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The links between firm-level productivity and modes of international expansion of firms from the Lodz Voivodeship

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ABSTRACT

The paper investigates the link between firm-level productivity and internationalisation (through exports, imports and foreign direct investment (F.D.I.)) in the Lodz Voivodeship, Poland. The Olley–Pakes algorithm was used to estimate firm-level productivity. Two hypotheses were then tested – self-selection hypothesis (stating that internationalisation is only possible at sufficiently high productivity levels) and learning hypothesis (claiming that engaging in international activity facilitates productivity growth). It has been found that productivity may affect firms' decisions about engaging in import and F.D.I., while there is no evidence of such an effect regarding exports. At the same time, there is no proof for learning, suggesting that within the timeframe of the analysis firms from the Lodz Voivodeship did not experience productivity gains due to international trade or investment.

1. Introduction

For many years international trade theory was focused on macro-research, with countries being the central unit of analysis. The same can be said about foreign direct investment (F.D.I.) theory that was considered to be only a sub-theory of international capital flows. It took decades before economists were able to find a way to explain the simple observation that, in fact, each firm has to take its own decision on whether to internationalise operations or not. The final breakthrough, leading to the establishment of the so-called New New Trade Theory (N.N.T.T.), took place in 2003, when Marc Melitz (2003) presented his simple model of individual export decisions among heterogeneous firms. The basis for diversification of firms was their productivity.

N.N.T.T. resulted in a wave of studies devoted to the verification of two hypotheses: self-selection and learning-by-exporting (in some cases: learning-by-importing or learning-by-F.D.I.). The former means that only initially productive firms are competitive enough to cover sunk costs of international expansion (for example, costs associated with the establishment of distribution channels). In other words, high firm-level productivity drives those

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enterprises to enter foreign markets. The latter is the case in which firms become more productive due to foreign expansion (since, for example, they must hire more skilled workers to upgrade the quality of the product to meet sophisticated consumers' preferences) – then learning effects appear.

Since these theories are still considered new, there is a strong need for their empirical testing in different national economies, performing in diversified conditions. Poland is a transition country which evolved from Soviet bloc central planning to a West-oriented economy, gradually converging with 'old' E.U. member-states. And Lodz Voivodeship is an average region of Poland[1]. It is therefore interesting to test the N.N.T.T. postulates on that particular ground.

The aim of the paper is to examine productivity differences between internationalised and non-internationalised enterprises and test possible causal linkages between productivity and firms' decisions about engaging in three primary forms of international operations. Our study focuses on three modes on internationalisation of firms: exports, imports and F.D.I. It is worth stressing that whenever imports and importers are mentioned, it is strictly related to the import of intermediate and capital goods, as only those sorts of imports seem to be a source of long-term economic development.

The main body of this article is accordingly divided into three sections. Section 2 is the overview of the existing literature. Section 3 refers to applied methodology and describes the data. Section 4 presents the results and the last section concludes.

2. Literature review

Since at least the post-war years, economists have been analysing the discrepancies between classical trade theories and empirics of international trade. New theoretical models were needed to explain, for example, why one observes significant trade flows between rather similar countries (in terms of technological advancement and factor abundance) and why such flows very often take form of intra-industry trade. The so-called New Trade Theory has become a very influential theoretical analysis approach. According to these models, monopolistic competition with internal scale economies justifies the presence of international trade between similar countries. However, one conclusion of New Trade Theory has been highly questionable. Using the assumption of symmetry between firms within the industry (the same production functions and the same demand conditions), these models focused on the so-called representative firm. As an implication, if such a firm exports, then one should expect that every firm in the industry (or at least the majority of enterprises) does so.

Observation violates that theoretical conclusion. Bernard, Jensen, Redding, and Schott (2007) discovered that in 2002 only 18% of American firms were exporters. Eaton, Kortum, and Kramarz (2004) presented data on exporting behaviour of French firms in the mid-1980s. They found that only 17.4% were engaged in export. Mayer and Ottaviano (2007) examined international operations of firms from several European countries in 2003. They found that export participation varies across countries, but still non-exporters remain a significant part of the population of enterprises.

All those observations needed explanation. In particular, it was necessary to find differences in firms' characteristics which could lead to differences in firms' behaviour. Bernard et al. (2007) found that in the U.S.A. exporters are bigger (in terms of employment and shipments), more productive, pay higher wages and are more capital- and skill-intensive than

non-exporters. The same was true in other countries, and when one compared importers with non-importers (as documented in Bernard, Jensen, Redding, & Schott, 2012).

Apparently, firm-level productivity has become the feature that has been at the centre of the theoretical and empirical analysis. Regarding theory, new models have been presented. The so-called N.N.T.T. emerged – its originators added firm heterogeneity to New Trade Theory. However, the correlation between firm efficiency and engagement in trade can be seen in different ways. The dominant explanation of the correlation is the so-called self-selection hypothesis. According to that view only the most productive firms enter foreign markets through export or import. Self-selection means that firms take into account their own characteristics when they decide which form of activities to start. In the context of international trade it is almost exclusively equivalent to the statement that firms choose among several possibilities (exit from the market, operating only on domestic market, entry into foreign market) bearing in mind their productivity. The existence of additional fixed (sunk) costs of exporting or importing forms a productivity threshold for international operations – only firms productive enough can gain market share big enough to generate profits. This means that the direction runs from efficiency to trade. Numerous theoretical and empirical studies have examined this hypothesis. Among the most influential are Melitz (2003), Bernard, Eaton, Jensen, and Kortum (2003) and Melitz and Ottaviano (2008).

It is well known, however, that correlation does not indicate causality. Bearing that in mind, other relations between firm-level productivity and engagement in trade are likely to exist. One of them changes the direction between mentioned variables. In the learning-by-exporting (L.B.E.) hypothesis, exporters benefit from participation in trade through increased productivity. The proponents of that view are Yeaple (2005), Verhoogen (2008) and Bernard, Redding, and Schott (2011), to name but a few. Firms may become more productive since they face more intense competition and must adopt better technology to survive on the market. The other possibility is, for example, that export to more advanced economies means that firms face consumers with more discerning preferences – to improve firms' product quality a firm must hire more skilled workers, which boosts productivity. Moreover, a firm may skip the production of goods that are produced with relatively low efficiency and specialise in high-productivity goods. That change in product portfolio may increase firm-level productivity.

Below we present an overview of the literature devoted to each of these hypotheses. It should be pointed that both hypotheses have been tested for many Central and East European Countries. Ur Rehman (2016) proved both self-selection and learning for 29 countries belonging to that region. Burger, Jaklic, and Rojec (2008) found evidence for self-selection and (however, only transitory) L.B.E. effects among Slovenian firms. Damijan, Polanec, and Prasnikar (2004) also used the dataset for Slovenian enterprises; they found self-selection in the case of exporting to advanced economies. Similarly, they proved the L.B.E. effect but only based on exporting to high-income countries.

2.1. Self-selection

Typical models of self-selection explain trade in the form very similar to lotteries. In order to win a prize, a participant (faced with uncertainty) must buy a lottery ticket – only then is one allowed to take part in a draw. Similarly, in N.N.T.T. models firms are uncertain about their productivity (it is a random variable drawn from a common distribution) and must
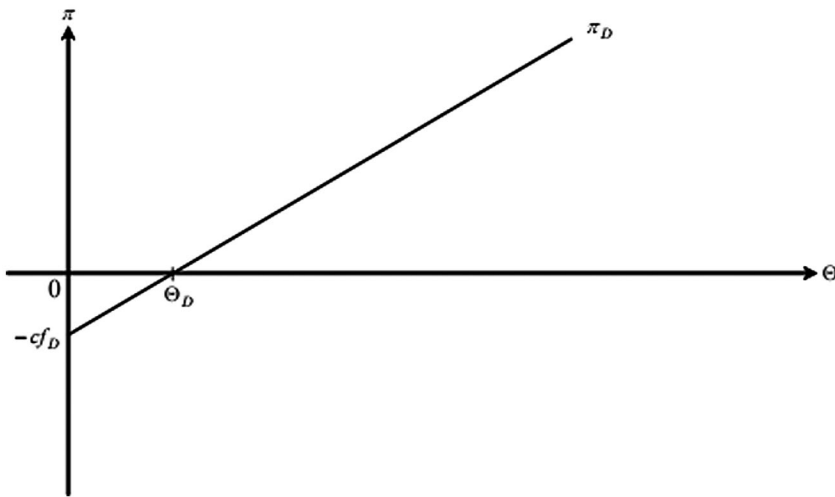
Figure 1. Producing and Nonproducing Firms – productivity and profits. Source: Helpman (2006), p. 5.

pay fixed costs of entry to find the realisation of that variable. After that phase firms decide whether to stay in the market or not – the least efficient enterprises are forced to exit. This means that there is a productivity threshold for domestic operations. The existence of the mentioned sunk costs of trade creates the other threshold – the most productive firms find it reasonable to start trading activities.

The most important model of self-selection is Melitz (2003). In this model firms are heterogeneous in terms of their productivity. Trade liberalisation makes exporting profitable for the most productive firms. By doing so they increase the demand for labour (the supply of which is fixed; labour is the only production factor in the model) and, hence, real wages. That process translates into the increase in production costs. The least productive firms (those having high marginal costs) find it impossible to remain competitive and they are forced to exit the market. In other words, the expansion of exporters occurs at the expense of the least efficient enterprises.

The basic conclusions of Melitz's (2003) model can be presented graphically. Figure 1 (taken from Helpman, 2006) plots profits arising from domestic operations against productivity (see Helpman, 2006, for details). It is apparent that the least efficient firms are unable to avoid losses, so they exit. This means that there is a productivity threshold for domestic operations in the industry.

Figure 2 is similar to Figure 1 but has a new line – the one linked to exporting activities. The existence of additional costs of trade makes it more difficult for firms to service the export market than the domestic market. The productivity threshold for export is higher in such circumstances.

Melitz's (2003) model shows that after trade liberalisation one observes an increase in the average productivity in sectors. However, the mechanism explaining that effect of trade is not very intuitive – competition on factor market increases the costs of production. Melitz and Ottaviano (2008) showed that intensified competition (due to trade liberalisation) also has a more intuitive effect – compression of mark-ups. In order to model such an effect the author had to skip the constant elasticity of substitution (C.E.S.) function when presenting
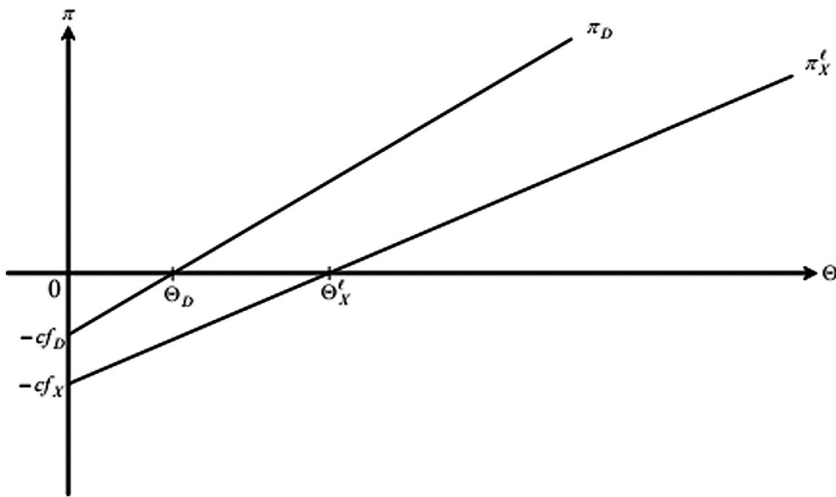
Figure 2. Exporting and Non-Exporting Firms – productivity and profits. Source: Helpman (2006), p. 6.

consumer preferences. They adopted quasi-linear quadratic utility function from which they obtained linear demand function and non-constant price elasticity. Hence, mark-ups in their model were not fixed. Trade liberalisation makes firms with high marginal costs uncompetitive. These firms have to exit the market while exporters expand. Eventually, the average productivity in the industry increases. In other words, while both Melitz's (2003) and Melitz and Ottaviano's (2008) models showed the Darwinian evolution of the industry, the former points to the competition on factor market and the latter the competition on product market as the main source of intra-industry reallocations.

Bernard et al. (2007) embedded Melitz (2003) in Helpman and Krugman's (1985) framework. By doing so they were able to analyse the effects of the coexistence of firm heterogeneity and comparative advantage based on factor abundance. In the model comparative advantage drives inter-industry trade (explaining why some countries are net exporters in the analysed products), scale economies are the source of intra-industry trade (explaining why one observes two-way trade flows in particular sectors) and firm heterogeneity is associated with self-selection (explaining why only a subset of firms exports).

Firm heterogeneity has been also included in models explaining the import behaviour of enterprises. Gibson and Graciano (2011) and Ramanarayanan (2007) and (2012) develop models in which only the most efficient firms are able to start importing. In this aspect, these models resemble Melitz (2003) and other papers on the exporting activities of firms. Bernard, Moxnes, and Ulltveit-Moe (2014) stand out in this wave of theoretical research by allowing for heterogeneity within both importers and exporters (they call it two-sided heterogeneity). According to their model, highly productive importers (exporters) purchase products from (sell products to) many sellers (buyers).

Melitz's (2003) paper has been extended in numerous ways. Several authors have incorporated this type of modelling into F.D.I. analysis. Helpman, Melitz, and Yeaple (2004) analysed horizontal F.D.I. This form of internationalisation means duplication of activities conducted at home, and is motivated by market seeking. Export is seen as an alternative to that type of foreign investment. The biggest difference between these two forms of servicing
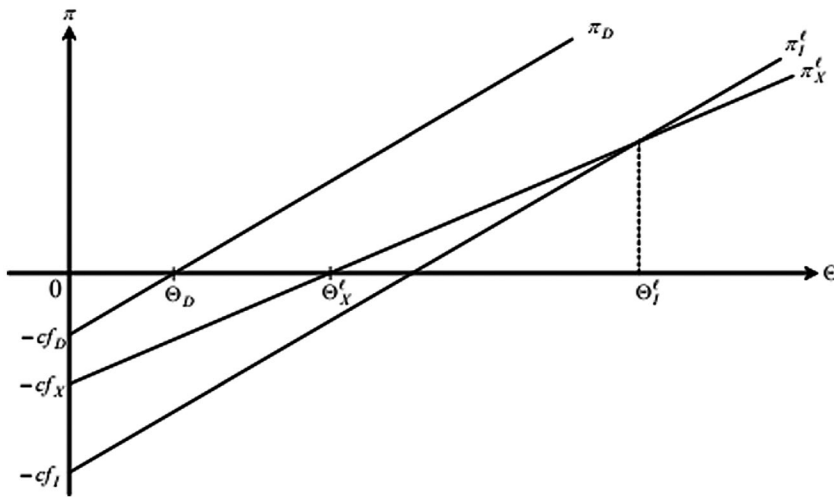
Figure 3. Multinationals, Exporting and Non-Exporting Firms – productivity and profits. Source: Helpman (2006), p. 8.
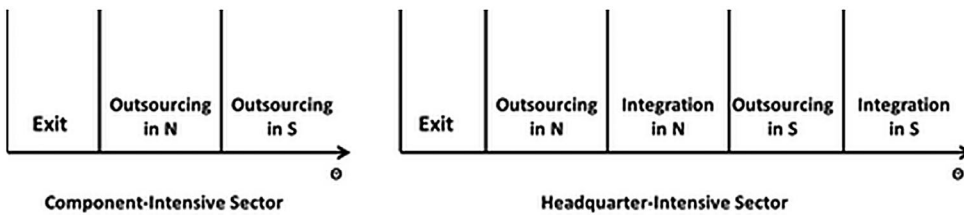

Figure 4. Organisational forms of sourcing. Source: Antras and Helpman (2004), p. 565.

foreign markets lies in the cost structure – F.D.I. generates higher (lower) fixed (variable) costs than export. The authors prove that only the most productive firms invest abroad, while slightly less efficient enterprises export. This can be presented graphically. Figure 3 has an additional (when compared with Figures 1 and 2) profit line associated with investment.

Assuming that the firm may choose only one form of internationalisation, one may see that the threshold for F.D.I. is higher than that established for export.

Vertical F.D.I. has also been analysed using Melitz's (2003) framework. This type of foreign investment is motivated mainly by resource seeking, and the other forms of international sourcing are alternative to it (to simplify, one may consider only international outsourcing). Antras and Helpman (2004) combined Melitz's (2003) model with property rights theory of incomplete contracts. They showed that characteristics of the sector interact with firm heterogeneity (based on productivity), affecting the mode of sourcing. Figure 4 presents this graphically. In the model there are two countries – North (N; with higher wages) and South (S; with lower wages). The firm from N chooses between vertical integration (with the possibility of vertical F.D.I. when integration takes place in S) and outsourcing.

Integration in S occurs only when it is conducted by a high-productivity firm. Hence, self-selection may be observed even in the context of vertical F.D.I.

The empirical literature generally supports the self-selection hypothesis. Regarding Poland, Hagemejer (2006) and Hagemejer and Kolasa (2008) used probit and panel data models, respectively, and found that more productive firms become exporters and importers of investment goods.

2.2. Learning-by-exporting

The correlation between firm-level productivity and engagement in trade has led many economists to conclude that efficiency affects the decision whether to participate in trade. However, there are numerous models presenting the opposite direction of that link. Because authors have usually considered engagement in export, the name L.B.E. has been proposed. Intuitively, the list of mechanisms generating the increase of exporter's productivity is quite long. The most obvious are:

- adjustments within multi-product firms;
- the use of better technology and/or factors.

The first of these was presented by Bernard, Redding, and Schott (2006). In their model, firm productivity results from the interaction of two elements – ability (characterising the whole firm) and expertise (associated with each product). Both are drawn from the common distribution. Similar to Melitz (2003), the model introduces sunk costs of entry into domestic and export markets as well. This means the presence of domestic and export productivity thresholds. After trade liberalisation, competition on factor market becomes fiercer and the domestic productivity threshold increases. Firms with the lowest abilities exit the market, while firms with low expertise skip the production of goods which they make inefficiently. In other words, firms concentrate on their own core competence. In the next version of their model, Bernard et al. (2011) showed that similar results can be obtained when one gives two-factor heterogeneity a more demand-side interpretation. In the free trade environment firms concentrate on the production of the products for which the consumer demand is relatively high. In both cases the ultimate result is the increase in firm-level productivity.

The adjustments within multi-product firms were analyses by Mayer, Melitz, and Ottaviano (2014). They extended the Melitz and Ottaviano (2008) model and show that one effect of trade liberalisation is that multi-product firms cease production of goods generating high marginal costs. Nocke and Yeaple (2006) highlighted the importance of heterogeneity in organisational capabilities. When these capabilities are high, the firm is less affected by the level of marginal costs. When trade is liberalised, firms with high organisational capabilities and high marginal costs may concentrate on a narrow product portfolio. It is stated in the literature that adjustments regarding the number of products are feasible under the assumption of high elasticity of technology of production (Eckel & Neary, 2010). When it is easy to adjust the technology, firms may react to change in business environment (like trade liberalisation) by change in array of product, and not in the volume of production. This conclusion was also supported by Egelman, Epple, Argote, and Fuchs (2013), who showed that in the presence of high buyer-specific product variation, the adjustments may lead to a decrease in firm-level productivity. This variation is equivalent to low elasticity of technology.

The second channel through which engagement in export causes an increase in efficiency is the direct impact of trade on a firm's technology or production factors. Yeaple (2005) presented a model in which exporting firms must first adopt better technology and hire skilled workers. This means that the technology is endogenous. The decrease in trade barriers makes some firms improve technology and change the structure of employment in favour of skilled workers. Anticipating export opportunities, firms must adapt to become competitive, hence the enterprises increase their efficiency. Verhoogen (2008) built a similar model but introduced vertical product differentiation. He assumed that the destination market is of a higher level of economic advancement than the domestic market. Because there is positive correlation between income per capita and quality preferences, the destination market consists of customers who tend to choose high-quality varieties of a differentiated product. Exporters from a less developed country must hire skilled workers to produce varieties of satisfactory quality.

Empirical studies on the L.B.E. effect within Polish firms in inconclusive. Hagemejer (2006) found no evidence that engagement in export translated into higher productivity. However, this may have been the result of a limited time horizon of the analysis. At the same time, Hagemejer and Kolasa (2008) observed an increasing productivity gap (called premium) between internationalised firms and those operating only on the domestic market. This finding may indicate the existence of an L.B.E. effect for Polish firms.

3. Data and methodology

3.1. Data and definition of variables

The data used in the research came from annual statistical reports included in forms F-01 and F-02 submitted by all the companies listed in the R.E.G.O.N. register to the Polish Statistical Office (G.U.S.), thus they should be considered primary firm-level data. These forms present a wide range of basic information, as they were designed to facilitate official estimates of the national accounts. They include information about the companies' profit-loss calculation, legal situation, balance sheet and much more.

In our research we focused on manufacturing firms from the entire Lodz region (voivodeship). Due to statistical traceability issues we utilised coded data, and sectors with three companies or fewer were excluded (e.g., mining companies). Our research period was 2005–2011. The amount of observable manufacturing companies varied across the research period between 982 (in 2011) and 1044 (in 2005) companies. However, because of missing data, the sample size for probit regressions was limited to 5373 observations.

We utilised information about company's age (companies state the year of their establishment), employment and value of its existing physical capital at the end of the year. We also used data about expenditure on new items of physical capital (infrastructure, machines, tools and vehicles) as a measure of investment. The reports also supplied information on company's sectoral affiliation by assigning proper Polish Business Classification (P.K.D.) codes. Thanks to data about sources of income (home country or abroad) we were able to determine which companies were exporters. Data on the value of purchases of foreign intermediate goods and materials allowed us to determine which companies were importers of such merchandise. Companies which declared having a foreign department or branch office were considered foreign direct investors. In the F-02 form companies claim the

Table 1. List of variables.

Symbol	Description
h_{it}	Olley–Pakes estimation of firm-level Total Factor Productivity
k_{it}	log of the company's value of physical capital (in thousands of PLN)
i_{it}	log of the company's investment, interpreted as expenditure on new items of physical capital (in thousands of PLN)
l_{it}	log of the company's workforce (in people)
a_{it}	log of company's age (in years)
s_{it}	dummy for State Treasury in ownership structure (1 if ST has a non-zero share in the company's ownership, while 0 otherwise)
j_{it}	dummy for local government units in ownership structure (1 if LGU has a non-zero share in the company's ownership, while 0 otherwise)
z_{it}	dummy for foreign capital in ownership structure (1 if foreign subject has a non-zero share in the company's ownership, while 0 otherwise)
p_{1it}	sectoral dummy for food, beverages and tobacco (1 if the company is assigned to PKD divisions 10, 11 or 12, while 0 otherwise)
p_{2it}	sectoral dummy for textiles and clothes (1 if the company is assigned to PKD divisions 13, 14 or 15, while 0 otherwise)
p_{3it}	sectoral dummy for wood processing (1 if the company is assigned to PKD divisions 16, 17 or 31, while 0 otherwise)
p_{4it}	sectoral dummy for IT equipment (1 if the company is assigned to PKD divisions 18, 26 or 32, while 0 otherwise)
p_{5it}	sectoral dummy for non-metallic raw materials processing (1 if the company is assigned to PKD divisions 19, 22 or 23, while 0 otherwise)
p_{6it}	sectoral dummy for chemicals and pharmaceuticals (1 if the company is assigned to PKD divisions 20 or 21, while 0 otherwise)
p_{7it}	sectoral dummy for metal processing (1 if the company is assigned to PKD divisions 24 or 25, while 0 otherwise)
p_{8it}	sectoral dummy for electrical equipment (1 if the company is assigned to PKD divisions 27, 28 or 33, while 0 otherwise)
p_{9it}	sectoral dummy for vehicles and transportation equipment (1 if the company is assigned to PKD divisions 29 or 30, while 0 otherwise)
x_{it}	dummy for being an exporter (export status) (1 if more than 1% of the company's income comes from export, 0 otherwise)
m_{it}	dummy for being an importer of intermediate and capital goods (import status) (1 if the value of imported intermediate and capital goods is non-zero, 0 otherwise)
b_{it}	dummy for being a foreign direct investor (1 if the company declares having a foreign branch office, 0 otherwise)

PKD stands for Polish Business Classification: http://stat.gov.pl/Klasyfikacje/
Source: Own elaboration.

percentage of their own shares held by, among others, foreign subjects, State Treasury and Local Government Units, which allowed us to create the ownership variables we needed. The full list of variables, used on all stages of our research, is included in Table 1.

3.2. Total Factor Productivity – Olley–Pakes Algorithm

In the first stage we used data on companies' age, employment, capital and investment (as described in section 3.1) to obtain estimates of firm-level Total Factor Productivity (T.F.P.) with the Olley–Pakes Algorithm (O.P.A.). This is a semiparametric method of calculating productivity presented in detail by Olley and Pakes (1996). Their method is suitable for estimating firm-level productivity as it resolves two main problems connected with panel data: simultaneity and selection bias (Yasar, Raciborski, & Poi, 2008, p. 221). The first one refers to the situation in which observed inputs, such as labour or capital, may be correlated with unobserved inputs or productivity shocks, for example, quality of materials, management skills, technical wear of capital, etc. The second one concerns the problem of firms dropping

out of the dataset. Furthermore, such endogenous exits are usually correlated with other variables, for example with firm size (Aguirregabiria, 2009, p. 2). O.P.A. deals with these issues using investment as a proxy for the unobserved, time-varying productivity shocks and probit estimates of survival probability (Yasar et al., 2008, p. 222). O.P.A. was used by Hagemejer (2006) and Hagemejer and Kolasa (2008) – using the same method facilitates comparison of the results.

Olley and Pakes begin with stating the basic conditions for a firm's operations. They define capital accumulation and ageing of companies:

$$k_{it+1} = (1 - \delta)k_{it} + i_{it} \text{ and } a_{it+1} = a_{it} + 1 \qquad (1)$$

where k denotes capital, i denotes investment, a denotes age, δ is the depreciation parameter and t denotes time.

Then, they assume that productivity in period t+1 (ω_{it+1}) of each firm is determined by a Markov process conditioned on all the information known in period t. This is sampled from a certain distribution, and the family F_ω of such distributions is defined as:

$$F_\omega = \{F(\cdot|\omega), \omega \in \Omega\} \qquad (2)$$

It is assumed that the company's operational decisions depend on the fact that it maximises the expected discounted value (V) of future cash flows. This results in Bellman's optimisation problem:

$$V_{it}(\omega_{it}, a_{it}, k_{it}) = \max\{\Phi, sup_{i_{it} \geq o}\Pi_{it}(\omega_{it}, a_{it}, k_{it}) - c(i_{it}) + \beta\mathbb{E}[V_{i\,t+1}(\omega_{i\,t+1}, a_{i\,t+1}, k_{i\,t+1})|J_{it}\} \qquad (3)$$

where Φ is the company plant's value should it be sold, Π_t is the current profit, conditional on the costs of investment $c(i_{it})$, and β is the firm's discount factor for the expected future value, which is conditional on the information held by the company in current period J_{it}.

In other words, Olley and Pakes claim that a company's decisions about staying on the market and investment depend on its perception of the future based on current information. If the company's productivity is above a certain threshold $\tilde{\omega}_{it}$, which is dependent on the firm's age and capital, then the company continues its operations. Otherwise it has to shut down. This is known as the exit rule:

$$X_{it} = \begin{cases} 1 \text{ if } \omega_{it} \geq \tilde{\omega}_{it}(a_{it}, k_{it}) \\ 0 \text{ otherwise} \end{cases} \qquad (4)$$

The firm's productivity and age (which is a proxy for experience) are also crucial for its investment:

$$i_{it} = i_{it}(\omega_{it}, a_{it}, k_{it}) \qquad (5)$$

Firstly, we assume a Cobb-Douglas production function, and after logging it is:

$$y_{it} = \beta_0 + \beta_a a_{it} + \beta_k k_{it} + \beta_l l_{it} + \omega_{it} + \eta_{it} \qquad (6)$$

The last variable η could be interpreted simply as the error term, but Oley and Pakes prefer to view it as a productivity shock unforecastable in period t. The estimation is on panel data, thus the variables are now indexed by companies (i) and time (t).

Estimating (6) with ordinary least squares (O.L.S.) is biased, because of two problems. First of all, the expected value of current productivity is conditional on past values of productivity, but also on current inputs, which results in an endogeneity problem. What is more, since profits (Π) are a growing function of inputs, then companies with, for example, higher capital require lower productivity in order to maintain their operations (see (3)). In other words, the exit rule (4) is also a source of the so-called selection bias for the estimation.

Olley and Pakes try to deal with that problem. First, they suggest inverting (5) to obtain a productivity function:

$$\omega_{it} = h_{it}(i_{it}, a_{it}, k_{it}) \tag{7}$$

Now, the unobservable current productivity is a function h of observable current inputs and characteristics.

Incorporating (7) into (6) makes it impossible to estimate the β_a and β_k parameters, but we can still estimate β_l from the partially linear semiparametric model:

$$y_{it} = \beta_l l_{it} + \phi_{it}(i_{it}, a_{it}, k_{it}) + \eta_{it} \tag{8}$$

where

$$\phi_{it}(i_{it}, a_{it}, k_{it}) = \beta_0 + \beta_a a_{it} + \beta_k k_{it} + h_{it}(i_{it}, a_{it}, k_{it}) \tag{9}$$

Let us now consider the survival probability. Surviving through to the forthcoming period t+1 is conditional on the future productivity threshold, which depends on future capital and age levels (see (4)). Although Olley and Pakes are not clear about it in their paper, the construction of Bellman's problem for the company (see (3)) and the selection bias they describe indicate that every company should have its own productivity threshold, which is a decreasing function of age and capital. Let us now notice that future capital depends on current capital and investment, while future age depends on current age (see (1)). Productivity changes are a Markov process, so they depend on past productivity and other past information (e.g., data about inputs) as well. Thus we have:

$$P\left\{X_{i,t+1} = 1 \,\middle|\, \tilde{\omega}_{i,t+1}, J_{it}\right\} = p_{it}(i_{it}, a_{it}, k_{it}) \equiv P_{it} \tag{10}$$

From (6) we know, that output is conditional on age, inputs and the very fact the company has survived. That is why, when we consider (8), we get:

$$\begin{aligned}
&\mathbb{E}\left\{y_{i,t+1} - \beta_l l_{i,t+1} \,\middle|\, a_{i,t+1}, k_{i,t+1}, X_{i,t+1} = 1\right\} \\
&= \beta_0 + \beta_a a_{i,t+1} + \beta_k k_{i,t+1} + \mathbb{E}\left\{\omega_{i,t+1} \,\middle|\, \omega_{it}, X_{i,t+1} = 1\right\} \\
&\equiv \beta_a a_{i,t+1} + \beta_k k_{i,t+1} + g_{i,t+1}(\tilde{\omega}_{i,t+1}, \omega_{it})
\end{aligned} \tag{11}$$

where parameter β_0 has been incorporated into the g function, which is:

$$g_{i,t+1}\left(\tilde{\omega}_{t+1}, \omega_{it}\right) = \beta_0 + \int_{\underline{\omega}_{i,t+1}} \omega_{i,t+1} \frac{F(d\omega_{i,t+1}|\omega_{it})}{\int_{\tilde{\omega}_{i,t+1}} F(d\omega_{i,t+1}|\omega_{it})} \tag{12}$$

It is possible to invert (10) in a way that enables making the future productivity threshold a function of the probability of surviving and present productivity. This allows us to transform function g into function $\gamma_{i,t+1}(P_{it}, \omega_{it})$. Considering this and (7)-(12) we get:

$$
\begin{aligned}
y_{i,t+1} - \beta_l l_{i,t+1} &= \beta_a a_{i,t+1} + \beta_k k_{i,t+1} + \gamma_{i,t+1}(P_{it}, \omega_{it}) \\
&= \beta_a a_{i,t+1} + \beta_k k_{i,t+1} + \gamma_{i,t+1}(P_{it}, h_{it}) \\
&= \beta_a a_{i,t+1} + \beta_k k_{i,t+1} + \gamma_{i,t+1}(P_{it}, \phi_{it} - \beta_a a_{it} - \beta_k k_{it}) + \eta_{i,t+1} + \xi_{i,t+1}
\end{aligned}
\tag{13}
$$

where ξ could be interpreted as innovation. Of course, in practice both ξ and η are unobservable and combine to an error term. The fact that (13) is a two-period expression constitutes the need for the initial estimation of (8).

O.P.A. might seem complicated because of the numerous confounded functions of unknown form. However, every function can be approximated by a polynomial, which is a key to facilitating the O.P.A. procedure (as it transforms the estimated problems into a quasi-linear one and enables O.L.S. regressions[2]). Olley and Pakes used fourth-order polynomials, but they later admitted that in fact using only third-order polynomials where possible does not change the results significantly. In practice, O.P.A. requires three steps of estimation.

In the first step we estimate the production function:

$$
y_{it} = \hat{\beta}_l l_{it} + \hat{\phi}_{it}(i_{it}, a_{it}, k_{it}) + \varepsilon_{it}
\tag{14}
$$

where dashes indicate estimated parameters and ε denotes the error term. Function φ is a third (or fourth)-order polynomial with full interaction of variables i_{it}, a_{it} and k_{it}. The obvious effect of this step is obtaining an estimate for the β_l parameter, but receiving the theoretical values of φ_{it} is in fact just as important.

In the second step we estimate survival probability:

$$
X_{i,t+1} = \hat{P}_{it}(i_{it}, a_{it}, k_{it}) + \varepsilon_{i,t+1}
\tag{15}
$$

where ε again denotes the error term and P is a third (or fourth)-order polynomial with full interaction of variables i_{it}, a_{it} and k_{it}. X is a binary dependent variable, which is why Olley and Pakes used probit estimation for this step. In our calculations we have also utilised a probit model, but logit would also be suitable for this purpose. The estimates of survival probability are necessary for conducting the third and final step of the O.P.A. procedure.

In the last step we carry out an estimation of a model

$$
(y_{i,t+1} - \hat{\beta}_l l_{i.t+1}) = \hat{\beta}_a a_{i.t+1} + \hat{\beta}_k k_{i.t+1} + \hat{\gamma}_{i.t+1}(\hat{P}_{it}, \hat{\phi}_{it}, a_{it}, k_{it}) + \varepsilon_{i,t+1}
\tag{16}
$$

where ε again denotes the error term and γ is a fourth-order polynomial with full interaction of variables a_{it} and k_{it} and estimates (theoretical values based on polynomial approximation) of functions P_{it} and φ_{it}, which we know from the first two steps of the estimation. Since variables a and k are in two periods, we get the estimates of β_a and β_k even though they are confounded in function γ. However, this also results in the collinearity problem, which is why Olley and Pakes used kernel estimators to obtain theoretical values of γ. Nevertheless, since biased estimation of parameters of this function is of minor consequence, we argue

that O.L.S. is sufficient, as it results in consistent (although not efficient in general) estimates of parameters β_a and β_k.

Finally, we can use our results to calculate estimated productivity using the expression:

$$\hat{h}_{it} = \hat{\phi}_{it} - \hat{\beta}_a a_{it} - \hat{\beta}_k k_{it} \qquad (17)$$

where function h_{it} is in fact a polynomial approximation of ω_{it}, which stands for productivity (in the total factor productivity sense).

3.3. Self-selection – probit regression

Probit regression is a standard method of building a model for assessing probability and it is not our intention to describe it here. This method is also useful to us for two reasons. First, it has been used in one of the stages of O.P.A. (see section 3.2). Second, it can be utilised to test the self-selection hypothesis, which claims that higher productivity should increase the probability of internationalisation. We consider independently three types of internationalisation in our research: export, import of intermediate goods, F.D.I. Therefore, we have performed three probit regressions based on a similar general framework:

$$y_{it} = \alpha h_{it} + \boldsymbol{\beta}' \boldsymbol{B_{it}} + \boldsymbol{\gamma}' \boldsymbol{S_{it}} + \boldsymbol{\delta}' \boldsymbol{I_{it}} + \zeta + \varepsilon_{it} \qquad (18)$$

where α is a parameter, β, γ and δ denote vectors of parameters, ζ stands for the intersection parameter, while ε_{it} is an error term. Variable h_{it} is an O.P.A. measure of T.F.P. B_{it}, S_{it} and I_{it} are vectors of three groups of variables considered. B_{it} includes basic information about the company: age, employment and three binary variables corresponding with State Treasury, local government units (L.G.U.'s) or foreign subjects being included in the company's ownership. S_{it} is a vector sectoral dummies. A dummy for sector 9 (vehicles and transportation equipment) has been left out in order to avoid collinearity. I_{it} contains internationalisation status dummies. This vector's composition changes depending on which status dummy is considered as a base for the latent variable y_{it}. In respect to symbols used in Table 1, we can define these vectors as:

$$B_{it} = [a_{it} l_{it} s_{it} j_{it} z_{it}]'$$

$$S_{it} = [p_{1it} \cdots p_{8it}]'$$

$$I_{it} = \begin{cases} \left[m_{it} b_{it} \right]' & \text{if } y_{it} \text{ is a latent variable of } x_{it} \\ \left[x_{it} b_{it} \right]' & \text{if } y_{it} \text{ is a latent variable of } m_{it} \\ \left[x_{it} m_{it} \right]' & \text{if } y_{it} \text{ is a latent variable of } b_{it} \end{cases} \qquad (19)$$

We include vectors B_{it}, S_{it} and I_{it} to obtain wider information about the factors influencing particular companies' decisions about internationalisation (and its form) and to hedge our inference from the omitted variables bias. However, parameter α is the crucial one for testing the self-selection hypothesis. If it is positive and statistically significant, the hypothesis should be accepted.

3.4. Learning effects – measuring average productivity increments

The learning hypothesis claims that internationalisation leads to increase of productivity. It might be treated as an approach opposite to the self-selection hypothesis; however, it is also possible for both to occur simultaneously. Our methodology of testing this hypothesis is based on a simple but intuitive assumption: that if learning effects are significant, then the average level of productivity after engaging in a particular form of internationalisation should grow significantly.

Our data enabled us to determine companies that within our research period have changed their statuses (x_{it}, m_{it} or b_{it}) from 0 to 1. We focused only on such companies. We relativised the time, stating for each company the last year before engaging in a particular form of internationalisation t_0 and first three years after changing status respectively as t_1, t_2 and t_3. Then we compared average productivity levels of the newly engaged internationalised subjects in years 1, 2 and 3 with year 0. We have used the standard test for comparing mean values in two populations based on two samples to determine the statistical significance of the changes in time. To support the learning hypotheses we would expect increments (not necessarily all, but starting from a certain year after engagement) to be positive and significant.

The existence of learning effects could be tested with alternative methods. For example, Baležentis and Baležentis (2016) suggest using the bootstrapped Malmquist productivity indices to decompose and filter T.F.P. changes of their insignificant part. However, such methods are by far more complex. The main advantage of our approach is its simplicity and intuitive interpretation.

4. Results

4.1. Productivity distribution among internationalised and non-internationalised firms

Table 2 summarises the distribution of O.P.A. estimations of T.F.P. across different kinds of firms when multiple forms of internationalisation are taken into account. Five groups of subjects were determined: G1 – companies not engaged in any form of international activities; G2 – companies that only export; G3 – companies that only import intermediate or capital goods; G4 – both exporters and importers of intermediate or capital goods; G5 – companies engaged in all considered forms of internationalisation, that is export, import of intermediate or capital goods and F.D.I.

We have used a standard Welch's *t*-test to compare average values of T.F.P. across groups in 2005, 2008 and 2011. Table 3 presents the results.

The location test proves that all the differences are significant with considerably low probability of type-one error, excluding measures for G5 in 2008 and 2011, which are problematic mostly as a result of a small regional representation of companies engaged in all forms of internationalisation.

Our empirical findings support the main observations behind the N.N.T.T. – exporters are more productive than companies operating only on the domestic market. However, our results could be generalised to a wider range of types of international business. Companies that import capital and intermediate goods in the Lodz region were even more productive than just exporters. Furthermore, subjects incorporating multiple forms of

Table 2. T.F.P. estimates for firms engaged in different forms of internationalisation.

		2005	2008	2011
G5: Exporters, importers and investors	avg. TFP	–	6.87	7.40
	st. dev.	–	0.76	0.98
	No. of firms	2	17	26
G4: Exporters and importers, but not investors	avg. TFP	6.56	6.64	6.65
	st. dev.	0.68	0.74	0.76
	No. of firms	408	362	379
G3: Only importers	avg. TFP	6.34	6.46	6.50
	st. dev.	0.56	0.70	0.74
	No. of firms	143	165	141
G2: Only exporters	avg. TFP	6.12	6.22	6.27
	st. dev.	0.48	0.55	0.64
	No. of firms	140	132	130
G1: no international activity	avg. TFP	6.00	6.04	6.02
	st. dev.	0.46	0.48	0.52
	No. of firms	353	336	299

Source: Own calculations.

Table 3. Location test (Welch's t) for average T.F.P. (O.P.A. estimates) among companies engaged in different forms of internationalisation.

		2005	2008	2011
Comparing G5 and G4	t – statistic (degr. of freedom)	–	1.22 (492)	3.82*** (705)
Comparing G4 and G3	t – statistic (degr. of freedom)	3.81*** (89,843)	2.69** (74,565)	2.04* (47,486)
Comparing G3 and G2	t – statistic (degr. of freedom)	3.55*** (71,950)	3.31*** (56,053)	2.74** (38,087)
Comparing G2 and G1	t – statistic (degr. of freedom)	2.53** (109,490)	3.30*** (71,756)	3.93*** (50,879)

*– significant at α = 0.1.
**– significant at α = 0.05.
***– significant at α = 0.01.
Source: Own calculations.

internationalisation turned out to have still higher average T.F.P. estimates, with the top rank belonging to enterprises engaged in all the considered forms of international activities. Therefore, we find it well-grounded to test for causality in the observed relation, verifying the self-selection and learning hypotheses.

4.2. Self-selection

The self-selection hypothesis (in its original reference to export) has been supported by numerous empirical studies (e.g., Bernard & Jensen, 2004; Mayer & Ottaviano, 2007). Hagemejer (2006) even investigated the Polish case and found evidence for self-selection. Our research, however, differs from Hagemejer (2006) in terms of research period (after E.U. accession), geographical unit (regional scale) and the set of independent variables (inclusion of other forms of internationalisation).With this in mind, we tried to test if such evidence can be found among firms from the Lodz Voivodeship. As specified in section 3.3, we performed three independent probit regressions – for export, import and investment probability.

Table 4 presents results for a probit model assessing the probability of the firm being an exporter: $P(x_{it}=1|\bullet)$.

Table 4. Results of a probit estimation of export status (dependent variable: x_{it}, $N = 5373$).

Variable	Coefficient	Standard error	z	Marginal effect
const.	−1.816***	0.458	−3.964	–
h_{it}	−0.012	0.076	−0.163	−0.003
l_{it}	0.469***	0.045	10.508	0.112
a_{it}	0.116***	0.045	2.607	0.028
s_{it}	−0.176	0.186	−0.945	−0.042
j_{it}	−1.632*	0.983	−1.660	−0.390
z_{it}	1.323***	0.102	12.923	0.316
p_{1it}	−1.517***	0.241	−6.306	−0.362
p_{2it}	−0.562**	0.236	−2.379	−0.137
p_{3it}	−0.864***	0.251	−3.441	−0.212
p_{4it}	−1.248***	0.259	−4.827	−0.301
p_{5it}	−0.929***	0.243	−3.823	−0.228
p_{6it}	−1.304***	0.264	−4.939	−0.313
p_{7it}	−0.847***	0.248	−3.419	−0.208
p_{8it}	−0.921***	0.245	−3.762	−0.226
b_{it}	0.627**	0.287	2.182	0.137
m_{it}	1.337***	0.071	18.843	0.315
Statistics	Dependent variable – mean: 0.571Dependent variable – SE: 0.495McFadden R-squared: 0.226Adjusted R-squared: 0.222		Log likelihood: −2842.816Akaike criterion: 5719.633Schwarz criterion: 5831.667Hannan–Quinn criterion: 5758.754	

*– significant at α = 0.1.
**– significant at α = 0.05.
***– significant at α = 0.01.
Source: Own calculations.

Surprisingly, we found no proof of self-selection. This result could be viewed as evidence that the competitive edge of firms from the Lodz region is based not on productivity, but other characteristics. It can be speculated that these could be, for example, the high quality or the uniqueness of the products, high financial liquidity or access to vast networks of contacts. The low values of R-squared (McFadden R-squared or adjusted R-squared) indicate that these other factors play a main role when firms decide if they should enter foreign markets through export or not. This result might also indicate that the productivity threshold for export is low enough for the majority of firms from the region to exceed it. This would mean that the necessary condition of engaging in export formulated by N.N.T.T. is met by most companies.

The lack of self-selection should be very important for policymakers, as without it there are no intra-industry reallocations towards the most productive firms. Those reallocations are considered to be important contributors to aggregate productivity gains (Melitz, 2003; Pavcnik, 2002).

Moreover, the obtained results prove that the probability of exporting increases with company's size and age, thus companies with higher equity (usually larger) and more experience (usually older) are more likely to export. It is also higher for foreign-owned subjects, while public companies (especially owned by L.G.U.s) seem less prone to export.

What is more, the results show that if the firm was an importer of intermediate or capital goods or a foreign direct investor, then it was also more likely to explore external markets via export. The observed effects of foreign ownership and engagement in other forms of internationalisation led to the conclusion that being a part of an international production network increases the probability of becoming an exporter. These results are also consistent

Table 5. Results of a probit estimation of import status (dependent variable: m_{it}, $N = 5373$).

Variable	Coefficient	Standard error	z	Marginal effect
const.	−9.440***	0.508	−18.570	–
h_{it}	1.255***	0.084	14.891	0.294
l_{it}	0.224***	0.046	4.864	0.053
a_{it}	0.212***	0.047	4.513	0.050
s_{it}	−0.989***	0.200	−4.949	−0.232
j_{it}	−0.970	0.880	−1.102	−0.227
z_{it}	0.883***	0.105	8.419	0.207
p_{1it}	−1.395***	0.223	−6.242	−0.335
p_{2it}	−0.024	0.215	−0.113	−0.006
p_{3it}	−0.517**	0.234	−2.215	−0.126
p_{4it}	0.172	0.246	0.699	0.039
p_{5it}	−0.333	0.227	−1.466	−0.080
p_{6it}	0.715***	0.271	2.640	0.150
p_{7it}	−0.591***	0.228	−2.585	−0.144
p_{8it}	−0.399*	0.227	−1.761	−0.096
x_{it}	1.309***	0.071	18.372	0.304
b_{it}	0.288	0.296	0.972	0.065
Statistics	Dependent variable – mean: 0.571Dependent variable – SE: 0.495McFadden *R*-squared: 0.290Adjusted *R*-squared: 0.285		Log likelihood: −2609.729Akaike criterion: 5253.459Schwarz criterion: 5365.493Hannan–Quinn criterion: 5292.580	

*– significant at $\alpha = 0.1$.
**– significant at $\alpha = 0.05$.
***– significant at $\alpha = 0.01$.
Source: Own calculations.

with sequential internationalisation theories (like the Uppsala model), as export takes up the role of a necessary condition of engaging in other forms of internationalisation.

Furthermore, our results indicate the importance of the industry that the firm operates in. We divided industries into nine categories and used eight of them in estimations (omitting one to avoid collinearity). However, each of the coefficients was negative and significant. This suggests that belonging to the benchmark sector, which is the production of transport vehicles, increases the probability of exporting. It seems that the Lodz Voivodeship has a (static) comparative advantage in that sector.

Analogous estimation results for (intermediate and capital goods') import status (variable m_{it}) are presented in Table 5.

The results support the self-selection hypothesis. They indicate that firm-level productivity affects a firm's decision whether to import. This may be so for several reasons, such as additional sunk costs of importing (hence only firms with low marginal costs do not lose their competitiveness when they include those costs in price calculations) or the ability to absorb foreign technology (very productive firms may be able to make the most of imported, often specialist capital goods). At the same time, one may bear in mind that values of McFadden *R*-squared are rather low. This indicates that other factors influence decisions regarding whether to start importing. These might be variables unobservable to us, such as access to external funds or the level of standardisation of inputs.

In addition, the probability of importing increases with firm size and age, with a similar interpretation as in the case of export. Again, foreign-owned enterprises are more prone to expand via import, and public firms (with the Treasury among the owners) are less likely to import. Engagement in export increases the probability of becoming an importer of intermediate or capital goods, which might suggest that companies which import inputs

Table 6. Results of a probit estimation of F.D.I. status (dependent variable: b_{it}, $N = 5373$).

Variable	Coefficient	Standard error	z	Marginal effect
const.	−9.787***	1.025	−9.544	–
h_{it}	0.333*	0.184	1.807	0.000
l_{it}	0.495***	0.135	3.682	0.001
a_{it}	0.512***	0.152	3.367	0.001
s_{it}	−2.398**	1.173	−2.044	−0.007
j_{it}	−703.665	3355.040	−0.210	−1.990
z_{it}	−0.273	0.229	−1.191	−0.000
p_{1it}	−1.140**	0.532	−2.142	−0.002
p_{2it}	−0.222	0.421	−0.527	−0.000
p_{3it}	−0.119	0.471	−0.253	−0.000
p_{4it}	−0.678	0.559	−1.212	−0.001
p_{5it}	0.0713	0.421	0.169	0.000
p_{6it}	−0.501	0.544	−0.920	−0.001
p_{7it}	−0.614	0.505	−1.216	−0.001
p_{8it}	−0.910*	0.512	−1.776	−0.001
m_{it}	0.393	0.288	1.363	0.001
x_{it}	0.772***	0.287	2.686	0.002
Statistics	Dependent variable – mean: 0.023Dependent variable – SE: 0.150McFadden *R*-squared: 0.137Adjusted *R*-squared: 0.108		Log likelihood: −509.152Akaike criterion: 1052.304Schwarz criterion: 1164.338Hannan–Quinn criterion: 1091.425	

*– significant at α = 0.1.
**– significant at α = 0.05.
***– significant at α = 0.01.
Source: Own calculations.

often supply foreign markets as well and are subject to foreign standards and requirements. Foreign direct investing, on the other hand, turned out to be insignificant.

As far as sectoral differences are concerned, it seems that the biggest likelihood of importing characterises firms operating in the chemical and pharmaceutical industries (p_6). This sector is heavily dependent on foreign inputs, and this translates into a high probability of importing. The probability of importing among companies from three sectors – textile (considered as typical for the Lodz region), IT equipment and processing of non-metallic raw materials – was statistically non-different than in the benchmark sector (production of transport vehicles). However, it was still higher than in sectors with significant and negative coefficients: food, beverages and tobacco production, wood processing, metal processing and production of electrical equipment.

In the last step we have performed a likewise probit estimation for F.D.I. status (b_{it}). However, because of underrepresentation of foreign direct investors in our sample (varying from 2 to 33 subjects across our research period), one should be very careful when interpreting the results, which are displayed in Table 6.

First of all, firm-level productivity significantly and positively influenced the decision of whether to invest abroad, but that impact was negligible in terms of its marginal effect. This could suggest that the productivity advantage may be crucial above a certain level, but not when considering productivity close to the mean, as direct investment requires productivity much higher than average. This would not only mean that self-selection is present among foreign direct investors, but also that it is strong and concerns high levels of economic efficiency.

Similarly to export and import, increasing size or age of a firm also leads to a higher likelihood of international expansion through F.D.I. However, unlike in the cases of international trade, foreign ownership turned out to be insignificant, which could be interpreted

that when a firm is itself a foreign affiliate, it is rarely a decision-maker when it comes to F.D.I. State-owned companies, on the other hand, again were reluctant to internationalise. Among the variables describing international status, only export was found to be statistically significant, which shows that export is more effective in pushing firms towards new forms of international activities than import or F.D.I. (as the parameter standing next to x_{it} was positive and significant in all cases). The latter are usually the results of increased expansion. As for sectoral patterns, only companies operating in food, beverages and tobacco industry, as well as electric equipment production sector, turned out to be less interested in F.D.I. Other sectors were no different to the benchmark.

All in all, our results support self-selection among importers of intermediate and capital goods and foreign direct investors, but not among exporters, which makes them partially inconsistent with N.N.T.T. postulates. Nevertheless, one should remember that exporting goods after Poland's accession to the E.U. has become significantly simplified and no longer includes a large portion of additional sunk costs, therefore the self-selection mechanism has been significantly weakened if not completely abolished.

4.3. Learning effects

The learning hypotheses suggest that the productivity shift is a result of exposure to foreign markets and international partners and competitors. In our research we tried to determine if firms from the Lodz region that enter foreign markets (new exporters, importers or investors) benefit from any productivity increases during the first three years after their engagement in new forms of international activities.

We have calculated average productivity increments in the first three years of exporting or importing of intermediate or capital goods and after gaining a status of F.D.I. investor, and used a location test to compare it with zero. In terms of export and import, only companies that began and maintained their trade for three years in the research period were considered. In terms of F.D.I., companies that opened a foreign branch and supported it for at least three consecutive years within the sample period were considered.

All of the found average productivity gains turned out to be statistically insignificant. Table 7 includes only our most general results, but we have also tried calculating average productivity increases by sectors or among 25% of the companies with the highest increments and all of the results remained insignificant. This leads to the conclusion that there were no observable learning effects in the Lodz region at all.

There are, however, two important arguments that might relax the previous pessimistic conclusion. First, our data came from the years 2005–2011, with most of that period being highly influenced by the global financial crisis. This might have had a strong influence on firms' capability to develop, especially to adopt new technologies and successfully meet higher standards, which means gaining experience and learning. Second, because of the short time horizon of available data, we could not focus on time-lags longer than three years. It seems reasonable, however, to believe that especially benefitting from F.D.I. could be more of a long-distance goal.

Table 7. Average productivity gains in the first three years after engaging in a new form of internationalisation.

	Average productivity (h_{it}) gain after		
	1 year	2 years	3 years
Export	0.019	0.029	0.032
Import of intermediate and capital goods	0.025	0.045	0.064
Foreign direct investment	0.004	0.003	0.003

*– significant at α = 0.1.
**– significant at α = 0.05.
***– significant at α = 0.01.
Source: Own calculations.

5. Conclusions and recommendations

Our research focused on two key aspects: the presence of self-selection and the existence of learning effects. Understanding the relation between productivity and internationalisation is of key importance for both companies and local authorities. Self-selection is crucial for companies, because its occurrence clearly indicates that in order to expand through international transactions they first need to concentrate on the efficiency of their internal processes. Learning effects are especially important for authorities, as their strength determines whether internationalisation promotion policy brings any real effects for the region's competitiveness. This problem is a contemporary important issue for the region as, for example, the Regional Operational Programme for Łódzkie Voivodeship 2014–2020 includes funds dedicated to supporting internationalisation of operations for small and medium enterprises (Regional Board of Lodz, 2017), which raises the question about the importance of such actions for the regional development. Learning effects are also significant for companies, because in an analogous way they might influence individual marketing strategies, defining the validity of engaging in international business in order to improve the company's market position.

We investigated three kinds of internationalised economic subjects from the Lodz Voivodeship: exporters, importers (of intermediate and capital goods) and direct investors. We compared them among each other and with companies that refrained from any international activities. As far as we can tell, our research is the first attempt to measure self-selection and learning effects on a regional level, which is the basic level for analysis and administrative decisions in the E.U.

Regarding productivity distribution, firms engaged in all kinds of international business were more productive than purely domestic enterprises. The average productivity of exporters and importers was similar, with a minor surplus to the advantage of importers. The productivity gap between F.D.I. investors and other subjects was almost twice the size and increased over time. What is more, with the exception of just a few companies, F.D.I. investors were also engaged in both exports and imports.

Using probit estimations of the exporter's, importer's and investor's status, we found evidence of self-selection among importers and investors. However, we found no proof for such a phenomenon among exporters. Thus, these results are not entirely consistent with the N.N.T.T. models which assume a productivity threshold for exporters. It is of course possible that such a threshold does exist but is low enough to be insignificant. In such a case,

the decision whether to export or not would not be productivity driven, as non-exporters also meet the necessary condition of exporting.

In terms of learning effects, we examined average productivity shifts among new exporters, importers and investors in the first three years of their international operations. We found positive increments; however, they turned out to be statistically insignificant in all cases. Two caveats arise immediately. First, our data came from the years 2005–2011, with most of that period being highly influenced by the global financial crisis. This might have had a strong influence on firms' capability to develop, especially to adopt new technologies and successfully meet higher standards, which means gaining experience and learning. Second, because of the short time horizon of available data, we could not focus on time-lags longer than three years. It seems reasonable, however, to believe that especially benefitting from F.D.I. could be more of a long-distance goal. Therefore we believe that further investigation of the learning effects is required, as long as it can be based on a longer and more tranquil period, which is so far limited by data availability.

In spite of the aforementioned problems we think that there are industries which may act as growth engines in the Lodz Voivodeship due to the internationalisation of firms (an increase in efficiency may be the result of intra-industry reallocations and learning). Specifically, we point to vehicles, transport equipment, and the chemical and pharmaceutical industries. The learning effects in these sectors, even though insignificant, were the strongest, which suggests that should the influence of crisis cease to affect the economy, these branches have the highest chance of showing substantial productivity dynamics as a result of internationalisation.

However, if the positive results of internationalisation were to remain unobservable in a longer and tranquil period, it should be treated as a clear indicator that stimulating economic growth through supporting foreign trade and investment would be a misplaced effort for policy makers. Furthermore, the lack of a clear self-selection mechanism in export proves that in the Lodz Voivodeship, promoting opening to international trade (usually focused on export) and increasing innovativeness and the pace of technological progress (both resulting in the growth of productivity) are, surprisingly, fully separated aims which may require independent sets of political instruments. This remains a huge challenge for the local authorities.

Notes

1. Poland consists of 16 Voivodeships, which means that, on average, one region should produce 6.25% of G.D.P. Lodz Voivodeship produces about 6.17% of Polish G.D.P. Moreover, it is the geographical centre of Poland, with a similar distance from Western (E.U.) and Eastern (C.I.S.) trade partners of Poland.
2. Another possibility (tried by Olley and Pakes), instead of approximating the unknown functions with polynomials, is to use kernel density estimators to obtain their expected values. However, the results are comparable, while O.L.S. is much easier in practice. Using K.D.E. results in the unknown functions having forms of mathematical expectations of certain distributions, which can be observed in the notation for function g (see (12)), which is in fact an expected value of a continuous distribution of ω (corrected with β_0 parameter).

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