new importers available in my sample. A firm is tagged as new importer if it switched from zero imports of intermediate inputs to a positive value and continued importing uninterruptedly until the last observation available (2003 or the closure). This definition excludes firms that started importing inputs in the first year of their market presence. Because the foreign trade data is available only for the period 1994-2003, new importers will be identified from this period. Performance measures unrelated to trade flow information, however, will be tracked over the longer period between 1994 and 2005, for which the accounting data is available.

Figures 2a and 2b depict the development of relative productivity as measured by value added per employee and total factor productivity, respectively. Both measures experience very similar movement in time, but they differ in the relative position. While average relative labour productivity of future importers is below industry average, their relative total factor productivity outstrips the industry average already before the beginning of importing. It should be stressed, however, that both productivity measures are still higher than the averages

for non-importing firms, because both variables are expressed relative to industry average and not relative to non-importers. Bearing in mind this consideration, the self-selection into importing hypothesis remains valid also in this context. Both indicators of productivity increase substantially after the first year of importing and slightly decline in the last four periods ((t+7) – (t+10)). Nevertheless, even at the end of the 10th year of importing, relative productivity of the remaining new importers stays above the levels prior to import initiation.

Figures 2a and 2b reveal another interesting finding that casts light on the possible weakness of value added per employee as a measure of productivity. If we compare the biannual upward shift in both productivity indicators from t-1 to t+1, we observe that relative labour productivity increased by 13 percentage points (or by 14.4%), while the increase for TFP amounts to only 1.9 percentage points (or 1.87% growth rate). The difference lies in the fact that labour productivity accounts for the changes in only one production factor (labour), while TFP considers the adjustment of firm capital stock in addition to labour input. The explanation for substantial difference can therefore be found by looking at the changes in relative capital-labour ratio during the same period (Figure 2e). It turns out that new importers not only increased the number of employees relative to the industry average (Figure 2f), but augmented to an even larger degree their capital stocks as suggested by the increase of relative capital intensity by 11 percentage points (or by 13%). Due to the observed stickiness of labour relative to capital input, the productivity measured by value added per employee overstates the actual productivity gains of importing as it assigns all the output growth to labour.

Figure 2c uncovers the fact that the largest improvement of performance in the period of importing comes in the form of significantly larger relative sales that escalate from less than 50% of the industry average a year before import start to roughly the industry average by the 7th or 10th subsequent year. In the years prior to import launch, the would-be importers were actually losing their relative market position. From this perspective, offshoring appears to be a deliberate strategic decision by which a firm is to be pulled out of the flagging condition. The evolution of employment in new importers closely relates to the movement in total revenue, although the shifts appear more moderate and even (Figure 2d). Unlike total revenue, employment in new importers never reaches the industry average but evens out at around 85%.

[Figure 2 about here]

The evidence in the previous sections revealed that more productive importers source broader range of distinct intermediate inputs from a larger number of countries and exhibit a larger share of foreign intermediates in the total material costs. Besides, the last figures also showed that new importers notably increase relative productivity after they start importing, so we examine whether these productivity gains influence the extent of involvement in foreign sourcing also in new importers. Figure 2f trails the number of imported varieties in an average

new importer through time. The number of varieties starts at 16 in the first year and gradually increases to 35 in the 8th year. Comparing the latter figure with the average number of varieties for the entire population of importers (48 varieties) reveals that broadening the range of imported intermediate inputs is a lengthy and demanding process. Apparently, firms need to gain experience, efficiency, absorptive capacity, and business networks as they carry out foreign sourcing in order to advance to broader range of foreign inputs.

Figure 2g follows the average number of countries from which new importers source their inputs. In the first six years of importing, additional import market is added every two years. After the ninth year, average new importer sources from 5 countries, up from 3.6 in the starting year. It appears that expanding to an additional import market requires a lot of resources since new importers are much faster at extending the range of intermediate inputs from abroad than spreading the upstream vertical chain geographically. However, given that the average number of import countries for the entire population of importers is 7.5, it can be observed that after nine years of importing denovo importers still lag significantly in the number of imported inputs and the number of countries from which these are procured. Finally, Figure 2h depicts the share of foreign inputs in new importers' material cost. Starting small, the share gradually increases from 10% to around 20% (the industry average) in the 9th year of importing. The doubling of the share in the period of 9 years is consistent with the doubling the number of imported input varieties, whereas the increase in the number of origin countries is much more modest.

5.2 Results from propensity score matching

we now turn to the main results as shown in Tables 6 – 9 where we present the average treatment effect[8] and cumulative effect of foreign sourcing of intermediate inputs on firm productivity. Table 6 presents the results for labour productivity where new importers' productivity growth rates[9] are tracked from the two years before to the end of the third year after the beginning of importing. As explained in the methodological section, average treatment effect is calculated as the average of the difference in (time) differences between new importers and the corresponding control group. The estimate gives the productivity growth premium new importers have experienced in each of the observed period. In other words, we estimate the excess (relative to that of a comparable group of non-importing firms) year-on-year increase in labour productivity before, at, and after the start of foreign sourcing.

[Table 6 about here]

[8] In the remainig part of the paper, we always refer to the average treatment effect *on the treated*.

[9] In case of value added per employee the use of the term growth rate is actually not exactly appropriate, since we are referring to the time differential of labour productivity ($y_{it} - y_{it-1}$). For the sake of brevity, however, we use the term growth rate. In case of total factor productivity, on the other hand, the use of the term is exact since TFP enters in logarithms, so that the time differential is an acceptable proxy for growth rate ($\ln y_{it} - \ln y_{it-1} \approx dy/dt$).

The results reveal that prior to the switch from domestic to foreign sourcing, prospective importers on average grew at the same rate as the control group since average DID_{-2} and DID_{-1} are not significantly different from zero. Already in the first year of importing, however, new importers significantly improved their labour productivity growth relative to control group of non-exporters. The average treatment effect is highly significant in all four variants of propensity score matching and can be interpreted as an additional increase of labour productivity in the amount of 550 thousand Slovene tolars of value added per employee. Compared to manufacturing average over the entire period 1994-2005 (2,680 thousand tolars), this amount represents a 20% increase of value added per employee. The effect remains significant in the following year but falls to roughly 220 thousand tolars in the case of nearest neighbour matching techniques. Next two periods' growth rates of new importers in excess of the growth rates in control firms drop further towards zero and become insignificant. Apparently, the effect of intermediate inputs imports on productivity growth is short lasting since new importers improve their productivity on the year-to-year basis significantly more than similar non-exporters only in the first two years of importing, whereas in the following years the growth premium dissipates.

[Table 7 about here]

However, the lack of significance in the average treatment effect in the second and the third year after import initiation should not be interpreted as the absence of productivity effect of importing. Even though the productivity of new importers stops growing significantly faster than that of non-exporters, the former can still experience higher year-on-year growth rates of productivity, leading to higher, increasing and persistently significant productivity level differential. To test for the existence of cumulative productivity gains in the absence of significant year-to-year growth rate differentials, we observe the entire productivity path of import entrants and compare it to that of the control group by estimating the productivity gain after s years of importing.

Table 7 reports the results of the average cumulative effect of foreign sourcing on labour productivity. In all four years after the import initiation, the productivity gains (relative to the year before importing) are higher in new importers than in control non-importers. The results are highly significant in each estimation technique and highly comparable in values. At the end of the third year after the beginning of importing, labour productivity in denovo importers is 1 million tolars per employee higher than would be had they not started importing intermediate inputs. This means that in each of the four years of importing, new importers increased their productivity on average by 250 thousand tolars per employee more than their competitors from the control group.

In light of the shortcomings of value added per employee as a measure of firm productivity, we present the results for analogous propensity score matching analysis on the total factor productivity estimated in the previous section by Kasahara-Rodrigue estimator.[10]

As before, new importers grow significantly faster than non-importers only in the first and conditionally the second year (Table 8). The extra growth rate of productivity in the first year of importing is impressive: the average productivity of new importers increases by as much as 20 percentage points faster than in non-importing firms. Compared to similar analysis of new exporters on the same data set, De Loecker (2007) and Damijan et. al. (2008) find significant but lower effects of exporting on productivity growth in the first year: 8 and 14 percentage points, respectively. In the second year after import initiation, the growth premium decreases to around 5 percentage points but remains significant only at 10% significance level. In the following periods new importers do not experience any significantly higher productivity growth in comparison to similar non-importers.

[Table 8 about here]

Despite the short-lived year-to-year growth effects of importing, firms that switched from domestic to foreign sourcing of intermediate inputs achieve significantly higher cumulative productivity improvements relative to the year prior to the change (Table 9). Cumulative effects are highly significant in all the years and, above all, increase steadily in time. After initial 20 percentage point hike, new importers later on gain additional 15 percentage points, so that by the end of the fourth year of importing, their four-year productivity growth is around 35 percentage points higher than the growth rate in control firms. The reassuring feature of the results is that the estimated effects are robust across different estimation techniques and number of observations. In addition, in the year prior to import initiation, prospective importers and their control counterparts experience equal productivity changes. Insignificant in any case, the difference in productivity growth between new importers and non-importers in this period is negative, rebutting possible claims that the productivity trend is higher already prior to the change.

[Table 9 about here]

In order to further substantiate the positive shift of productivity growth in the first years of offshoring compared to the periods before, we run the regression as specified in equation (4), where we compare productivity growth rates (*DIDs*) in the periods after the switch to foreign sourcing with those prior to import initiation. We additionally control for other factors that might influence the excess growth rate of new importers, such as capital intensity, imported

[10] The use of OLS estimates of production function did not change the results because the alternative TFP measures appear to be robust to time differencing. In other words, different coefficients in production function affect the levels of measured productivity but hardly the time changes – exactly what enters in my matching analysis.

inputs share, foreign ownership, multinationality status, and common time-specific industry-wide shocks. The emphasis in these regressions will be given to the temporal effects of import status expressed by the size and significance of a series of dummy variables ($start_s$). These will tell by how much, controlling for other factors, import of intermediate inputs increases productivity growth relative to non-importing firms and relative to periods before imports started. Difference-in-differences in the importing periods will thus be compared to the difference-in-differences prior to foreign sourcing initiation and this will identify the duration and significance of the perceived benefits from importing.

[Table 10 about here]

Table 10 reports the results for the difference-in-differences regression using value added per employee as a productivity measure. In contrast to Table 6 where the average treatment effect was significant only in the first two periods, the regressions above indicate that also the third year of importing brings about significantly higher productivity increases relative to control non-importers. Lagged dependent variable is also significant and negatively signed, meaning that high productivity growth in the previous period implies lower productivity growth in the present. Outward FDI (*oFDI*) is insignificant in all specifications which indicates that the effect of foreign sourcing does not differ between multinational and non-multinational new importers. In other words, captive offshoring does not seem to result in higher gains from international fragmentation of production chain. Where significant, the coefficient on foreign ownership (*iFDI*) is positive and of significant size with respect to other coefficients. Sourcing within foreign multinational network thus seem to be more beneficial for firm productivity growth. The reasons could be leaner supply chain, more sophisticated intermediate inputs, better control over the quality of inputs, superior on-time delivery, better cooperation and support services, and better management. Capital intensity and the intensity of input sourcing do not seem to have any significant effects although the coefficients are positive.

[Table 11 about here]

Similarly, Table 11 reports results for the impact of importing on productivity growth as measured by total factor productivity. As before, we find evidence of significantly higher productivity growth in the first two years of importing, yet in some specifications the third and the fourth year are significant as well. Lagged productivity enters significantly negative, while imported input share and lagged relative capital intensity do not affect current productivity growth rates. Importers with outward direct investment do not increase TFP significantly different than non-multinational new importers, but foreign-owned firms on average do grow faster than domestic new importers.

6 Conclusion

The purpose of the paper was to investigate productivity effects of offshoring using the data on the use of imported intermediate inputs in Slovenian manufacturing firms from 1994-2005. The theoretical prediction about the arrangement of firms according to their organizational mode was corroborated: the largest, most capital intensive and productive firms are importers with outward FDI, followed by non-multinational importers of intermediates and lastly the domestic sourcing firms. Productivity turned out to be positively correlated with import intensity (share of imported intermediate inputs in total inputs), import variety (number of distinct imported varieties of intermediate inputs) and geographical dispersion of imported inputs (number of sourcing countries). When applying propensity score matching and difference-in-differences regressions, we found that offshoring temporarily boosts productivity growth and increases productivity levels of new importers over a medium term. Estimated productivity effect from foreign sourcing of intermediate inputs is substantial and even higher than the effect of starting to export when comparing similar analyses of new exporters using the same data set. In the first year, offshoring brings about a 20% increase in labour productivity and approximately equal growth of total factor productivity. Despite the short-lived year-on-year growth rates of productivity in excess of non-importers, cumulative gain in productivity of new importers after four years remains significant at around 37% for labour productivity and 35% for total factor productivity.

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Appendix

Table 1: Descriptive statistics in 1994-2003

	Sales	VA/L	Emp	Capital	Mtotshare	Minpshare	Obs / N firms
All firms	887,716.0	2,531.1	97.3	356,737.2	0.241	0.150	22,041
	(27,920.8)	(14.72)	(1.78)	(9,140.5)	(0.002)	(0.001)	4,197
Continuous importers	1,267,127.0	2,802.5	137.2	511,693.6	0.351	0.220	13,301
	(42,636.1)	(19.33)	(2.65)	(13,832.7)	(0.002)	(0.002)	2,182
Non-importers	82,690.4	1,528.9	20.9	30,725.9			1,368
	(5,949.8)	(25.74)	(1.05)	(4,805.3)			480
Switchers	352,546.2	2,227.3	39.5	137,652.6	0.098	0.054	7,372
	(30,977.3)	(25.33)	(2.12)	(10,397.9)	(0.002)	(0.002)	1,535

Notes: Standard errors are in parentheses. The statistics are based on the restricted sample that excludes firms with less than 5 employees. *Continuous importers* are firms that imported every period. *Non-importers* are firms that never imported in the sample period. *Switchers* are firms that switched their import status at least once. *Sales*, value added per employee (*VA/L*), and *capital* are measured in 1000 Slovene tolars. *Emp* is the number of workers. Total import ratio (*Mtotshare*) and intermediate inputs import ratio (*Minpshare*) are the ratios of imports to total material cost. *Obs* is the number of observations (firm-year units) and *N firms* is the number of firms in the 1994-2003 period.

Source: own calculations.

Table 2: Average relative sales, labour productivity, employment and capital-labour ratio by intermediate input sourcing mode, 1994-2003.

	Domestic sourcing only					Importers without oFDI					Importers with oFDI				
	rsales	rval	rl	rkl	N	rsales	rval	rl	rkl	N	rsales	rval	rl	rkl	N
1994	0.25	0.83	0.31	0.75	310	0.89	1.01	0.92	1.01	1,231	3.57	1.26	3.22	1.45	142
1995	0.19	0.81	0.32	0.77	381	0.92	1.03	0.92	1.03	1,413	3.87	1.19	3.57	1.34	146
1996	0.27	0.81	0.34	0.80	489	0.93	1.07	0.93	1.03	1,391	4.12	1.15	3.83	1.42	148
1997	0.27	0.80	0.34	0.67	502	0.92	1.04	0.91	1.05	1,452	4.27	1.30	4.07	1.66	149
1998	0.28	0.84	0.35	0.70	548	0.94	1.04	0.94	1.04	1,524	3.96	1.21	3.71	1.65	165
1999	0.23	0.78	0.31	0.65	577	0.97	1.07	0.97	1.09	1,564	4.04	1.13	3.80	1.41	162
2000	0.22	0.76	0.29	0.63	551	0.89	1.06	0.89	1.09	1,604	4.22	1.19	4.02	1.29	189
2001	0.24	0.78	0.36	0.67	583	0.87	1.05	0.86	1.08	1,586	3.83	1.21	3.61	1.29	229
2002	0.26	0.80	0.39	0.71	624	0.84	1.05	0.83	1.06	1,568	3.49	1.18	3.26	1.32	287
2003	0.27	0.81	0.41	0.68	601	0.86	1.04	0.84	1.07	1,671	3.68	1.16	3.45	1.30	254

Note: The statistics are based on the restricted sample that excludes firms with less than 5 employees. The variables included are: *rsales* – relative total revenue; *rval* – relative value added per employee; *rl* – relative number of employees; *rkl* – relative tangible fixed assets per employee; *N* – number of firms.

Source: own calculations.

Table 3: Relative labour productivity, capital-labour ratio, employment and sales with respect to the share of imported intermediate inputs in total material costs, 1994-2003 average.

Import share (m)	rval	rkl	rl	rsales	N
m=0	0.801	0.697	0.339	0.250	5,159
m>0	1.065	1.092	1.206	1.238	16,626
0<m<0.30	1.041	1.086	1.050	1.037	12,393
0.30<m<0.50	1.103	1.093	1.727	1.819	2,511
0.50<m<1	1.179	1.130	1.563	1.839	1,722

Note: The statistics are based on the restricted sample that excludes firms with less than 5 employees. The variables included are: *rsales* – relative total revenue; *rval* – relative value added per employee; *rl* – relative number of employees; *rkl* – relative tangible fixed assets per employee; *N* – number of firms.

Source: own calculations.

Table 4: Relative labour productivity, capital-labour ratio, employment and sales with respect to the number of imported varieties, 1994-2003 average.

No. of imported varieties (v)	rval	rkl	rl	rsales	N
v=0	0.779	0.660	0.337	0.234	4,034
0<v<5	0.917	0.911	0.404	0.358	3,432
5≤v<10	1.009	1.031	0.504	0.483	2,017
10≤v<20	1.018	1.068	0.577	0.542	2,670
20≤v<30	1.053	1.114	0.695	0.685	1,878
30≤v<50	1.097	1.085	0.965	0.944	2,730
50≤v<100	1.113	1.129	1.454	1.505	3,079
v≥100	1.194	1.272	3.790	4.075	2,194

Note: The statistics are based on the restricted sample that excludes firms with less than 5 employees. The variables included are: *rsales* – relative total revenue; *rval* – relative value added per employee; *rl* – relative number of employees; *rkl* – relative tangible fixed assets per employee; *N* – number of firms. Number of imported varieties is defined as the number of distinct 6-digit tariff products imported by a firm in a given year.

Source: own calculations.

Table 5: Relative labour productivity, capital-labour ratio, employment and sales with respect to the number of import markets, 1994-2003 average.

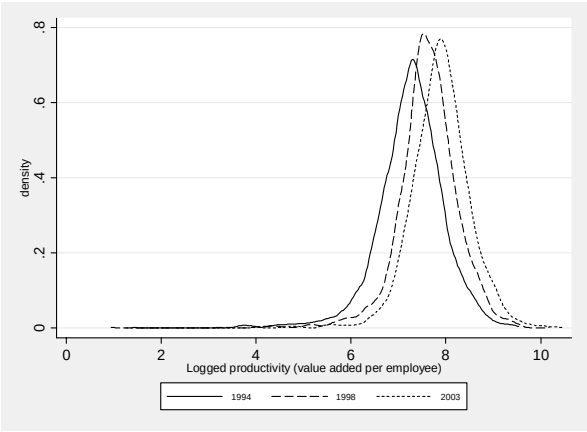
No. of import markets (n)	rval	rkl	rl	rsales	N
n=0	0.779	0.660	0.337	0.234	4,034
n=1	0.891	0.848	0.368	0.306	2,933
n=2	0.972	0.977	0.449	0.402	2,222
n=3	1.015	1.098	0.546	0.522	1,916
4≤n<6	1.079	1.146	0.697	0.704	2,799
6≤n<8	1.078	1.081	0.906	0.911	1,993
8≤n<10	1.119	1.159	1.159	1.187	1,436
n≥10	1.154	1.188	2.581	2.724	4,701

Note: The statistics are based on the restricted sample that excludes firms with less than 5 employees. The variables included are: *rsales* – relative total revenue; *rval* – relative value added per employee; *rl* – relative number of employees; *rkl* – relative tangible fixed assets per employee; *N* – number of firms.

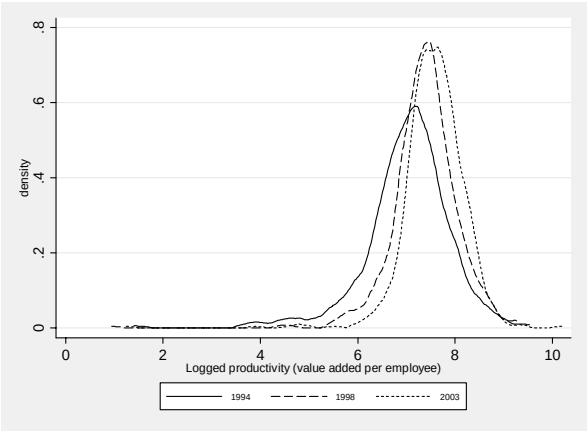
Source: own calculations.

Figure 1a-d: Distribution of a) Slovenian manufacturing firms, b) non-importing firms, c) importing firms, and d) new importers according to their productivity in 1994, 1998, and 2003.

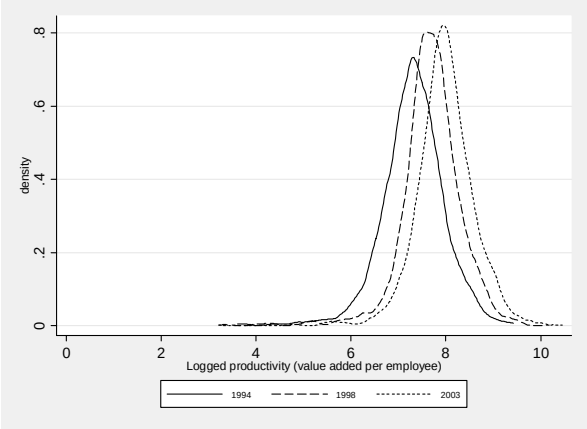
a) all firms



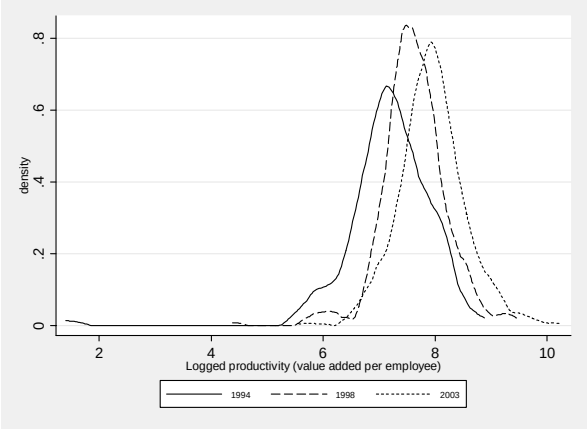
b) non-importers



c) importers



d) new importers

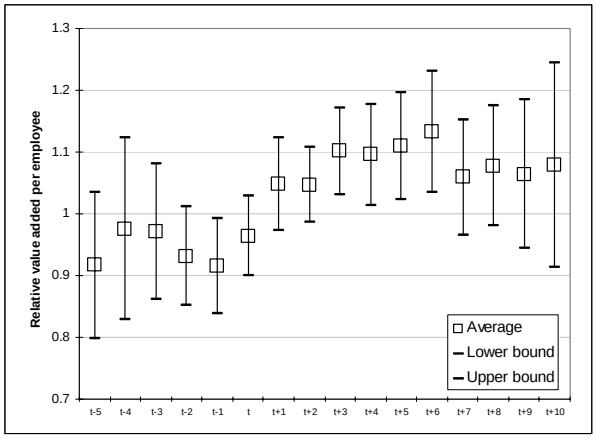


Note: The figures are based on the restricted sample that excludes firms with less than 5 employees. Lines represent univariate kernel density estimates of the distribution of logged productivity.

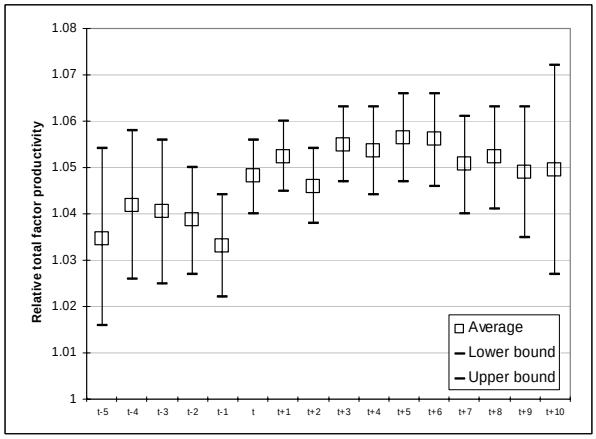
Source: own calculations.

Figure 2a-g: Performance of new importers before, at, and after the beginning of foreign input sourcing as measured by relative labour productivity (a), relative total factor productivity (b), relative sales (c), relative employment (d), relative capital intensity (e), number of imported varieties (f), number of imported markets (g), and share of imported intermediate inputs in total material costs, 1994-2005.

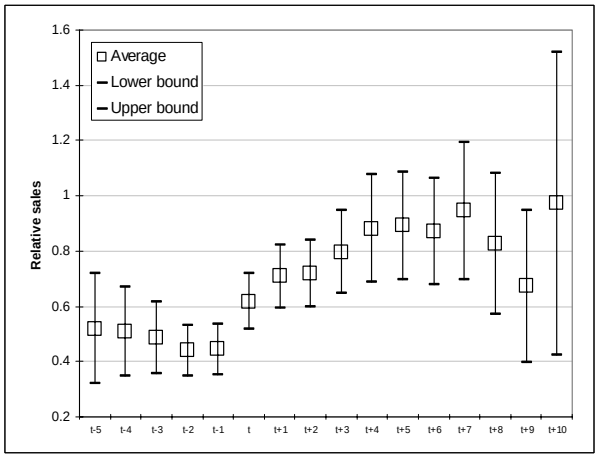
a)



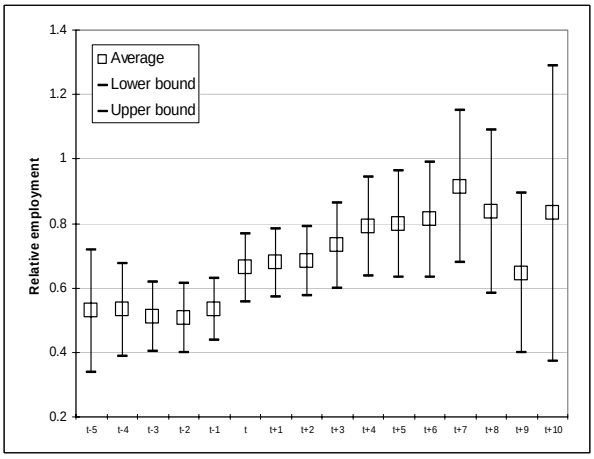
b)



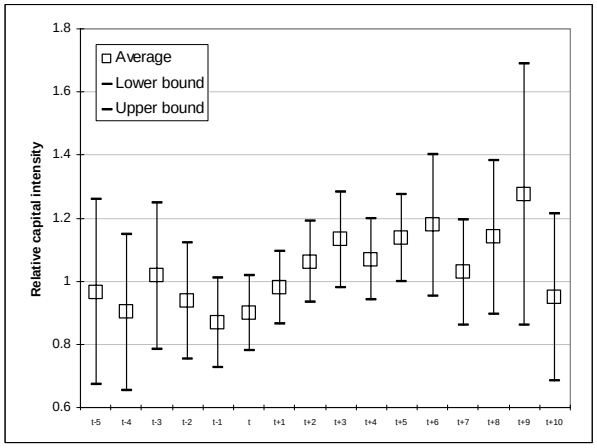
c)



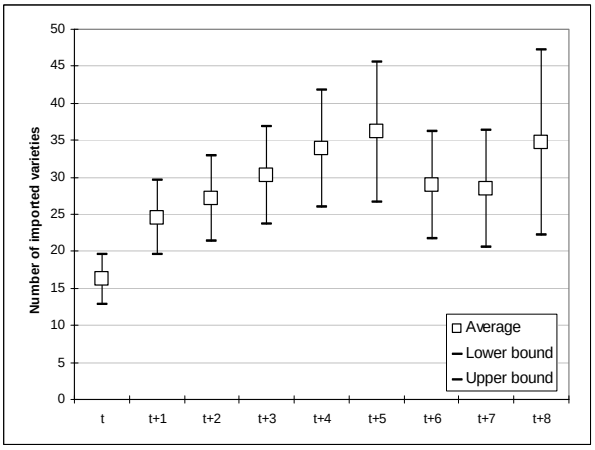
d)



e)

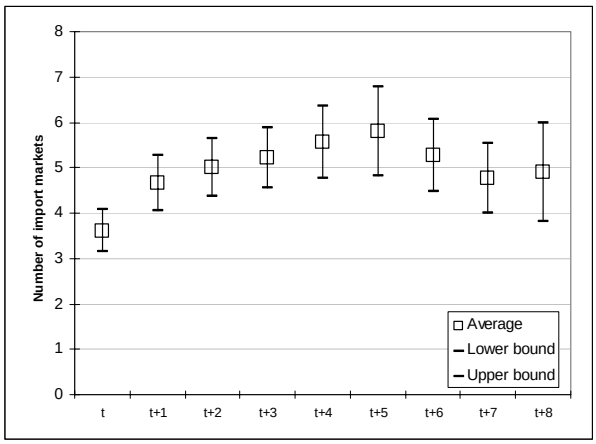


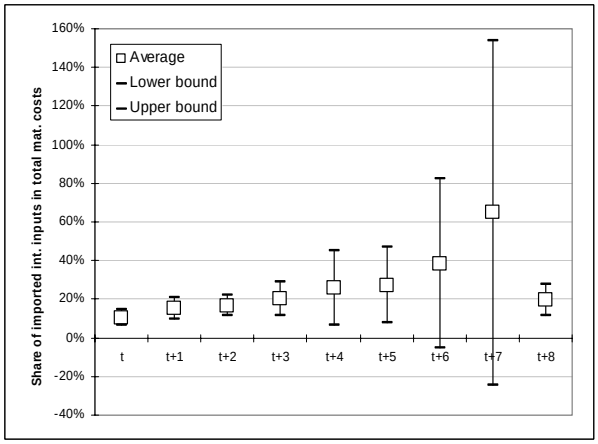
f)



g)

h)





Note: The statistics are based on the restricted sample that excludes the firms with less than 5 employees. New importers are firms that switched from non-importing to permanent foreign sourcing somewhere in the period 1995-2003. Performance measures for these new importers cover the period 1994-2005. Lower and upper bounds represent the 95% confidence interval for the average value of performance measure. Time *t* denotes technical time and is set in the way that *t+k* represents *k* years after the beginning of intermediates importing.

Source: own calculations.

Table 6: Average treatment effect of importing intermediate inputs on the growth of labour productivity (measured by value added per employee), 1994-2005.

Time span	Matching type	ATT	SE[a]	Pr	Obs
DID_{-2}	nearest neighbour	37.663	123.930	0.3805	267
	k-nearest neighbours	84.850	110.390	0.2210	267
	mahalanobis	-188.602	106.033	0.9625	109
	mahalanobis w caliper	-152.940	125.392	0.8885	103
DID_{-1}	nearest neighbour	-240.215	112.779	0.9000	369
	k-nearest neighbours	-239.937*	175.733	0.9140	369
	mahalanobis	-45.055	116.344	0.6505	154
	mahalanobis w caliper	30.388	108.807	0.3900	142
DID_{0}	nearest neighbour	546.653***	116.840	0.0000	517
	k-nearest neighbours	578.616***	95.965	0.0000	517
	mahalanobis	548.401***	92.174	0.0000	247
	mahalanobis w caliper	514.248***	95.013	0.0000	233
DID_{+1}	nearest neighbour	236.173**	111.999	0.0175	469
	k-nearest neighbours	199.094***	75.270	0.0040	469
	mahalanobis	70.079	111.881	0.2655	208
	mahalanobis w caliper	104.914	174.282	0.2735	197
DID_{+2}	nearest neighbour	134.399*	96.998	0.0830	434
	k-nearest neighbours	66.125	73.269	0.1835	434
	mahalanobis	99.136	108.901	0.1815	186
	mahalanobis w caliper	99.168	159.117	0.2665	175

DID_{+3}	nearest neighbour	10.365	137.642	0.4700	284
	k-nearest neighbours	8.863	112.987	0.4685	284
	mahalanobis	25.431	171.368	0.4410	104
	mahalanobis w caliper	69.960	195.605	0.3605	102

Notes: DID_t denotes $\Delta y_{it}^{Newimporter} - \Delta y_{it}^{Control}$, where *y* is value added per employee (in 1,000 Slovene tolars). [a] bootstrapped standard errors (100 repetitions). For nearest neighbour matching sub-sampling based standard errors (100 repetitions) are reported. *, **, *** indicate significance at 10%, 5% and 1% level, respectively.

Source: own calculations.

Table 7: Cumulative effect of importing intermediate inputs on the growth of labour productivity (measured by value added per employee), 1994-2005.

Time span	Matching type	ATT	SE[a]	Pr	Obs
CUM_0	nearest neighbour	546.653***	116.840	0.0000	517
	k-nearest neighbours	578.616***	95.965	0.0000	517
	mahalanobis	548.401***	92.174	0.0000	247
	mahalanobis w caliper	514.248***	95.013	0.0000	233
CUM_1	nearest neighbour	692.892***	120.825	0.0000	469
	k-nearest neighbours	694.063***	93.110	0.0000	469
	mahalanobis	769.523***	175.554	0.0000	213
	mahalanobis w caliper	762.706***	197.771	0.0000	199
CUM_2	nearest neighbour	827.364***	137.518	0.0000	436
	k-nearest neighbours	798.025***	116.096	0.0000	436
	mahalanobis	888.347***	144.549	0.0000	186
	mahalanobis w caliper	869.714***	145.444	0.0000	174
CUM_3	nearest neighbour	999.305***	196.175	0.0000	288
	k-nearest neighbours	945.410***	156.949	0.0000	288
	mahalanobis	1034.032***	219.338	0.0000	107
	mahalanobis w caliper	1102.297***	228.316	0.0000	105

Notes: CUM_t denotes $\left(y_{i,s=t} - y_{i,s=-1}\right)^{Newimporter} - \left(y_{i,s=t} - y_{i,s=-1}\right)^{Control}$, where *y* is value added per employee (in 1,000 Slovene tolars). [a] bootstrapped standard errors (100 repetitions). For nearest neighbour matching sub-sampling based standard errors (100 repetitions) are reported. *, **, *** indicate significance at 10%, 5% and 1% level, respectively.

Source: own calculations.

Table 8: Average treatment effect of importing intermediate inputs on the growth of productivity (measured by total factor productivity), 1994-2005.

Time span	Matching type	ATT	SE[a]	Pr	Obs
DID_{-2}	nearest neighbour	-0.057	0.065	0.8080	218
	k-nearest neighbours	-0.049	0.054	0.8210	218
	mahalanobis	-0.060	0.067	0.8145	91
	mahalanobis w caliper	-0.070	0.080	0.8085	85

DID_{-1}	nearest neighbour	-0.058	0.057	0.8456	295
	k-nearest neighbours	-0.053	0.039	0.9120	295
	mahalanobis	-0.051	0.068	0.7730	132
	mahalanobis w caliper	-0.032	0.067	0.6815	116
DID_0	nearest neighbour	0.198***	0.048	0.0000	453
	k-nearest neighbours	0.222***	0.037	0.0000	453
	mahalanobis	0.208***	0.048	0.0000	206
	mahalanobis w caliper	0.189***	0.045	0.0000	198
DID_{+1}	nearest neighbour	0.061*	0.046	0.0885	425
	k-nearest neighbours	0.042*	0.029	0.0770	425
	mahalanobis	0.101*	0.066	0.0615	174
	mahalanobis w caliper	0.057	0.072	0.2165	161
DID_{+2}	nearest neighbour	0.060*	0.042	0.0785	398
	k-nearest neighbours	-0.004	0.028	0.5525	398
	mahalanobis	-0.055	0.053	0.8529	157
	mahalanobis w caliper	-0.044	0.054	0.7929	148
DID_{+3}	nearest neighbour	0.002	0.047	0.4830	256
	k-nearest neighbours	0.001	0.031	0.4855	257
	mahalanobis	0.117**	0.063	0.0315	81
	mahalanobis w caliper	0.077	0.082	0.1760	78

Notes: DID_t denotes $\Delta y_{it}^{Newimporter} - \Delta y_{it}^{Control}$, where y is total factor productivity. [a] bootstrapped standard errors (100 repetitions). For nearest neighbour matching sub-sampling based standard errors (100 repetitions) are reported. *, **, *** indicate significance at 10%, 5% and 1% level, respectively.

Source: own calculations.

Table 9: Cumulative effect of importing intermediate inputs on the growth of productivity (measured by total factor productivity), 1994-2005.

Time span	Matching type	ATT	SE[a]	Pr	Obs
CUM_0	nearest neighbour	0.198***	0.048	0.0000	453
	k-nearest neighbours	0.222***	0.037	0.0000	453
	mahalanobis	0.208***	0.048	0.0000	206
	mahalanobis w caliper	0.189***	0.045	0.0000	198
CUM_1	nearest neighbour	0.243***	0.062	0.0000	411
	k-nearest neighbours	0.275***	0.042	0.0000	411
	mahalanobis	0.327***	0.061	0.0000	179
	mahalanobis w caliper	0.287***	0.080	0.0000	164
CUM_2	nearest neighbour	0.265***	0.067	0.0000	378
	k-nearest neighbours	0.247***	0.049	0.0000	378
	mahalanobis	0.206***	0.057	0.0000	162

	mahalanobis w caliper	0.166***	0.070	0.0090	153
CUM_3	nearest neighbour	0.344***	0.074	0.0000	240
	k-nearest neighbours	0.345***	0.063	0.0000	240
	mahalanobis	0.414***	0.070	0.0000	83
	mahalanobis w caliper	0.332***	0.101	0.0005	80

Notes: CUM_t denotes $\left(y_{i,s=t} - y_{i,s=-1}\right)^{Newimporter} - \left(y_{i,s=t} - y_{i,s=-1}\right)^{Control}$, where y is total factor productivity. [a] bootstrapped standard errors (100 repetitions). For nearest neighbour matching sub-sampling based standard errors (100 repetitions) are reported. *, **, *** indicate significance at 10%, 5% and 1% level, respectively.

Source: own calculations.

Table 10: Productivity improvements of new importers relative to domestic sourcers of intermediate inputs (difference-in-differences matching using value added per employee), 1994-2005.

	nearest neighbour		k-nearest neighbours		mahalanobis		mahalanobis w caliper	
$rval_{t-1}$	-471.349***		-497.595***		-215.955**		-236.929**	
	(-7.06)		(-8.72)		(-2.50)		(-2.19)	
rkl_{t-1}	36.640	-38.756	43.346*	-36.248*	37.767	28.361	56.087	46.611
	(1.36)	(-1.55)	(1.88)	(-1.68)	(0.91)	(0.68)	(1.10)	(0.91)
start0	775.319***	793.926***	775.817***	795.460***	594.494***	632.200***	534.235***	578.999***
	(4.92)	(4.98)	(5.76)	(5.79)	(4.36)	(4.65)	(3.11)	(3.38)
start1	613.799***	524.118***	536.047***	441.372***	225.627	199.666	173.863	147.172
	(3.46)	(2.92)	(3.53)	(2.86)	(1.42)	(1.25)	(0.87)	(0.74)
start2	621.081***	502.587**	499.877***	374.785**	280.000	254.787	334.870	310.729
	(3.15)	(2.53)	(2.97)	(2.19)	(1.51)	(1.37)	(1.43)	(1.33)
start3	339.537	217.236	315.236*	186.125	249.233	230.388	293.676	273.693
	(1.58)	(1.00)	(1.72)	(1.00)	(1.15)	(1.06)	(1.10)	(1.02)
$Minpshare_t$	165.464	291.869	48.369	181.813	195.438	228.908	187.730	220.906
	(0.54)	(0.95)	(0.19)	(0.69)	(0.97)	(1.14)	(0.76)	(0.90)
$oFDI_t$	-170.771	-239.386	-22.909	-95.345	-383.805	-481.614	-554.017	-661.908
	(-0.29)	(-0.40)	(-0.05)	(-0.18)	(-0.47)	(-0.58)	(-0.55)	(-0.66)
$iFDI_t$	-20.093	-130.505	310.188	193.627	866.634**	774.368**	908.285**	805.217*
	(-0.05)	(-0.34)	(0.95)	(0.58)	(2.30)	(2.06)	(1.97)	(1.75)
Ind. dummies	no	no	no	no	no	no	no	no
Time dummies	yes	yes	yes	yes	yes	yes	yes	yes
N	1847	1847	1847	1847	760	760	719	719
adj. R^2	0.0378	0.0121	0.0559	0.0172	0.0489	0.0422	0.0351	0.0298

Notes: the dependent variable is $\Delta y_{it}^{Newimporter} - \Delta y_{it}^{Control}$, where y is value added per employee (in 1,000 Slovene tolars); t-statistics are in parentheses. *, **, *** indicate significance at 10%, 5% and 1% level, respectively.

Source: own calculations.

Table 11: Productivity improvements of new importers relative to domestic sourcers of intermediate inputs (difference-in-differences matching using total factor productivity), 1994-2005.

	nearest neighbor		k-nearest neighbours		mahalanobis		mahalanobis w caliper	
$rtfp_{t-1}$	-2.670***		-2.686***		-3.248***		-3.388***	
	(-14.26)		(-18.96)		(-10.64)		(-10.13)	
rkl_{t-1}	0.002	-0.012	0.003	-0.011	0.000	-0.009	0.002	-0.007
	(0.24)	(-1.37)	(0.53)	(-1.57)	(-0.01)	(-0.66)	(0.13)	(-0.51)
start0	0.270***	0.274***	0.300***	0.304***	0.258***	0.316***	0.241***	0.295***
	(4.84)	(4.63)	(7.10)	(6.52)	(3.44)	(3.90)	(2.96)	(3.35)
start1	0.262***	0.192***	0.207***	0.136***	0.255***	0.206**	0.193**	0.137
	(4.17)	(2.89)	(4.35)	(2.61)	(2.88)	(2.15)	(2.00)	(1.31)
start2	0.243***	0.149**	0.174***	0.080	-0.008	-0.062	0.074	0.005
	(3.52)	(2.05)	(3.33)	(1.39)	(-0.08)	(-0.57)	(0.66)	(0.04)
start3	0.122	0.008	0.180***	0.065	0.339***	0.233*	0.270*	0.162
	(1.59)	(0.09)	(3.12)	(1.03)	(2.64)	(1.68)	(1.94)	(1.08)
$Minpshare_t$	0.062	0.182	-0.002	0.120	-0.069	0.013	-0.150	-0.051
	(0.45)	(1.25)	(-0.02)	(1.04)	(-0.42)	(0.07)	(-0.84)	(-0.27)
$oFDI_t$	-0.216	-0.295	-0.058	-0.138	-0.394	-0.383	-0.562	-0.524
	(-1.02)	(-1.32)	(-0.36)	(-0.78)	(-0.92)	(-0.82)	(-1.24)	(-1.07)
$iFDI_t$	0.292**	0.171	0.289***	0.168	0.276	0.249	0.525*	0.395
	(2.19)	(1.22)	(2.87)	(1.51)	(1.05)	(0.87)	(1.77)	(1.23)
Ind. dummies	no	no	no	no	no	no	no	no
Time dummies	yes	yes	yes	yes	yes	yes	yes	yes
N	1673	1673	1673	1673	659	659	615	615
adj. R^2	0.1224	0.0152	0.1992	0.0258	0.1655	0.0197	0.1632	0.0209

Notes: the dependent variable is $\Delta y_{it}^{Newimporter} - \Delta y_{it}^{Control}$, where *y* is total factor productivity; t-statistics are in parentheses. *, **, *** indicate significance at 10%, 5% and 1% level, respectively.

Source: own calculations.