The Link between Firm-Level Productivity and Decisions to Export – the Case of Lodz Voivodeship

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SUMMARY

The aim of this article is to test whether there are differences in productivity between exporters and non-exporters among manufacturing firms from Lodz Voivodeship. Not only do we look for a correlation, but also we verify two main hypotheses about the causality of the postulated relation: self-selection and learning-by-exporting (LBE). We use microeconomic data from the Central Statistical Office of Poland and the Olley-Pakes algorithm to estimate the total factor productivity (TFP) of firms. Then we apply that data to probit and logit estimations of export status and examine TFP increments of new exporters. We did not find sound evidence for self-selection among firms in Lodz Voivodeship. We managed, however, to prove the existence of an LBE effect, though this effect seems to be weak and restricted to certain sectors with comparative advantages. One should keep in mind that our research was limited by data availability and further studies are required. However, this study is a rare example of a regional analysis of international trade and deals with main New New Trade Theory postulates in a complex manner.
Keywords: productivity, internationalisation, export, Lodz Voivodeship
Journal of Economic Literature (JEL) code: F14, F23

INTRODUCTION

Since the establishment of the New Trade Theory (NTT) it has been acknowledged that monopolistic competition under internal scale economies and consumers' love for variety can be seen as the environment within which international trade occurs (Krugman 1979, 1980; Helpman & Krugman 1985). However, NTT models were based on the assumption of a representative (typical) firm, which led to conclusion that if such a firm exports, then empirically one should see that all firms within the same narrowly defined industry do so. Casual observation violates that theoretical conclusion, raising question about characteristics distinguishing exporters from firms operating only domestically.

The new theoretical revolution, giving rise to the so-called New New Trade Theory (NNTT), started in the early 2000s. Melitz (2003) proved that firm-level productivity is the most crucial factor affecting the decision of whether to export or not. Only the most productive firms are competitive enough (due to low marginal costs) to make such high revenue from exporting that they can cover the sunk fixed costs of exporting (arising, for example, from the formation of distribution channels or promotion activities). Specifically, in every industry there exists a productivity threshold of exporting – if a firm's efficiency is below that value, then it is unable to start or continue exporting. Similar results were obtained in other theoretical models (Bernard et al. 2003; Melitz & Ottaviano 2008).

The phenomenon in which firm-level productivity influences the decision of exporting is called self-selection. This hypothesis is based on an empirically found correlation between firms' efficiency and their export status. However, correlation does not indicate causality, hence another direction of the link between productivity and exporting has been proposed. In the so-called Learning-by-exporting (LBE) hypothesis, engagement in international trade boosts a firm's efficiency[1]. Yeaple (2005) showed that in order to export, firms must adopt better technology and more skilled workers – the ultimate result being an increase in firm-level productivity. In a similar model Verhoogen (2008) demonstrated that foreign customers' preferences for high quality forces exporting firms to hire more skilled workers. Bernard et al. (2010) built a model in which engagement in export leads to concentration on the firm's core competence. The LBE hypothesis has also been tested in numerous empirical papers with mixed results (see Wagner 2005).

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[1] See De Loecker (2013) on empirical issues connected with detecting the LBE effect.

The empirical literature shows that self-selection is a more common phenomenon than LBE. For instance, using simple VAR models Hagemejer (2006) found no evidence of LBE but at the same time proved the existence of self-selection among Polish manufacturing firms. In probit regression he also found that firm-level productivity affects the probability of exporting.

In this article we present the results of our research on the impact of productivity on the exporting activities of firms from Lodz Voivodeship. The choice of that voivodeship is motivated by the fact that it is a representative region with average economic power and sophistication compared to other regions of Poland. In the next section we compare the distributions of exporters' and non-exporter's productivity. Then we verify the self-selection and LBE hypotheses. The last section states our conclusions.

EXPORTERS AND NON-EXPORTERS – MAIN DIFFERENCES IN DISTRIBUTION OF PRODUCTIVITY

Productivity in general is a feature that describes how well a given company performs or, in other words, how efficiently it uses its resources in order to maximise its product. Particularly, the Total Factor Productivity (TFP) is a measure of how effectively all inputs on production components are converted into economic outcomes[2]. However, technically it can be difficult to estimate TFP, as simple measures often suffer from serious biases which make conclusions based on them far from real.

Olley and Pakes (1996) proposed a semi-parametric method of estimating TFP, which we incorporated in our research. Their method is suitable for estimation of firm-level productivity as it resolves two main problems arising when dealing with panels of firm-level data: simultaneity and selection bias (Yasar et al. 2008, p. 221). The former refers to the fact that observed inputs, such as labour or capital, may be correlated with unobserved inputs or productivity shocks, such as quality of materials, management skills, technical wear of capital, etc. The latter refers to the problem of subjects falling out from the data set. Moreover, these endogenous exits are often correlated with other variables, most often with size (Aguirregabiria 2009, p. 2). The Olley-Pakes algorithm (OPA) copes with these issues by employing investment as a proxy for the unobserved, time-varying productivity shocks and using estimates of survival probability (Yasar et al. 2008, p. 222).

In our research we measured firm-level productivity (using OPA on Central Statistical Office data) of companies from Lodz Voivodeship (Poland), dividing them into two groups: exporters and non-exporters. We repeated our calculations for the years 2005 (the

aftermath of Polish EU accession), 2008 (the verge of the subprime crisis) and 2011 (latest available data, global crisis entering its fadeout). We expected to obtain higher productivity measures for exporters in all the research periods. Table 1 contains the results.

Table 1
Results of TFP estimations

TFP estimates	Number of companies					
	Exporters			Non-exporters		
	2005	2008	2011	2005	2008	2011
(0.0 - 5.5]	17	21	26	59	52	58
(5.5 - 6.0]	140	97	96	162	148	134
(6.0 - 6.5]	170	165	163	173	180	143
(6.5 - 7.0]	120	108	107	80	78	66
(7.0 - 7.5]	56	58	85	17	28	23
(7.5 - 8.0]	34	46	33	4	11	15
(8.0 - 8.5]	7	13	17	1	4	3
(8.5 - 9.0]	6	4	6	0	0	1
(9.0 - 9.5]	0	0	1	0	0	0
9.5 <	0	1	4	0	1	1
Total number (% of all comp.)	550 (53%)	513 (51%)	538 (55%)	496 (47%)	502 (49%)	444 (45%)
Avg. TFP	6.45	6.53	6.59	6.09	6.18	6.18
St. deviation	0.66	0.72	0.78	0.51	0.59	0.65

Source: own calculations based on Central Statistical Office data

The most important observation is the fact that the average productivity of exporters was higher than that of non-exporters in all years of calculation. It is worth stressing that our calculation was based on a set of information about all production companies from Lodz region, so our averages are in fact expected values of complete discrete distributions given in Table 1. That is why there is no necessity for testing the significance of differences in averages if we wish to provide conclusions referring only to Lodz Voivodeship. Should we, however, wish to widen our inference, we could treat our sets as subsets of productivity distribution among exporters and non-exporters in general (or at least in Poland) and our averages as estimates of expected values. In that case one would also find, based on simple statistical testing, that these differences are significant at α=0.01.

When referring to dynamics of average productivity, two pieces of information seem to be crucial. Firstly, exporters' TFP was growing in the entire period, whereas non-exporters' productivity grew in 2008 in comparison to 2005, but in 2011 the average TFP was exactly the same as in 2008. Secondly, although the crisis at its beginning brought a drop in the number of both exporters and non-exporters, leading even to an increase of the non-exporters' share in the amount of all companies, in 2011 the number of exporters began to rise again, while more and more non-exporters dropped out of the market. That is why it is safe to point out that when the first shock of global crisis had passed, it was the group of exporters that managed to recover more efficiently.

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[2] The basic idea of TFP is to present the relation of output value to sum of all costs of inputs incurred during the production process. TFP over 1 means that the value of enterprise's production (usually – sold production) exceeds its costs. In general, the higher TFP, the better, as it indicates more effective performance.

Since all averages belong to the (6.0 – 7.0) range, let us fix 7.0 as the threshold for extraordinarily high productivity and 6.0 as the threshold for extraordinarily low productivity. For non-exporters, the shares of companies with low productivity were 45%, 40% and 43% for 2005, 2008 and 2011, respectively, and the share of companies with high productivity was 4%, 9% and 10%. As for exporters, the share of companies with low TFP (for 2005, 2008 and 2011, respectively) was 29%, 23% and 23% again, while the shares of exporters with high productivity were 19%, 24% and 27% respectively. This again shows that the productivity gap between the group of exporters and non-exporters is increasing with time.

THE SELF-SELECTION HYPOTHESIS

According to standard NNTT models (Bernard et al. 2003; Melitz 2003) exporters are more productive than non-exporters[3]. That view has been proved by numerous empirical studies (e.g. Bernard & Jensen 2004, Mayer & Ottaviano 2007, to name but a few). Hagemejer (2006) investigated the case of Poland. He found that self-selection characterises Polish manufacturing firms – more productive firms are more likely to become exporters. Bearing that result in mind, we tried to find whether such a phenomenon is present among firms from Lodz Voivodeship.

Our research was based on logit and probit estimations with export status (1 for exporter, 0 for non-exporter) playing the role of dependent variable. The sample consists of 5,373 observations. Table 2 enumerates independent variables used in the estimations.

Table 2
List of independent variables

Symbol	Description
ht	Olley-Pakes estimation of firm-level TFP (ratio)
lt	log of i-th firm workforce (people)
at	log of i-th firm age (years)
st	dummy for Treasury in ownership structure
jt	dummy for local government in ownership structure
zt	dummy for foreign capital in ownership structure
pt1	dummy for PKD (Polish Business Classification) divisions 10, 11 or 12
pt2	dummy for PKD divisions 13, 14 or 15
pt3	dummy for PKD divisions 16, 17 or 31
pt4	dummy for PKD divisions 18, 26 or 32
pt5	dummy for PKD divisions 19, 22 or 23
pt6	dummy for PKD divisions 20 or 21
pt7	dummy for PKD divisions 24 or 25
pt8	dummy for PKD divisions 27, 28 or 33
pt9	dummy for PKD divisions 29 or 30
mt	dummy for being an importer of capital goods
bt	dummy for investing abroad in the form of FDI

Source: own elaboration based on Central Statistical Office data

Both logit and probit estimations lead to the same qualitative conclusions (see Table 3). Surprisingly, we find no evidence of self-selection. Not only is the marginal effect of change in productivity negligible, but also firm-level efficiency appears in estimated equations with negative coefficients. That result can be interpreted as proof that the competitive edge of firms from Lodz Voivodeship is based on characteristics other than productivity (intuitively, high quality or uniqueness of products, high financial liquidity and access to vast networks of contacts can be seen as these traits). Low values of R-squared (McFadden R-squared or adjusted R-squared) indicate that factors other than productivity play a key role when firms decide whether to enter foreign markets through export.

The lack of self-selection is of paramount importance from policymakers' point of view. Without such a phenomenon there are no intra-industry reallocations in the direction of the most productive firms. Those reallocations are seen as a serious contributor to aggregate productivity gains (Pavcnik 2002; Melitz 2003). It seems that in Lodz Voivodeship the only productivity-connected effect of exporting resulting from the behaviour of individual firms may be LBE.

The results of logit and probit estimations also indicate that the probability of exporting increases with firm size (proxied by workforce) and age. It seems that the bigger the firm is, the more human resources it can devote to conducting international operations. The result for age can be seen in two different ways. Firstly, according to sequential internationalisation theories (like the Uppsala model) only firms successful enough on the domestic market can start international activities. Gaining such success requires time, hence older firms are more likely to become exporters. Secondly, there is probability of the so-called hysteresis effect – firm actively exporting in previous periods remain exporters. In such a situation age can be seen as a proxy for past exporter status.

Apart from that, the results show that ownership is another important aspect of firm-level decisions on international operations. Treasury-owned or local-government-owned firms are less prone to engage in exporting. At the same time foreign ownership increases the probability of exporting. What is more, if the firm is an importer of capital goods or invests abroad (FDI), then it is also more likely to enter foreign markets via export. The effects of foreign ownership and engagement in other forms of internationalisation lead to the conclusion that firms belonging to international production networks are more likely to be exporters.

Our results also indicate that the industry in which the firm operates has an effect. Having divided the industries into nine categories, we used eight of them in estimations (we skipped one to avoid the problem of collinearity). However, each of the coefficients was negative, meaning that belonging to the non-included (ninth) sector

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[3] *Self-selection can be found in importing as well. See also Bernard et al. (2013) with two-sided firm heterogeneity.*

increases the probability of exporting. In general, that industry is connected with production of vehicles. It seems this is where the (static) comparative advantage of Lodz Voivodeship lies.

Table 3
Results of probability estimations

Var.	Logit estimation				Probit estimation			
	Coef.	Stand. error	z	Marg. effect	Coef.	Stand. error	z	Marg. effect
const.	-1.816	0.458	-3.96	---	-1,016	0,256	-3,97	---
ht	-0.012	0.076	-0.16	-0.003	-0,023	0,044	-0,54	-0,009
lt	0.469	0.045	10.51	0.112	0,278	0,026	10,65	0,108
at	0.116	0.045	2.61	0.028	0,065	0,026	2,48	0,025
st	-0.176	0.186	-0.95	-0.042	-0,093	0,109	-0,86	-0,036
jt	-1.632	0.983	-1.66	-0.390	-1,014	0,573	-1,77	-0,393
zt	1.323	0.102	12.92	0.316	0,761	0,057	13,24	0,295
pt1	-1.517	0.241	-6.31	-0.362	-0,864	0,133	-6,50	-0,334
pt2	-0.562	0.236	-2.38	-0.137	-0,297	0,130	-2,29	-0,116
pt3	-0.864	0.251	-3.44	-0.212	-0,468	0,140	-3,34	-0,185
pt4	-1.248	0.259	-4.83	-0.301	-0,708	0,144	-4,92	-0,276
pt5	-0.929	0.243	-3.82	-0.228	-0,527	0,134	-3,94	-0,208
pt6	-1.304	0.264	-4.94	-0.313	-0,732	0,148	-4,93	-0,285
pt7	-0.847	0.248	-3.42	-0.208	-0,476	0,137	-3,47	-0,188
pt8	-0.921	0.245	-3.76	-0.226	-0,512	0,136	-3,77	-0,202
bt	0.627	0.287	2.18	0.137	0,821	0,043	19,26	0,314
mt	1.337	0.071	18.84	0.315	0,364	0,156	2,33	0,133
Stat.	Dependent var. – mean			0.571	Dependent var. – mean			0.571
	Dependent var. – SD			0.495	Dependent var. – SD			0.495
	McFadden R-squared			0.226	McFadden R-squared			0.226
	Adjusted R-squared			0.222	Adjusted R-squared			0.222
	Log likelihood			-2842.8	Log likelihood			-2844.7
	Akaike crit.			5719.6	Akaike crit.			5723.4
	Schwarz crit.			5831.7	Schwarz crit.			5835.4
	Hannan-Quinn crit.			5758.8	Hannan-Quinn crit.			5762.5

Source: own calculations based on Central Statistical Office data

THE LEARNING-BY-EXPORTING HYPOTHESIS

The LBE hypothesis is one of the views referring to a link between productivity and engagement in international trade, according to which, companies that enter foreign markets by exporting manage to benefit from it not only due to increases in sales, but also thanks to being exposed to new technologies, more demanding customers, higher competition, different management styles and operational standards, etc. as well as through joining production chains and networks. This may enable them to specialise either in a narrower range of goods or in just a part of production process, leading to investment in more advanced and specialised human resources and equipment and benefiting from economy of scale (see Redding 2010). All of this helps them to develop and thus become more productive. In other words, supporters of the LBE hypothesis claim that TFP productivity shift is a result of establishing contacts with foreign markets and international partners.

Whether the LBE effect is an existing real phenomenon or just a theoretical construct remains uncertain. Some results support its existence (see i.e. Isgut 2001 or Maggioni 2010), others stand against it (see i.e. Bernard 1995; Delgado et al. 2002; Wagner 2002). As for research on the LBE effect in Poland, the situation is very similar. Out of three main research projects on that issue, one showed the existence of LBE (Hagemejer & Kolasa 2008), one found that export was insignificant for productivity changes, so there is no LBE (Bukowski et al. 2006), and one was inconclusive (Hagemejer 2006).

In our research we tried to find out if firms entering foreign markets (new exporters) note any productivity increases during the first three years of their international activities. We analysed increments of the variable ht – the OPA productivity estimator (see Table 4).

Table 4
Productivity gains in the first three years after engaging in exports

	Productivity (ht) gain after		
	1 year	2 years	3 years
Mean	0.019	0.029	0.032
St. deviation	0.085	0.101	0.121
25th percentile	-0.018	-0.025	-0.037
50th percentile	-0.003	0.005	0.014
75th percentile	0.037	0.066	0.087

Source: own calculations based on
Central Statistical Office data

Firstly, the average increases in productivity are positive and growing with time, though with falling

dynamics. However, they are also very small. With an average of ht about 6.5, the gain of more or less 0.03 is only about 0.5%, which is not much. Moreover, in the first year half of new exporters suffered from a negative productivity change and in the following years at least 25% maintained that condition. To make matters worse, the standard deviation is almost four times the mean, which only proves that effects of becoming an exporter (in terms of TFP changes) were soundly heterogeneous. However, though it would be hard to treat these results as strong arguments in favour of the LBE hypothesis, one should also consider that our research period, 2005-2011, mostly coincided with a crisis, which strongly increases volatility and negative production dynamics.

LBE effects are also not equal in all sectors. Table 5 shows our results for average productivity gains with sectoral filtration imposed.

Table 5
Sectoral differences in averages of the productivity gains within the first three years of exporting

Sector	Avg. productivity (ht) gain after		
	1 year	2 years	3 years
pt1	0.018	0.035	0.043
pt2	0.012	0.025	0.018
pt3	0.026	0.017	0.014
pt4	0.026	0.022	0.013
pt5	0.040	0.055	0.072
pt6	0.028	0.027	0.039
pt7	0.006	0.006	0.001
pt8	0.001	0.012	0.014
pt9	0.019	0.058	0.077

Source: own calculations based on
Central Statistical Office data

As appears from gathered data, the strongest learning benefits were observed in two general sectors. The first one, marked as pt5, stands for production of non-metallic raw materials, especially oil refining products, gums and plastics. The second, marked as pt9, is the production of vehicles and other transportation equipment. This sector was already identified as the sector in which the exporting probability – in the sense of self-selection for reaching and maintaining positive exporting status – is the highest. Now it is also clear that the LBE effect is the strongest in that industry. Again it would seem, then, that it should be one of the most strategic sectors for Lodz Voivodeship.

What is more, a traditionally and historically important sector for the Lodz region, the textile industry (pt2), turned out to place among the least promising in terms of productivity stimulation via export. Moreover, one of the strategic ideas of the local government to boost development of the region was to encourage business process outsourcing (BPO) services in Lodz. However, production of IT technology, marked as pt4, which is complements the BPO services production industry, was also one of the sectors with the lowest LBE effects. The very lowest learning benefits from exports were noted for the production of metallic raw materials, marked as pt7. Based on our results, these sectors should not be backed by local business support institutions.

CONCLUSIONS

According to the new theoretical models regarding international trade there is a strong link between firm-level productivity and export status. The results of our research contrast with that view. We found that there is no self-selection characterising the exporting behaviour of firms from Lodz Voivodeship (at least not favouring the most productive establishments). At the same time the results proved that the extent of learning-by-exporting (LBE) in the region is highly limited. Those results are of great importance. It seems that the only export-related mechanism causing total factor productivity (TFP) growth within sectors is LBE (though the strength of that mechanism may be rather scant), and not self-selection.

Probably the most important conclusion refers to the sectoral aspect of the link between efficiency and the export status of firms. It seems that firms operating in the transport vehicle industry are not only more likely to engage in trade but also benefit the most in terms of increases in productivity. Bearing that in mind, rational policymakers should be able to save scarce resources by limiting trade promotion to that sector. By supporting firms from that industry (in which Lodz Voivodeship apparently has a comparative advantage) the region would enhance its growth potential.

One must be also aware of the limitations of our research. Especially, introduction of access to the credit market or proxies for quality of goods in the logit regression could shed light on other determinants of firm's decision to export. Due to lack of data we were unable to do so, hence we recommend it for future research on the topic.

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