INTERNATIONAL FRAGMENTATION OF PRODUCTION AND FIRM PRODUCTIVITY: EVIDENCE FROM SLOVENIAN MANUFACTURING FIRMS

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Povzetek:

Vedno večje število podjetij se odloča za zunanje izvajanje neključnih funkcij z namenom zniževanja stroškov in osredotočanja na ključne kompetence. Članek prispeva k omejenemu naboru empirične literature na temo kavzalne povezanosti čezmejnega zunanjega izvajanja proizvodnje vmesnih dobrin in produktivnosti podjetja. Namen raziskave je preveriti prisotnost pozitivnega učinka mednarodnega zunanjega izvajanja del pri produktivnosti podjetij. V ta namen uporabim panelno podatkovno bazo slovenskih podjetij iz predelovalne industrije v obdobju 1994–2005 s podrobnimi računovodskimi informacijami, podatki o mednarodni trgovini na ravni podjetij in podatki o neposrednih tujih investicijah.

Primerjava značilnosti podjetij z izključno domačimi viri vmesnih proizvodov ter uvoznikov brez neposredne tuje investicije v tujini in z njo potrdi teoretične napovedi glede vrstnega reda skupin podjetij po uspešnosti poslovanja. Najproduktivnejša, največja in najbolj kapitalno intenzivna so podjetja, ki uvažajo inpute in imajo v tujini tudi vsaj eno investicijo, sledijo jim uvozniki brez izhodnih neposrednih tujih investicij, najslabša po omenjenih kazalcih pa so na domači trg vmesnih dobrin omejena podjetja. Produktivnost, velikost in kapitalna intenzivnost so tudi pozitivno korelirane z deležem uvoženih inputov v celotnih materialnih stroških, številom različic uvoženih vmesnih dobrin in številom držav, iz katerih prihajajo vmesne dobrine.

Z ekonometričnimi tehnikami paritve na podlagi ocenjenih verjetnosti (angl. propensity score matching) nato testiram, ali podjetja, ki začnejo uvažati inpute, kasneje postanejo bolj produktivna. Analiza potrdi kavzalnost med uvozom in dvigom produktivnosti, saj novi uvozniki vmesnih proizvodov postanejo statistično značilno bolj produtivni od primerljivih kontrolnih podjetij. Učinek za prvo leto uvažanja dela vstopnih inputov iz tujine je povečanje produktivnosti dela v višini 550 tisoč SIT dodane vrednosti na zaposlenega. Glede na povprečje v predelovalni industriji v obdobju 1994–2005 (2.680 tisoč SIT) ta prirast predstavlja 20-odstotno rast dodane vrednosti na zaposlenega. Učinek se zmanjša, vendar ostane značilen tudi v naslednjem letu po začetku uvažanja inputov iz tujine, v kasnejših obdobjih pa izgine. Kljub kratkoročnemu učinku na povečanje rasti produktivnosti pa razlika v produktivnosti med novimi uvozniki vmesnih proizvodov in primerljivimi, na domači trg omejenimi podjetji raste v času še naprej: po štirih letih uvažanja je dodana vrednost na zaposlenega za približno 1 milijon SIT višja kot v kontrolnih podjetjih. To predstavlja 35–40-odstotno povečanje glede na povprečno produktivnost dela v opazovanem obdobju. Tudi z vidika skupne faktorske produktivnosti je dodatna dosežena rast produktivnosti v prvem letu uvoza vmesnih dobrin impresivna: v povprečju se produktivnost v novih uvoznikih poveča za 20 odstotnih točk hitreje kot v kontrolnih neuvoznikih. V drugem letu po začetku uvažanja dela inputov iz tujine se premija v rasti skupne faktorske produktivnosti zniža na 5 %, zatem pa novi uvozniki ne povečujejo svoje produktivnosti več značilno hitreje kot podobna domača podjetja. Do konca četrtega leta uvažanja vmesnih proizvodov znaša kumulativno povečanje produktivnosti nad tisto v kontrolni skupini podjetij okrog 35 odstotnih točk. Dodatne regresije na podlagi razlik v razlikah pokažejo, da uvozniki vmesnih proizvodov z neposrednimi naložbami v tujini ne povečujejo produktivnosti značilno hitreje kot uvozniki brez naložb v tujini, vendar pa podjetja v tuji lasti v povprečju rastejo hitreje kot novi uvozniki v domači lasti.

Rezultati empirične analize podjetij slovenske predelovalne industrije torej kažejo, da mednarodna fragmentacija proizvodnega procesa v smislu nabave vmesnih proizvodov iz tujine povečuje rast produktivnosti v prvih nekaj letih po začetku uvažanja. Poleg tega raven produktivnosti v novih uvoznikih naraste glede na produktivnost v podjetij z izključno domačo nabavo inputov in ostane statistično značilno višja tudi srednjeročno.

Ključne besede: *zunanje izvajanje proizvodnje vmesnih proizvodov, produktivnost, paritev z razlikami v razlikah*

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Abstract:

An increasing number of firms contract out business activities to foreign providers to cut costs and stay focused on their core capabilities. This paper contributes to a limited body of empirical research on the relationship between offshoring of intermediate inputs and firm productivity. I use a unique firm-level panel data set of Slovenian manufacturing firms operating in the 1994–2005 period with detailed accounting information and foreign-trade data. Using propensity-score matching techniques combined with the difference-in-differences approach, I consider whether firms that start importing intermediate inputs become more productive. The results imply that new importers receive a temporary boost in productivity growth and increase their productivity level relative to a non-importing control group over the 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 excess year-on-year growth rates of productivity relative to non-importers, the cumulative gain in productivity of new importers after four years remains significant, at around 37% for labour productivity and 35% for total-factor productivity.

Key words: *intermediate inputs outsourcing, firm productivity, difference-in-differences matching.*

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 to lower costs. An improved legal and business environment, the proliferation of the Internet, and improvements in information and communications technology (ICT) have made the separation of production processes and the coordination of resulting activities possible. Particularly noteworthy has been the spread of offshore outsourcing or "offshoring" – international sourcing of intermediate goods and services based on a contractual, arm's length relationship between a producer and an input provider.[1]

International fragmentation of production, especially offshoring of services, has received a great deal of attention in the media. Strong media interest notwithstanding, there is relatively little empirical evidence on its economic impact. Because the debate has mainly been focused on the job-relocation aspect of offshoring, most of the existing research on the subject has primarily centred on labour-market issues. Numerous studies have assessed the number of jobs 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), the employment effect of international sourcing (e.g. Harrison and McMillan 2006; Head and Ries 2002), and changes in the price elasticity of labour demand as a consequence of enhanced internationalisation of value chains (e.g. Paul and Siegel 2001). The impact on productivity at the level of firms, however, has received little attention.

The goal of this paper is to test whether the use of imported intermediate goods increases firm productivity, using firm-level data on Slovenian manufacturing firms from 1994–2005. The data set features heterogeneity in foreign sourcing across firms and across time and allows me to identify firms that have switched from purely domestic sourcing of inputs to offshoring. I use these firms to disentangle the causal effect of foreign sourcing on productivity growth from the parallel self-selection effect. Like this study, previous studies 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 a randomised experiment, we must deal with the difficulty that imports may depend on unobserved productivity, which leads to problems of reverse causality. I cope with this problem of endogenous differences using the empirical methodology developed by Kasahara and Rodrigue (2008) to estimate firm-level productivity more accurately. To identify the causal effect from importing intermediates to productivity growth, I test for the differential effect of offshoring by applying non-parametric difference-in-differences (DIDs) matching techniques.

The rest of this paper is organised as follows: Section 2 describes the theoretical framework and gives an overview of 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 final section draws conclusions.

2. THEORY AND EMPIRICAL EVIDENCE

Existing aggregate models of productivity gains from importing emphasise two mechanisms (see Connolly 2001; Keller 2001; Rivera-Batiz and Romer 1991). In the first mechanism, learning occurs through the incorporation of new intermediate products invented abroad in the firm's production chain. The use of foreign intermediate products transmits the embodied

[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))

technological capability and R&D of the foreign supplier. 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 expanding the firm's technological expertise. Using patent citations in French firms' patents, MacGarvie (2006) confirms these 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.

Görg, Hanley and Strobl (2008) identify three channels for increased productivity from international outsourcing. In the short run, international outsourcing opens up access to internationally traded inputs that may be available at lower costs or at higher quality than domestic substitutes. Second, in the longer run, international outsourcing may affect productivity through changes in factor shares. Outsourcing some of the upstream production abroad brings about a reallocation of production in the firm towards more skill-intensive downstream production. This leads to a rise in average labour productivity in the firm. Third, general equilibrium effects are associated with firm-level outsourcing activity. International outsourcing changes the relative demand for factors of production in the domestic economy, which affects relative factor prices in the economy.

Although much of the literature on international fragmentation of production is theoretical, looking at the relationship between outsourcing and wages, or measuring 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. Because of the relatively recent emergence of data that combines accounting information with data on international trade flows at the firm level, empirical evidence on the level of firms has only recently begun to increase. Nevertheless, the existing evidence is revealing.

Among the earliest studies to estimate the effects of production sharing on firm productivity using micro-data are those by Görzig and Stephan (2002), and Girma and Görg (2004). Both find a positive correlation between outsourcing and productivity, but neither distinguishes between domestic and international sourcing. 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 input 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 sectors, the firms in the latter appear to increase their level and growth of labour productivity as they increase the intensity of international service outsourcing, but not in the case of material outsourcing. In contrast, Görg and Hanley (2005), using the same dataset, find a significant positive correlation between international outsourcing on total-factor productivity (TFP) in the whole sample of firms. In the low-export-intensity group of firms, only material outsourcing appears to be significantly correlated with firm productivity levels, while the high-export-intensity 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 for a longer time period (1990–1998) and for the whole manufacturing sector. Point estimates suggest that an increase in outsourcing intensity of one percentage point leads to a 1.2% increase in productivity at the level of the plant. Splitting the sample further according to ownership status reveals 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 from materials outsourcing for non-exporters.

Analysing 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 by approximately 0.12% as the proportion of downstream materials imported rises by 1%. Amiti and Konings (2007) study the effect of Indonesian trade liberalisation on plant productivity by disentangling gains into 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 a much larger effect on productivity growth than a reduction in 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 a significant growth effect, probably because the sector studied, textiles, allows little scope for technological advances to be embedded in imported inputs. 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 period 1986–1998, Muendler (2004) separates and analyses three different mechanisms behind trade-induced productivity change: the competitive push, the foreign-input push, and competitive elimination. The evidence points in the direction of strong competitive-push effects as a source of firm-level productivity changes, 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 data for large Hungarian exporters in the period 1992–2003. The results imply that an increase in imported intermediates from 0 to 100% of total intermediate inputs used increases a firm's productivity by an average of 14%. About two thirds of this effect comes from imperfect substitution of domestic and foreign inputs, while the remaining third comes from higher quality of foreign goods used.

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

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

3. METHODOLOGY

To be able to explore the effect of foreign sourcing of intermediate inputs on productivity, an appropriate measure of it is required. Besides value added per employee, I employ TFP derived from a production-function estimation. However, any approach dealing with production-function estimation has to contend with some crucial endogeneity issues. To manage the issues of simultaneity, self-selection, and endogeneity of import decisions, I apply the Kasahara and Rodrigue (2008) estimation framework, which 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. It is further assumed that import status has a positive dynamic effect on productivity, as proposed.

Once the parameters of production function are estimated. I calculate TFP 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 this I use propensity-score matching, a method used extensively in labour economics to evaluate the impact of different social programmes.[2]

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

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

As a dependent variable, I use an indicator for the *start* of importing intermediate inputs. Firms that import throughout the entire sample period are excluded from the analysis as they do not provide the necessary dynamics and are also not 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, I also include a left censoring dummy for firm age as a regressor. This variable has value 1 if a firm was operational by 1994 and is hence probably older than (*t*-1994) years. The age variable is used to make sure that firms of a similar age are matched and to proxy for unobserved ability, managerial experience, organisational knowledge, and survival probability.[3] I include export status, since it is expected that having an

[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 well established that younger firms have a higher probability of exiting (Klette and Kortum 2004, pp. 990).

established business relationship with export markets helps firms in their pursuit of internationalisation of the production chain. I also include a set of year and industry dummy variables to control for common aggregate shocks and specific industry characteristics. I use a third-order polynomial in the elements of *h* in order to improve the fit of the model. I denote the predicted probability to start importing (i.e. the propensity score) with P_{it}.

I match de novo importers with appropriate non-importing control firms within the same two-digit NACE industries and in the same year. Consequently, I 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 thereafter. The potential control group consists only of non-importing firms so that the possibility of a de novo importer being matched with a forthcoming importer (i.e. a future importer that is not yet importing at the time of matching) is excluded. This way I 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 greater confidence in the results, the average treatment effect on the treated is estimated using several matching methods. Among traditional matching estimators, I use nearest-neighbour matching within caliper and K-nearest-neighbour matching within caliper. In addition, I also perform a more complex Mahalanobis-matching estimator. To ensure 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 the import decision (a year before the start of import).

The relatively long time dimension of the data set 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 with the differences between prospective new importers and control firms in the years prior to the start of import by observing the average DIDs as defined by equation (2) from τ_{-2} to τ_3. This allows me to check the validity of the matching procedure,[4] the 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:

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

In case of *Y* denoting TFP, the value $\hat{\alpha}_s$ of 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 industry and the same year. In other words, the value of the effect represents the extra productivity growth that can be attributed to a firm's decision to procure intermediate inputs abroad.

To explore a different, yet tightly related, aspect of productivity effects of importing, I also observe how a decision to start to import intermediate inputs affects the productivity trajectory. I 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

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

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 won 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-internationalisation productivity level, a pattern which has been 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

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

each year after the switch to foreign sourcing, I therefore estimate cumulative effects in addition to the effect on year-to-year productivity growth.

Once the matching is complete and DIDs values assigned to all the matched de novo importers for the periods $\tau_{-2} - \tau_{3}$, I 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 a de novo importer and its control group, defined as the difference between the productivity growth rate of an importer $(\omega_{it}^{M} - \omega_{it-1}^{M})$ and a non-importing control firm/group $(\omega_{it}^{C} - \omega_{it-1}^{C})$. Explanatory variables include 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 the $ß_3$ coefficients, which will reveal whether there are any productivity gains attributable to import status. The 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 $ß_3$ coefficients would confirm that international fragmentation of the production chain brought about notably higher productivity growth rates for importers compared with pre-outsourcing periods. The vector of variables in *X* includes the share of imported inputs in total material costs (*m*), an indicator variable for firms with outward foreign direct investment (*oFDI*), and the foreign ownership dummy (*iFDI*). θ_t is the time dummy that captures the temporal shocks common to all firms. I 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 the Agency of the Republic of Slovenia for Public Legal Records and Related Services (AJPES), information on FDI status provided by the Bank of Slovenia, and trade data from the Slovenian Customs Office. Financial statements include data from balance sheets and income statements for every firm in Slovenia and are collected annually, regardless of size and ownership. Reporting is obligatory for all firms, so the resulting unbalanced panel includes information on exit and entry. Among other information, this source provides data on gross revenue, number of workers employed, stock of fixed assets, value of exports, material costs, and labour costs. The period covered is 1994–2005. FDI-related information is provided by the Bank of Slovenia through its annual mandatory survey of firms with foreign ownership and/or foreign direct investments abroad. Unfortunately, from this otherwise rich survey data, only the indicators of inward and outward foreign direct investment were made available to me by the Bank of Slovenia. The time span of this data source is 1994–2003. Trade data comes from the 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 1994–2003. Information provided includes the six-digit TARIC code of the goods being shipped, the value in Slovenian tolars and US dollars, country of origin and country of destination, physical quantity, and date of dispatch. In classifying products into intermediate inputs, I use the UN Comtrade classification of goods in SNA in the categories of BEC (Broad Economic Activities). However, I exclude the Food and beverages, primary and processed categories (BEC codes 111 and 121, respectively), the primary Fuels and lubricants category (BEC code 31), and the primary Industrial supplies not elsewhere specified category (BEC code 21). All value data are in Slovenian tolars[6] and are deflated with the corresponding two-digit NACE industry-producer price indices. In the empirical analysis, only data for firms with five or more employees was used, so as to partially clean the dataset from outliers. The other outliers were removed after inspection of the most important variables (sales, employment and capital), industry by industry. Eventually, my database comprised 4,197 manufacturing firms in the period 1994–2003, yielding 22,041 observations in total.

5. RESULTS

Table 1 reports descriptive statistics for variables in the period 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.

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

[6] On 1 January 2007, when the euro was adopted in Slovenia, the conversion rate between Slovenian tolars (SIT) and euros was 239.64 SIT/€.

Table 1: **Descriptive statistics, 1994–2003**

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

Source: own calculations.

Note: Standard errors in parentheses. statistics based on restricted sample that excludes firms with less than five 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 thousands of Slovenian tolars. *Emp* is 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.

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 three-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: **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

Source: own calculations.

Note: The statistics are based on the restricted sample that excludes firms with less than five 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.

The 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 Slovenian 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, I turn to 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 input sourcing and relevant firm characteristics in Slovenian manufacturing firms. Unlike export intensity (see Damijan and Kostevc 2006; Blalock and 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 measured by number of employees are the most import-intensive firms dominated by firms with intermediate involvement in foreign input sourcing. A higher share of foreign inputs in total material costs therefore appears to demand and/or cause higher productivity, capital intensity and greater size of importing firms.

Table 3: **Relative labour productivity, capital-labour ratio, employment and sales with respect to 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

Source: own calculations.

Note: Statistics based on restricted sample that excludes firms with less than five employees. 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.

Higher intensity of foreign input sourcing can come about either as a consequence of a larger number of imported varieties (extensive margin) or through higher import values of the existing range of imported varieties (intensive margin). If the former is at work, I should identify a 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 that a firm has higher productivity to cover all the fixed costs. Table 4 reveals productivity uniformly increasing with 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 three-digit industry. Because of high collinearity between productivity and capital intensity, revenues and employment, the relationship between the last three performance measures and the number of imported varieties exhibits the same robust pattern as for productivity.

Table 4: **Relative labour productivity, capital-labour ratio, employment and sales with respect to 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

Source: own calculations.

Note: Statistics based on restricted sample that excludes firms with less than five employees. 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 six-digit tariff products imported by a firm in a given year.

[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 come from increased variety.

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 nine countries are on average 15% more productive than the average firm in the same narrowly defined industry. Except for a minor irregularity in relative capital intensity, the capital-labour ratio and 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 establishment and maintenance of costly business connections and other transaction costs) and thus demands higher productivity.

Table 5: **Relative labour productivity, capital-labour ratio, employment and sales with respect to 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

Source: own calculations.

Note: Statistics based on restricted sample that excludes firms with less than five employees. 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.

5.1. WHAT HAPPENS TO FIRMS THAT SWITCH TO FOREIGN SOURCING OF INTERMEDIATE INPUTS?

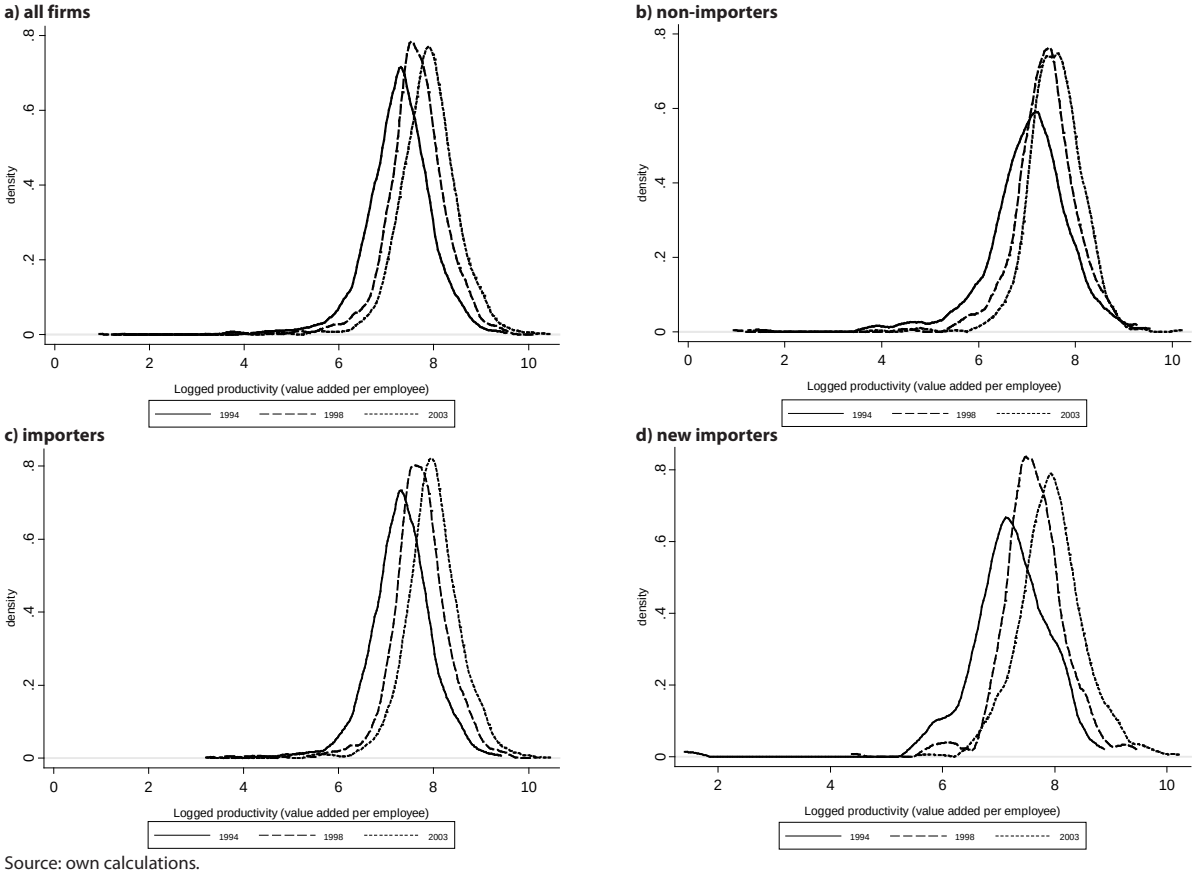
Up to this point, I have analysed only static differences between importers of intermediate inputs and domestic firms. Although highly informative, the above findings do not establish any unambiguous causality from importing to various performance measures. In addition, importers are heterogeneous in many dimensions and differ not only from their domestically oriented competitors but also from their importing counterparts. To disentangle the effects of intermediate inputs importing from self-selection effects, it is therefore not enough to compare the means of importers and non-importers, Instead we must also focus on firms that switched from domestic to foreign input sourcing and impose even starker methodological restrictions. 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 of 1994–2003.

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

Figure 1a reveals 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 the distribution functions reveals the reduction in the variance of productivity between firms as the distributions become more condensed. At the start 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 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 value than that of intermediate input importers. Next, while non-importers experienced

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



Source: own calculations.

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

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 across 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.

Compared to non-importers, new importers exhibit even stronger positive shifts in productivity distribution, leading to the assumption that importing status accelerated productivity growth in these firms (Figure 1d). 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.

In the remaining part of this section, I will describe the effects of importing even more thoroughly by tracing the movement of various firm characteristics in the 917 new importers available in my sample, prior to and after the year in which foreign sourcing started. 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 corresponding three-digit industry averages a year before the start of imports to roughly the industry average by the seventh or tenth subsequent year. The evolution of employment in new importers closely relates to the movement in total revenue, although the shifts appear more moderate and even. Unlike total revenue, employment in new importers never reaches the industry average, but evens out at around 85%. In addition, new importers not only increase their number of employees relative to the industry average, but augment to an even larger degree their capital stocks, as suggested by the observed increase of relative capital intensity by 11 percentage points.

The number of varieties in new importers starts at 16 in the first year and gradually increases to 35 in the eighth 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 to advance to a broader range of foreign inputs. In the first six years of importing, an additional import market is added every two years. After the ninth year, the 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 significant 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, de novo importers still lag significantly in the number of imported inputs and the number of countries from which these are procured. Finally, the share of foreign inputs in new importers' material costs gradually increases from 10% to around 20% (the industry average) in the ninth year of importing. The doubling of the share during the time interval is consistent with 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

I now turn to the main results as shown in Tables 6–9 where I 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, with new importers' productivity growth rates[9] tracked from the two years prior to the start of imports to the end of the third subsequent year. As explained in the methodological section, the 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 periods. In other words, I 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: **Average treatment effect of importing intermediate inputs on 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

Source: own calculations.

Notes: DID_t denotes $\Delta y_{it}^{Newimporter} - \Delta y_{it}^{Control}$ where *y* is value added per employee (in thousands of Slovenian 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.

[8] In the remainig part of the thesis, I 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 I am referring to the time differential of labour productivity ($y_{it} - y_{it-1}$). For the sake of brevity, however, I use the term growth rate. In the case of TFP, on the other hand, the use of the term is exact since TFP is entered 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 the 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 550,000 tolars of value added per employee. Compared with the manufacturing average over the entire 1994–2005 period (2.68 million tolars), this amount represents a 20% increase of value added per employee. The effect remains significant in the following year but falls to roughly 220,000 tolars in the case of nearest-neighbour matching techniques. In the next two periods, the excess growth rates of new importers compared with control firms drop further towards zero and become insignificant. Apparently, the effect of intermediate inputs imports on productivity growth is short lived, since new importers improve their productivity on a year-to-year basis significantly more than similar non-exporters only in the first two years of importing, while in the following years the growth premium dissipates.

Table 7: **Cumulative effect of importing intermediate inputs on 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

Source: own calculations.

Notes: CUM_t denotes $(y_{i,s=t} - y_{i,s=-1})^{Newimporter} - (y_{i,s=t} - y_{i,s=-1})^{Control}$, where *y* is value added per employee (in thousands of Slovenian 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.

However, the lack of significance in the average treatment effect in the second and the third year after the start of imports should not be interpreted as an absence of a productivity effect from 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 a 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, I observe the entire productivity path of new importers and compare it with 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 start of imports, the productivity gains (relative to the year before importing) are higher in new importers than in control non-importers. The results are highly significant using each estimation technique and highly comparable in values. At the end of the third year after the start of imports, labour productivity in de novo importers is 1 million tolars per employee higher than it 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 250,000 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, I present the results for analogous propensity-score matching analysis on the

TFP estimated in the previous section with the Kasahara-odrigue estimator.[10]

As before, new importers grow significantly faster than non-importers only in the first and conditionally in 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 with 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, of 8 and 14 percentage points, respectively. In the second year after the start of imports, the growth premium decreases to around 5 percentage points, but remains significant only at 10% significance level. In the subsequent periods, new importers do not experience any significantly higher productivity growth in comparison with similar non-importers.

Table 8: **Average treatment effect of importing intermediate inputs on 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

Source: own calculations.

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.

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 years and, above all, increase steadily in time. After an initial 20-percentage-point increase, new importers later gain an 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 the 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 the start of imports, 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 already higher prior to the change.

[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.

Table 9: **Cumulative effect of importing intermediate inputs on 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

Source: own calculations.

Notes: CUM_t denotes $(y_{i,s=t} - y_{i,s=-1})^{Newimporter} - (y_{i,s=t} - y_{i,s=-1})^{Control}$, 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.

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

Source: own calculations.

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

To further substantiate the positive shift of productivity growth in the first years of offshoring compared with the previous periods, I run the regression specified in equation (4), where I compare productivity growth rates (i.e. *DIDs*) in the periods after the switch to foreign sourcing with those prior to import initiation. I additionally control for other factors that might influence the excess growth rate of new importers, such as capital intensity, share of imported inputs, foreign ownership, multinational status, and common time-specific industry-wide shocks. Emphasis in these regressions is 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 the start of imports. DIDs in the importing periods are thus compared to the DIDs prior to the start of foreign sourcing and this identifies the duration and significance of the perceived benefits from importing.

Table 10 reports the results for the DIDs regression using value added per employee as a productivity measure. In contrast to Table 6, in which the average treatment effect was significant only in the first two periods, the regressions above indicate that the third year of importing also brings about significantly higher productivity increases relative to control non-importers. The 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 the production chain. Where significant, the coefficient of foreign ownership (*iFDI*) is positive and of significant size with respect to other coefficients. Sourcing within a foreign multinational network thus seems to be more beneficial for firm productivity growth. This could be due to a leaner supply chain, more sophisticated intermediate inputs, better control over the quality of inputs, superior on-time delivery, better cooperation and support services, or 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: **Productivity improvements of new importers relative to domestic sourcers of intermediate inputs (difference-in-differences matching using total-factor productivity), 1994–2005.**

	nearest neighbour		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

Source: own calculations.

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

Similarly, Table 11 reports results for the impact of importing on productivity growth as measured by TFP. As before, I 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 also significant. Lagged productivity is 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 more (or less) than non-multinational new importers, but foreign-owned firms on average do grow faster than domestic new importers.

6. CONCLUSION

The purpose of this paper was to investigate productivity effects of offshoring using data on the use of imported intermediate inputs in Slovenian manufacturing firms in 1994–2005.

The theoretical prediction about the arrangement of firms according to their organisational 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 domestic-sourcing firms. Productivity was discovered to have been 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, I found that offshoring temporarily boosts productivity growth and increases productivity levels of new importers over the medium term. The 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. Within the sample, in the first year, offshoring was found to bring about a 20% increase in labour productivity and approximately equal growth of TFP. Despite short-lived year-on-year growth rates of productivity in excess of those for non-importers, the cumulative gain in productivity of new importers after four years remains significant at around 37% for labour productivity and 35% for TFP.References

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