INTERNATIONAL TRADE COMPLEXITY AND PRODUCTIVITY OF A FIRM: THE CASE OF UKRAINIAN MANUFACTURING

by

Orlovska Inna

A thesis submitted in partial fulfillment of
the requirements for the degree of

MA in Economics

Kyiv School of Economics

2010

Thesis Supervisor: _____Professor Volodymyr Vakhitov

Approved by _____

Head of the KSE Defense Committee, Professor Tom Coupe

_____

_____

_____

Date _____

Kyiv School of Economics

Abstract

INTERNATIONAL TRADE COMPLEXITY AND PRODUCTIVITY OF A FIRM: THE CASE OF UKRAINIAN MANUFACTURING

by Orlovska Inna

Thesis Supervisor: Professor Volodymyr Vakhitov

The present research is devoted to investigation of the effect of international trade complexity on the performance of a firm. To approximate the predictor an index of inverse diversification along product and geographic markets is constructed, performance is measured as total factor productivity retrieved as a residual from a production function. A dataset on Ukrainian manufacturing firms throughout the period of 2001-2007 is employed. The estimation results for exporters show that sticking to the traditional product mix and gradual geographic diversification is associated with higher productivity level. As for the importers, no significant relationship was found, and the reason might be rooted in the problems with the data. The value of the work is in explanation of the trade-productivity patterns, which may be useful for trade policy implications (issues of trade liberalization, its pace and scope, international trade cooperation and so on).

TABLE OF CONTENTS

LIST OF TABLES

Number *Page*

ACKNOWLEDGMENTS

The author wishes to thank sincerely her research adviser Volodymyr Vakhitov for a valuable piece of advice on relevant literature, sources of data, helpful ideas on model construction and assistance is the estimation procedures.

Thanks to Tom Coupe and Elena Besedina for having carefully read my research proposal, useful comments, insightful questions and suggestions on how to improve the present work.

GLOSSARY

Total factor productivity - a variable which accounts for effects in total output not caused by inputs.

Diversification - a form of corporate strategy for a firm, which seeks to increase profitability through greater sales volume obtained from new products and new markets.

Chapter 1

INTRODUCTION

It is a well established fact in empirical literature that exporters are more productive (Bernard and Jensen 1999). This fact provides grounds for policy implications: export intensive enterprises contribute to a higher industry aggregate productivity and overall economic growth. More recent studies (Kasahara and Lapham 2008) find a productivity premium for importers as well. Firms in international trade are highly heterogeneous. Besides productivity differences, traders are also larger and more capital intensive (Pavcnik 2002) with exports and imports being highly correlated.

There are two theoretical concepts to explain why companies operating in the international market outperform their domestic counterparts: self-selection and learning by doing hypotheses. The theories are not mutually exclusive; they rather complement each other. Self-selection hypothesis considers the fact that every firm entering a foreign market faces sunk costs. Those may be expenses to establish a distribution chain or transportation charges for exporters; expenditure to search for a foreign supplier and additional investment into specific assets in order to integrate foreign inputs into the own production process for importing firms. Therefore, only more productive enterprises are able to pay those sunk costs and start exporting/importing activities. The trading premium is explained by self-selection of more efficient firms. The second concept is related to a post-entry period. Exporters should exert more managerial effort to remain competitive in the foreign markets, they may benefit from trade linkages with customers from more developed economies through production and managerial advice. Importers learn from an advanced foreign technology, more varieties of inputs in the international market may lead to a better match with production requirements of a firm, better quality

of inputs that will add more value to the final product. Thus, the productivity premium is explained by trading history.

In order to understand better the nature of exporting/importing premium, recent empirical literature started to investigate the product and geographical composition of trade operations (Bernard et al. 2007). The relationship between firms extensive (number of products, geographical origins and destinations) and intensive (shares of sales per product, geographical area) reveals the patterns of the firm's growth.

The present study is going to consider how international trade diversification influences productivity of a firm. It is reasonable to assume that more productive firms self-select into more complex trade operations. However, the question of interest is whether diversification itself leads to a higher productivity level. The intuition behind this is: a more diversified firm takes advantage of wider market possibilities and minimizes its risks. The empirical literature suggests the patterns of the relationship are different for exporters and importers as well as for developed and developing countries. Muuls and Pisu (2007) in a study for Belgium found that firms trading many products with many countries are more efficient. On the other hand, Elliot and Virakul (2008) used Thailand data and reached a conclusion that product and geographical diversification has a positive influence on the exporters' performance, in the importers' case the relationship is insignificant. Thus, to investigate the aforementioned relationship for Ukrainian economy is a non-trivial research question.

The present research employs unbalanced panel of Ukrainian manufacturing firms for the period 2001-2007. The measure of firm-level performance is total factor productivity retrieved as a residual from the production function. Since production function estimation poses a number of econometric problems, the current study is going to use several estimation procedures (OLS, fixed effect, Olley and Pakes (1996), Levinsohn and Petrin (2003) approaches). This is to eliminate the possibility

that the final conclusions are just a matter of choice of methodology. The dependent variable of interest is a measure of inverse diversification. It is constructed by analogy to Herfindahl-Hirschman index for both exports and imports along product and geographical market dimensions.

The stylized facts obtained in the course of the research will help to understand the patterns followed by Ukrainian manufacturing firms. This may provide empirical grounds for policy implications: which directions of trade liberalization are promising, which priorities should the government pursue in international trade relations, whether structural reforms are urgent and so on.

The structure of the research is the following. Literature review presents a summary of the related academic articles. Then, the data and sample construction procedure are described and explained. The methodology part elaborates the econometric instruments to be used in the analysis. Finally, the estimation is performed and carefully explained step by step. The conclusion provides deductions and suggestions based on the study results.

Chapter 2

LITERATURE REVIEW

It is possible to structure the whole variety of the relevant literature into several strands: exporters' analysis, importers analysis against non-traders and a comprehensive approach combining the two previous directions. Within each group of the academic papers it is possible to distinguish those primarily concerned with the presence of self-selection effect and the other cluster of literature looking for the learning-by-doing effect. More recent papers make an attempt to integrate the outlined research directions and extend the analysis to incorporate trade complexity: product differentiation, geographical diversification, quality of goods traded level of economic development of the partner-countries and so on.

The literature on exporters has a longer history and a broader heritage. Beginning with a seminal paper by Bernard and Jensen (1995) a bunch of empirical works using micro-level data from different countries and time-periods found exporting firms to be more productive, profitable, larger, paying higher wages compared to their non-trading counterparts.

Bernard and Jensen (1995) searched for an evidence of self-selection into the exporting markets; also, they tried to figure out whether the growth rates of exporting firms are higher compared to the non-trading counterparts. The study was carried out at the time when pitfalls of North American Free Trade Agreement were widely discussed and the questions of the pace and scope of changes to the General Agreement on Tariffs and Trade were in the focus of public attention. The paper has found that exporters are systematically different in terms of size, wages, investment and capital intensity, productivity, measured per unit of labor and by total factor productivity. The findings supported the self-selection hypothesis. However, as for the dynamic post-entry effects, the results were inconclusive: short

term growth rates differences proved to be significant, but in the long run the pattern was not sustainable.

In the subsequent literature the empirical evidence of sunk costs presence and self-selection into the foreign markets became a well-established fact. As for the learning by doing hypothesis, the results are mixed.

The self-selection hypothesis is tested in several ways. For example, Farinas and Martin-Marcos (2003) used unbalanced panel of Spanish manufacturing firms for the period of 1990-1999 to investigate the differences in productivity for exporters and non-exporters. The authors found internationally active enterprises to be systematically more efficient and assigned the observed premium to the self-selection effect. They compared early exporters against late ones in the sample: both groups proved to be similar in terms of efficiency measure. Also the researchers distinguished between firms according to their choice of output distribution channel in the foreign market (whether it is building an own marketing network or outsourcing of the sales operations), this characteristic was employed as a proxy for the magnitude of the entry cost into the foreign market: on average efficiency of high cost firms was three times as high as that of the low cost business entities.

Roberts and Tybout (1997) study how sunk costs and firm's prior experience influence the probability of entering the exports market. The discrete choice export behavior model helps to distinguish the effect of the two factors. Sunk costs are found to be significant and prior exporting behavior increases the probability of participation in foreign markets up to 60% for a sample of Columbian manufacturing firms between the years of 1981 and 1989.

On the other hand, in an attempt to search for learning by doing effects Clerides et al. (1998) used the dataset on Colombia, Mexico, and

Morocco. The author tried to answer the question of whether firms are getting more efficient once they broke into an exports market. The results were not supportive to the learning by doing hypothesis, thus, well-known positive association between productivity and international trading status was completely assigned to the self-selection effect. However, the study revealed some positive externalities originating from exporting practices for the local firms in a region.

Another study by Kraay (1997) was more successful looking for a post-entry effect. The study used a data set on Chinese industrial enterprises for the period of 1988-1992. The author proposed to control for firm specific fixed effects and for past performance of a business entity to eliminate alternative explanations for why exporting history might positively correlate with present-day performance. The intuition behind this: first, unobserved characteristics of a firm could jointly determine exports and performance and, second, firm's performance might be persistent over time. When precautions made, past exports produced significant improvements in the efficiency estimates. Further, the author proposed to take a look at the young and established exporters separately. Learning effects were pronounced for the second group, while, for the first one the effect was sometimes even negative. Kraay found as well that there were externalities in learning effect for a firm when exporting activities concentrate either within a geographical area or a sector of economy.

Recently scientists started arguing that to better understand the nature of firms' heterogeneity in the economy one should take into account an importing status. As well as for exports, empirical results show positive correlation between imports and a firm's performance.

Amity and Konings (2007) studied the policy effects on the regulation of intermediate input imports. They used a sample of Indonesian manufacturing firms for the period of 1991-2001. Lower import tariffs can introduce a tougher competition into the intermediate markets and facilitate

learning by importing through technological, variety and quality effects. The empirical results show that a 10% reduction in the import tariff lead to a 12% gain in productivity which is twice as much one can obtain by reducing tariffs in the output markets.

Further studies on importers considered how input composition affected the productivity of an enterprise. Forlani (2009) used Irish dataset during the period of 2000-2006 containing information on both manufacturing and services sectors. The main conclusion of the paper is that foreign-owned firms use more imported intermediate goods and are more productive; moreover, domestic firms become more efficient as well once they increase the import intensity of their production. The policy implications of the paper justify trade liberalization.

There is a strand of literature that combines the previous two divisions of academic articles: about exporters and about importers. They distinguish four types of firms depending on the involvement in the international trading activities. This comprehensive approach poses similar research questions: on heterogeneity of firms, trade premium, sources of the performances superiority, and, further, try to look deeper into the determinants of total factor productivity through incorporation of additional characteristics like foreign ownership status, product mix, and product quality, geographical origins and destinations of the traded goods so on.

Castellani (2009) referred to the concentration of importing and exporting activities and found a pattern that two-way traders were the best performers, and importers outperformed pure exporter, not to mention the internal-only market participants. The study focused on the association of an import status with significant firm heterogeneity, mostly explained by self-selection mechanism. Another finding, important in the framework of the present study, was that significant portion of efficiency premium could be explained by geographical and product diversification of trade.

Another paper showed that failing to control for importing operations of a company could lead to overestimation of an exporting productivity premium on a plant level (Altomonte and Bekes 2009).

In more recent literature scientists make attempts to retrieve some stylized facts on the role of diversification in the international trade operations. Muuls and Pisu (2007) in a study for Belgium found that firms trading many products with many countries are more efficient. On the other hand, Elliot and Virakul (2008) used Thailand data and reached a conclusion that product and geographical diversification has a positive influence on the exporters' performance, in the importers' case the relationship is insignificant.

Manova and Zhang (2009) employed the dataset on Chinese firms for the period 2003-2005 to see how multi-product enterprises choose the geography of their suppliers and customers. They found that on average an importing firm imports more product varieties than an exporting firm, however, importers conduct their operations with fewer countries than exporters do. This may suggest an intuitive explanation of the form: companies buy a range of intermediate goods for further processing and assembling into final products from certain destinations, say, low-cost ones, and then re-export the output to a number of countries, in search for larger market size, provided that a share of two-way trades is significant.

Among studies using Ukrainian firms' data are Bleaney et al. (2000), A. Nesterenko (2003) and E. Besedina (2008). Bleaney et al. (2000) empirically tested the presence learning by exporting effect. The study used the data from Russia, Ukraine, and Belarus. The conclusion was positive for the stated hypothesis. Nesterenko (2003) investigated the determinants of a firm's decision to enter the exports market and the way exporter differed from their non-exporting counterparts. Besedina (2008) has found that there is a significant productivity premium for Ukrainian exporters compared to

the non-exporting counterparts, however, this effect differs greatly across manufacturing sectors.

The present research is going to contribute to the empirical literature on international trading patterns employing data on Ukrainian firms for the period 2001-2005 in manufacturing sector. Due to the established order in the relevant literature, first, evidence on heterogeneity of firms in international trade is obtained; then, the exporting/importing premium is estimated. This will add up to the existing literature on Ukrainian international traders, since a relatively recent dataset is employed, and can be insightful for further considerations. Once productivity premium is fixed, the study refers to the trade complexity issue. Preliminary analysis addresses the relationship between a firm's extensive and intensive margins. This may suggest the patterns of growth and development of the firms in international trade. The final step is to trace the impact of the trade complexity measure (the inverse diversification measure in the current study) and the total factor productivity.

Further research may incorporate quality of traded goods as well as the level of economic development of the geographical origins and destinations into the analysis of total factor productivity of a firm exposed to international markets.

Chapter 3

DATA DESCRIPTION

The dataset employed contains micro-level data on Ukrainian manufacturing firms throughout the period of 2001-2007. Production data comes from Ukrainian registries provided by National Committee of Statistics and trade data comes from Ukrainian Customs Office. Characteristics at hand originate from financial statements and include net sales (revenue less indirect taxes) in thousand of UAH to be used as a proxy for output, employment in number of employees for labor, material cost in thousand UAH for intermediate inputs, total fixed assets as of the end of the period in thousand UAH to approximate capital, total investment in thousand UAH for production investment. All those are necessary to estimate production function in order to retrieve the Solow residual, namely total factor productivity. Also the set of non-production firm characteristics is available to serve as control variable in the regressions of interest: firm's location (two-digit zip-code to identify oblast), sector (two-digit code of economic activity), type of ownership (state/private, domestic/foreign). This major dataset is going to be merged with information on enterprise's exports and imports (volume in thousands of USD), corresponding destinations and origins (country code according to Ukrainian Customs office classification), and characteristic of the goods traded (four-digit code according to Harmonized commodity description and coding system).

The sample is constructed as follows. Only manufacturing enterprises are kept in the initial panel. Also, firms are dropped if they report zero or do not report at all the data on net sales and employment.

Table1. Sample construction

Initial # of observations	1 348 998
Non-manufacturing firms dropped	-1 254 588
Manufacturing firms only	94 534
Observations dropped if zero or missing net sales and employment	-24 140
Sample to use	70 394

The number of firms in the sample is distributed almost uniformly throughout the period under study. However, the number of firms involved in international trade is increasing, overall and within separate trade status, namely, two-way traders involved in export and import operations, pure exporters and importers.

Table2. Number of firms in the sample by international trade status and year

Year	Non-traders	2-way traders	Exporters-only	Importers-only	Total
2001	7,578	551	601	360	9,090
2002	8,309	579	696	463	10,047
2003	8,405	615	758	467	10,245
2004	8,381	686	807	531	10,405
2005	8,232	731	766	623	10,352
2006	8,570	735	769	723	10,797
2007	7,362	817	761	518	9,458
Total	56,837	4,714	5,158	3,685	70,394

As Table 2 suggests the proportion of firms exposed to international markets in Ukrainian manufacturing evolved from about 17% in 2001 to 22% in 2007, with two-way traders accounting approximately for a third of the total number of traders.

Table3. Average firm characteristics by trade status in 2007

Variable	2-way trader	Exp-only	Imp-only	Non-trader
Employment	387.9939	85.86597	47.23166	19.46265
Total assets	20820.96	3623.432	2611.053	587.9992
Net sales	69265.44	12889.81	11217.83	2762.69
Investment	7635.401	877.1272	1708.413	426.3094
Capital intensity	33.07482	23.4141	34.2915	19.59867
Labor productivity	234.354	172.6909	292.9258	144.5891
Observations	817	761	518	7362

In the table above the heterogeneity of firms conditional on international trade status can be observed. The traders are larger in terms of employment, total assets and net sales, have higher investment, are more capital intensive (value of total assets per employee) and perform better measured by labor productivity compared to non-trading counterparts. Two-way traders are the best performers followed by pure exporters or importers depending on the characteristic. Although table 3 presents only a point estimate in time, namely the year 2007, the revealed pattern is persistent over the whole period since 2001.

The preliminary analysis of the complexity of international trade operations can be extracted from table 4. As for exporters, the average number of the trading partners increased throughout the period under study, however, only by 2; the number of traded goods oscillated around 16. As for importers, they on average operated 2 times as many product varieties as exporters at the beginning of the period, constantly increasing the scale, and eventually ended up by 3 times as many goods compared to exporters; the number of trading partners grew at a slightly higher pace than for exporters.

Table4. Average number of traded products and partner countries per a firm by status and year

		Exporters		Importers	
Year	Variable	#partners	#products	#partners	#products
2001	Observations		65 506		164 566
	Mean	7	16	6	36
2002	Observations		68 066		215 501
	Mean	8	14	6	42
2003	Observations		72 561		242 663
	Mean	8	15	7	42
2004	Observations		81 261		216 148
	Mean	9	17	7	44
2005	Observations		81 151		266 082
	Mean	9	17	7	47
2006	Observations		80 893		290 221
	Mean	9	17	8	52
2007	Observations		85 249		299 627
	Mean	9	16	9	54

This may suggest a story like this: exporters stick to their traditional product markets, they maintain existing trade relationships but at the same time reveal a gradual geographic diversification. Importers also adhere to the traditional sources; however, as they tend to buy more and more input varieties, new trade partners are involved.

Chapter 4

METHODOLOGY

The research question implies two-stage estimation procedure: first, production function is estimated to retrieve total factor productivity at micro-level; second, the regression of interest is run to trace the relationship between total factor productivity and an inverse measure of international trade diversification across product and geographical markets, the latter is constructed as Herfindahl-Hirschmann index.

To estimate the production function Cobb-Douglas functional form in logs is assumed:

$$y_{it}=\beta_0 + \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + w_{it} + e_{it} \quad (1)$$

where y_{it} is log of output of a firm *i* at period *t,* l_{it} ,k_{it}, m_{it} are labor, capital and intermediate inputs in logs correspondingly, β_l, β_k, β_m are the parameters of the production function; w_{it} is the unobserved productivity shock at period t, which follows an exogenous Markov process; $e_{it} \sim iid\ N(0,\ \sigma_e^2)$.

Therefore, the firm-level productivity measure is defined in such a way:

$$tfp_{it} = \exp(y_{it} - \beta_l l_{it} - \beta_k k_{it} - \beta_m m_{it}) \quad (2)$$

where p_{it} is total factor productivity of i-th firm at period t.

In order to obtain a measure for firm-level productivity, it is necessary to estimate the parameters of the production function. However, this procedure encounters several econometric obstacles. First, there is a selection problem which arises from correlation between decision to continue the economic activity and unobserved productivity shocks. The

intuition behind this is the following: a firm maintains its operations only if its productivity is above a certain threshold, therefore, a bunch of firms that do not meet the minimum requirement is dropped out of the sample. As a result an econometrician works with a panel selected conditional on some unobserved productivity threshold. If this selection rule is not accounted for explicitely in the model, the estimation results will be biased. The consideration of this problem dates back to the paper by Wedervang (1965). Another severe problem is that of simultaneity (Marschak and Andrews 1944). This is due to correlation between input demands and unobserved firm-specific productivity shocks. A firm's decision as for the amount of inputs depends on the level of its productivity. Since the productivity shock is unobserved and, thus, not accounted for in the regression, OLS estimates will be biased.

To account for the outlined issues it is necessary to add more structure to the production function identification. Olley and Pakes (1996) set up a maximization problem: a firm compares its salvage value to the discounted revenues if staying in business conditional on all the information available in the current period. If it is not profitable to continue the operations the firm closes down, if not, it chooses the level of investment. The solution to the problem generates an exit rule to solve for the selection problem:

$$\chi_{it} = \begin{cases} 1, & if\ w_{it} \geq w_{it}(k_{it}) \\ 0, & otherwise \end{cases} \tag{3}$$

and investment demand function to account for simultaneity:

$$i_{it} = i_{it}(w_{it}, k_{it}) \tag{4}$$

The assumptions of the Olley and Pakes (1996) approach are: there is only one unobservable state variable, this is productivity shock; and investment is an increasing function in unobserved productivity, which allows inverting the function to obtain an expression for w_{it}:

$$w_{it} = w_{it}(i_{it}, k_{it}) \tag{5}$$

Substitute (5) into (1):

$$y_{it}=\beta_l l_{it} + \beta_m m_{it} + \varphi_{it}(i_{it}, k_{it}, w_{it}) + e_{it}\ , \tag{6}$$

where:

$$\varphi_{it}(i_{it}, k_{it}, w_{it}) = \beta_0 + \beta_k k_{it} + w_{it}(i_{it}, k_{it}) \tag{7}$$

Estimation of equation (6) in the first stage allows identifying the labor and material costs coefficients, provided that $\varphi_{it}(i_{it}, k_{it}, w_{it})$ is approximated by Taylor polynomial series (Andrews 1991; Newey 1995).

The second stage requires the estimation of the survival probabilities using polynomial series approximation of $w_{it}(i_{it}, k_{it})$ as a regressor in the probit procedure. The regression to be estimated:

$$\Pr\{\chi_{it+1} = 1 | w_{it+1}(k_{it+1}), J_{it}\} =$$

$$= \Pr\{w_{it+1} \geq w_{it+1}(k_{it+1}) | w_{it+1}(k_{it+1}), w_{it}\} =$$

$$= \Phi_{it}\ (w_{it+1}(k_{it+1}), w_{it}) = \Phi_{it}\ (i_{it}, k_{it}) = P_{it}\ , \tag{8}$$

where the third equality comes from (5) and $k_{it+1}=(1-d)k_{it}+i_{it}$; J_{it} is information set available at period t for i'th firm.

The final third step makes use of the equation (6), taking a conditional expectation on the available information and survival of the form:

$$E\{y_{it+1} - \beta_l l_{it+1} - \beta_m m_{it+1} | k_{it+1}, \chi_{it+1} = 1\} =$$

$$= \beta_0 + \beta_k k_{it+1} + E\{w_{it+1} | w_{it}, \chi_{it+1} = 1\}$$

$$= \beta_k k_{it+1} + g(w_{it+1}, w_{it}) =$$

$$=\beta_k k_{it+1} + g(P_{it}, \varphi_{it} - \beta_k k_{it+1}), \quad (9)$$

This partially linear regression equation is named a semi-parametric estimator (Engle et al. 1986; Robinson 1998). By substitution of the estimated values and polynomial series expansion the coefficient on capital is retrieved.

The present study assumes that implicit prices for the inputs are not identical across firms due to the different adjustment costs caused by previous decisions firms took or other pre-existing conditions. This assumption assures there is no collinearity problem (Bond and Soderbom 2005) in the present estimation procedure.

Further, Levinsohn and Petrin (2003) use intermediate inputs to account for the simultaneity problem. The advantages in using the intermediate inputs instead of investment are the following. The first benefit is purely data-type. The approach of Olley and Pakes (1996) is relevant only for firms which report non-zero investment. The second issue is that adjustment costs may cause the investment function to produce kink points, which means that enterprises not fully respond to a productivity shock with their investment activity, at least the response is not smooth. As a result investments tend to capture less variation in unobserved productivity which makes them a poor instrument. As for the intermediate inputs they are believed to be more flexible and thus respond to changes in efficiency factor in a more pronounced way.

Once the measure of a firm individual efficiency is retrieved, the study is going to refer to the estimation of the international trade premium. The general specification to be pursued follows Castellani et al. (2009):

$$tfp_{it}=\alpha_0 + \alpha_1 TW_{it} + \alpha_2 IM_{it} + \alpha_3 EX_{it} + \gamma_1 X_{it} + \lambda_i + \varepsilon_{it} \quad (10)$$

where TW, IM, EX are dummy variables for two-way trader, pure importer and exporter status accordingly; X_{it} the vector of controls include

firm size (log of employment) to capture the scale effect, ownership type (foreign/domestic), also, year (to control for macroeconomic factors as inflation), region (spatial effect) and industry (differences in production technology) are incorporated into the model. Also, variables to proxy the market structure are used. These are the share of a firm in the industry output and Herfindahl-Hirschmann index. The first one represents the bargaining power of a specific firm in the industry, the second one takes into account the structure of the industry itself. The two variables are elaborated to capture the possible mark-ups in the market for a single firm's output. Since the production function estimation was performed in value terms, one needs to handle the productivity premium with caution, trying to possibly clear it up from the effect of prices.

Pooled OLS and fixed effect procedure are used to estimate the specification above. Since, this specification makes no attempt to figure out the direction of the influence between international trade status and productivity, the interpretation of the coefficients may be: conditional differences in productivity premium depending on the exposure to the international markets.

The current study is not particularly interested in the direction of status-total factor productivity effects as this involves testing the self-selection and learning by doing hypothesis, which is a well-established practice in literature. Instead the attention is turned to the influence of trade complexity on the productivity of a firm.

Trade complexity measures are constructed as indices of inverse diversification for both importers and exporters along product and geographical dimensions.

$$I_{pit}^{ex}=\sum_{i}^{n}(sh_{pit}^{ex}\text{^}2) \tag{11}$$

$$I_{cit}^{ex}=\sum_{i}^{n}(sh_{cit}^{ex}\text{^}2) \tag{12}$$

Shares of each product/country in total exports of a firm per period are squared and summed up. Similar indices are obtained for importers.

The equation of interest follows such a specification:

$$tfp_{it}=\theta_0 + \theta_1 tfp_{it-1} + \theta_2 Complexity_{it-1} + \gamma_2 X_{it-1} + \lambda_i + u_{it} \quad (13)$$

To reveal the presence of the diversification effect the study is going to follow the Kraay's (1997) specification. To break the simultaneity between current productivity and diversification level, all the dependent variables are lagged one period. Therefore, contemporaneous total factor productivity cannot effect the past realizations of the regressors.

So, the relationship of interest is whether the past diversification indicators are strongly correlated with present realizations of the firms productivity levels. However, the issue should be handled with caution. The correlation might be present due to a third factor affecting both variables, assume an unobserved firm specific heterogeneity (the rationale may be rooted in specific managerial policies persistent over time). Also there might be a joint trend in variables, productivity and international trade complexity measure; pretend a firm is experiencing economies of scale, each period the productivity grows and the firm self-selects into different product and geographical markets. This will cause the correlation between complexity indices and present efficiency level without the causal effects. To avoid those problems the lagged total factor productivity variable is introduced as explanatory factor.

As preliminary look at the data and relevant literature as well as economic intuition will suggest, the relationship between product diversification for exporters and importers should be positive due to economies of scope for exporters and assumed quality superiority of the imported inputs. The direction of influence of geographical diversification is undetermined. Although, the descriptive statistics show some positive trend, the empirical literature evidence is mixed.

Chapter 5

EMPIRICAL RESULTS

This section provides a detailed description of the estimation procedure.

To obtain robust coefficients of the production function, the data a hand should be organized in compliance with theoretical considerations. First, manufacturing firms are different in terms of technology employed. Thus, on the one hand it s possible to disaggregate the sample by two-digit industry affiliation code to account for the specific technology more accurately. On the other hand, the small number of observations in some industries makes it necessary to group the latter somehow, relying on common sense and economic intuition. The following table presents the way of industry aggregation used in the present study:

Table5. Industry aggregation

#	Industry code	Industry
1	15,16	Food and Tobacco industry
2	17,18,19	Textile, clothing, furs and leather industries
3	20,21	Wood processing, wood and paper products
4	22	Publishing, printing, reproduction of printed materials
5	23,24,25	Coke, oil refinery, chemicals and plastics
6	26	Manufacture of other non-metallic mineral products
7	27,28	Metallurgy
8	29	Manufacture of machinery and equipment
9	30,31,32,33	Office, computing, electrical machinery; radio, television
10	34,35	Cars and transport equipment
11	36,37	Manufacture of furniture; other types of production; waste

Production function should be estimated for each industry separately to account for different input shares in the production process.

The variables to proxy output and inputs are available in nominal values; therefore, it is necessary to deflate those latter using appropriate indices to eliminate the inflation from the production function residual term. So, producers' price indices are employed to denominate net sales in the prices of the year 2001. To express the value of total fixed assets in terms of the base year, the PPI of the machinery and equipment industry is used. As for the material cost, a more sophisticated approach is required. Since, the data on inputs composition is not available, the research proceeds with the construction of an industry-specific price index for intermediate inputs. The input-output tables suggest on average the structure of the inputs utilized by each industry. A synthetic index is constructed for each sector as a sum of PPIs of the industries corresponding to the inputs weighted by the share of those inputs in the total material costs. All the data on prices is taken from Ukrainian Committee of Statistics.

The estimation of the production function is hindered by the presence of outliers. It is not reasonable to eliminate those from the analysis, since there is a high probability for the largest enterprises to be an exporter, importer or both: this information is crucial from the prospective of the current study. It is possible to include a dummy variable for the outliers. However, again due to the high correlation between a firm's size and international trade status, the coefficient on the dummy captures a lot of variation in the residual term, which badly affects the subsequent estimation stages. The solution to the problem is to exclude the outliers from the estimation procedure and then to extrapolate the results on the whole sample, so that to retrieve maximum possible information on total factor productivity from the sample.

Finally, to eliminate the influence of the estimation method selection on the results of the study, several procedures are performed, namely OLS regression, fixed effect estimation, Olley and Pakes (1996) and Levinsohn and Petrin (2003). The coefficients on production function are presented in

the appendix. OLS regressions produced significant coefficients on production inputs, however, as theory implies, those are biased. In particular, a minus sign appearing on capital input suggests that the coefficient is downward biased. This is perfectly in line with theoretical considerations predicting downward direction of the bias on fixed inputs and upward on the variable ones.

FE estimation takes into account unobserved firm heterogeneity, but only the time invariant part of it. This would be too strict an assumption that unobserved productivity shocks a firm faces each period do not change over time.

Thus, the study is proceeding to the Olley and Pakes (1996) semi-parametric method. Based on the theoretical consideration, this method should clear the coefficients from simultaneity and selection effects, so that they are closer to the true values. The problem encountered here is about the number of observations used in the estimation procedure. The method requires a firm to have a non-zero investment; those with zero investment and those which did not report the information were dropped from the sample. Investments in Ukrainian manufacturing are not very intensive, in fact, in the sample under study for only about 40% of observations non-zero investment was reported. This suggests an explanation why coefficients on capital are insignificant for some sectors, namely, lack of observations.

Levinsohn and Petrin (2003) approach employs a more flexible variable as a proxy. Material costs are reported in the 90% of cases. However, still insignificant coefficients appear on capital input.

The obtained results may imply that there is a problem with the data itself and not with the theoretical specification of the production function. In theory production function should be estimated using real values. The present study, based on the information available, makes an attempt to approximate those with value-based variables. A particular concern is about

capital proxy: fixed assets of the Ukrainian enterprises mostly are old enough, so that there are problems in reflecting their fair value in the balance sheet, which makes total fixed assets not a perfect proxy for capital.

Making note of the problems encountered the study proceeds to retrieving the total factor productivity measure as a residual from the production function. It is important to mention that the individual error term obtained for each enterprise is industry specific and in general non-comparable across the whole sample. Thus, one needs to normalize total factor productivity estimates through adjustment for an industry average. Average total factor productivity is calculated for each sector, and then a firm level efficiency measure is divided by the industry average. As a result, an index measure of the Solow residual is retrieved possessing the advantage of cross-industry comparability.

Eventually, the attention is switched to the issue of firms' heterogeneity in international trade. The issue of interest is the premium associated with a trade status of a firm. This premium reveals itself in the higher productivity, bigger size, and higher capital intensity. So far, the study is not particularly interested in the direction of the influence, namely, whether it is self-selection or learning by doing effect that account for the trade premium. Thus, a specification of the equation (10) is followed: different firm characteristics are regressed on a set of international trade status dummies and available controls. Pooled OLS and FE estimation procedures are employed.

To save space only coefficients on trade dummies are reported. However, special attention is paid to controlling variables, since their inclusion corrects the size of the trading premium considerably. The regression takes into account the type of ownership: firms with more than 10% of foreign capital are assigned a foreign ownership dummy. To capture some agglomeration and purely geographic effects a set of regional dummies is included. Regions are defined according to administrative division, with

Sevastopol suppressed to the Crimea region. Since a lot of firms are attracted to reside in Kyiv a specific dummy is generated for the capital. To distinguish the scale effect on total factor productivity the total employment is used to proxy the size. In order to account for macroeconomic situation year dummies are incorporated. Also, industry specifics are pointed out through a set of sector dummies. Market structure is approximated by HHI and output share of a firm to capture mark-ups effect.

The interpretation of the estimates at hand can be the following: coefficients represent the conditional difference in firms' characteristics depending on the exposure to the foreign markets.

Table 6 shows that trades are statistically different from non-trading counterparts. Also the premium is considerable.

Table6. International trade status premium, POLS

VARS	2-way	St. errors	exp_only	St. errors	imp_only	St. errors	Obs
tfp_ols	0.463***	(0.0166)	0.261***	(0.0154)	0.518***	(0.0183)	54,938
tfp_fe	0.616***	(0.0171)	0.371***	(0.0158)	0.682***	(0.0188)	54,938
tfp_op	0.608***	(0.0168)	0.347***	(0.0156)	0.636***	(0.0185)	54,938
tfp_lp	0.713***	(0.0178)	0.416***	(0.0165)	0.694***	(0.0197)	54,938
Net sales	3.276***	(0.0308)	2.109***	(0.0279)	2.091***	(0.0329)	70,394
Capital	3.032***	(0.0378)	1.802***	(0.0350)	1.495***	(0.0409)	59,400
Labor	2.401***	(0.0202)	1.276***	(0.0190)	0.799***	(0.0223)	70,394
Lprod	331.4***	(54.42)	336.01***	(51.13)	356.9***	(60.23)	70,394
Kintens	11.24***	(5.171)	15.908***	(4.857)	31.84***	(5.722)	70,390
Standard errors in parentheses							
*** p<0.01, ** p<0.05, * p<0.1							

In the next table fixed effect estimation results are presented. The economic intuition suggests the presence of firm specific time invariant characteristics. Thus, once they are accounted for, the coefficient depicting trading premium decreased significantly.

Table7. International trade status premium, FE

VARS	2-way	St. errors	exp_only	St. errors	imp_only	St. errors	Obs
tfp_ols	0.246***	(0.0202)	0.194***	(0.0160)	0.164***	(0.0193)	18,627
tfp_fe	0.350***	(0.0193)	0.269***	(0.0153)	0.217***	(0.0184)	18,627
tfp_op	0.331***	(0.0197)	0.253***	(0.0156)	0.212***	(0.0187)	18,627
tfp_lp	0.378***	(0.0209)	0.282***	(0.0166)	0.243***	(0.0200)	18,627
Net sales	1.109***	(0.0311)	0.771***	(0.0243)	0.672***	(0.0290)	24,246
Capital	0.439***	(0.0269)	0.222***	(0.0213)	0.283***	(0.0253)	20,162
Labor	0.524***	(0.0176)	0.295***	(0.0138)	0.283***	(0.0165)	24,246
Lprod	316.6***	(77.87)	328.97***	(61.19)	338.9***	(72.97)	24,246
Kintens	11.40***	(2.297)	10.969***	(1.805)	10.379***	(2.152)	24,245
Standard errors in parentheses							
*** p<0.01, ** p<0.05, * p<0.1							

It is possible to figure out the two-way traders to be the most productive and the largest in terms of sales volume, number of employees and total assets available; also, they proved to be the most capital intensive. Then, exporters come in the second place, except for labor productivity premium. Importers are the last, however, by labor productivity indicator they are the best performers.

Finally, the attention is directed to the issue of trade complexity and its influence on the productivity of a trader. Trade complexity is understood as a degree of diversification of the trade operations across product and geographical markets. The inverse measure of trade diversification is elaborated as specified by expressions (11) and (12). The distinct product variety is defined at the 4-digit level of the Harmonized commodity description and coding system, geographical market is established at a country level.

The hypothesis to be tested is that international trade diversification positively influences the productivity of a firm. The relationship most probably is two-way: more productive firms self-select into more complex

operations and trade diversification leads to improvements in productivity. Thus, it is necessary to break the simultaneity. The objective is reached by taking lags of the explanatory variables: in which case past realizations of diversification level influence the contemporaneous productivity, however, the latter has no impact on the trading history. To account for persistence in productivity, its lagged value is included as a predictor into the regression. Regressions for exporters and importers are run separately using distinct samples. To capture the effect of two-way trading a dummy is included. Fixed effect estimator is used. First, for each index (import/export inverse diversification by product/country) regressions are run without controls, and then a set of those is added. Incorporation of control variables clears the coefficients on indices.

Table8. The effect of trade diversification on exporters' productivity

VARIABLES	tfp_ols	tfp_fe	tfp_op	tfp_lp
	Without controls			
L.exI_p	0.0524***	0.0505***	0.0505***	0.0453***
	(0.0144)	(0.0134)	(0.0137)	(0.0173)
L.exI_c	-0.0204***	-0.0169***	-0.0176***	-0.0189**
	(0.00612)	(0.00569)	(0.00581)	(0.00735)
Observations	2,632	2,632	2,632	2,632
R-squared	0.009	0.010	0.010	0.005
Number of firms	1,240	1,240	1,240	1,240
Standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

Index of inverse product diversification reveals positive correlation with the productivity, which means that the less product markets an exporter is exposed to the more productive it is. This may imply a story of exporters that tend to concentrate on their core competences, product varieties they are able to produce and export most efficiently. At the same

time, the relationship between inverse index of geographical diversification with total factor productivity is negative. Thus, the more trading partners are involved the higher is the efficiency of a firm. The intuition behind this may encompass diversification of risks and learning possibilities in a business environment rich with different managerial practices.

Table9. The effect of trade diversification on exporters' productivity

VARIABLES	tfp_ols	tfp_fe	tfp_op	tfp_lp
	With a set of controls			
L.exI_p	0.0418***	0.0361***	0.0388***	0.0350**
	(0.0134)	(0.0123)	(0.0126)	(0.0137)
L.exI_c	-0.0225***	-0.0205***	-0.0201***	-0.0212***
	(0.00578)	(0.00530)	(0.00547)	(0.00593)
Observations	2,580	2,580	2,580	2,580
R-squared	0.194	0.214	0.201	0.410
Number of firms	1,214	1,214	1,214	1,214
Standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

Inclusion of controls has lowered the coefficients on the inverse diversification measures. These latter parameters estimates seem to be more reliable, since they are purified from other effects, which are not in focus of the current study.

As for the importers, an analogical procedure is performed. The results obtained reveal no particular pattern, since the coefficients of interest are insignificant.

Table10. The effect of trade ddiversification on importers' productivity

VARIABLES	tfp_ols	tfp_fe	tfp_op	tfp_lp
	Without controls			
L.imI_p	-0.0283	-0.00740	-0.0185	-0.0231
	(0.0340)	(0.0308)	(0.0299)	(0.0357)
L.imI_c	-0.000682	-0.000820	-0.000254	0.00234
	(0.00409)	(0.00371)	(0.00361)	(0.00430)
Observations	1,531	1,531	1,531	1,531
R-squared	0.001	0.000	0.001	0.001
Number of firms	850	850	850	850
Standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

Adding controls did not change the outcome. The coefficients are still not statistically different from zero.

Table11.The effect of trade diversification on importers' productivity

VARIABLES	tfp_ols	tfp_fe	tfp_op	tfp_lp
	With a set of controls			
L.imI_p	-0.0336	-0.0183	-0.0323	-0.0478
	(0.0329)	(0.0289)	(0.0296)	(0.0313)
L.imI_c	0.00187	0.00176	0.00207	0.00520
	(0.00397)	(0.00348)	(0.00357)	(0.00378)
Observations	1,531	1,531	1,531	1,531
R-squared	0.001	0.000	0.001	0.001
Number of firms	850	850	850	850
Standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

An extended version of the regression tables can be found in the appendix.

In fact the estimation results for exporters comply with the preliminary inference form the data. Exporters tend not to increase the average number of products traded and gradually diversify geographically. As for importers the story is not so clear cut. The model revealed no significant relationship; however, data description provided evidence on the rapid increase of the goods sourced from abroad and gradual increase in the geographical diversity. Since the specification of the model seems to be correct, the problem may be rooted in the data. In fact there is no clear evidence on the use of the imported product varieties in the production and not for resale. There is a bunch of firms conducting trading operations performing the role of an intermediary link. In the latter case the notion of imports influencing a firm's productivity is distorted. Thus, since our data do not contain information on the use of imported product varieties in manufacturing, it is not legitimate to make a final conclusion about lack of relationship between trade complexity and firm performance. It might be insightful to study more carefully the composition of trade flows of a firm: an enterprise importing and exporting within the same product codes should be withheld from the analysis or at least net values of trade flows should be used to trace the link between trade operations and a firm production efficiency.

Chapter 6

CONCLUSION

The present work analyzes the effect of international trade complexity on the performance of a firm.

To approximate the predictor an index of inverse diversification along product and geographic markets is constructed, performance is measured as total factor productivity retrieved as a residual from a production function. Since production function estimation is a difficult task (the opinion is widely shared in the related literature), it is addressed with precautions and four estimation procedures are employed to retrieve the total factor productivity. This is to eliminate the possibility that the results eventually obtained cab be attributable just to the choice of production function estimation method.

As for the relationship of interest, the interest is primarily focused on the effect diversification produces on firm-level productivity. The specification employed allows tracing this 'learning effect'.

The first estimation result for exporters shows that sticking to the traditional product mix and gradual geographic diversification is associated with higher productivity level. As for the importers, the second result is that no significant relationship of interest was found, and the reason might be rooted in the problems with the data. Since the information on production utilization of the imported goods is missing, it becomes difficult to link trading activity to the production efficiency measure.

The value of the work is in explanation of the trade-productivity patterns, which may be useful for trade policy implications (issues of trade liberalization, its pace and scope, international trade cooperation and so on).

To outline the prospects for a future research: it might be insightful to study more carefully the composition of trade flows of a firm. An enterprise importing and exporting within the same product codes should be withheld from the analysis or at least net values of trade flows should be used to trace the link between trade operations and firm production efficiency. One may also distinguish the quality of goods approximated by the level of economic development of the trade partner, and so on.

WORKS CITED

Altomonte, Carlo, and Bekes, Gabor. 2009. Trade Complexity and Productivity, *IEHAS Discussion Papers* 0914, Institute of Economics, Hungarian Academy of Sciences.

Amiti, Mary, and Konings, Joseph. 2007. Trade liberalization, intermediate inputs and productivity: evidence from Indonesia, *American Economic Review* 97: 1611-1638.

Andrews, Donald W.K. 1991. Asymptotic Normality of Series Estimators for Nonparametric and Semiparametric Regression Models, *Cowles Foundation Discussion Papers* 874R, Cowles Foundation, Yale University.

Bernard, A. B. and Jensen, Jacob B. 1995. Exporters, Jobs, and Wages in US Manufacturing: 1976-87, Brookings Papers on Economic Activity: Microeconomics, 67-112.

Bernard, Andrew, Jensen, J. Bradford, Redding, Stephen J. and Schott, Peter. 2007. Firms in International Trade, *Journal of Economic Perspectives* 21: 105-130.

Bernard, Andrew, Eaton, Jonathan, Jensen, Brad, and Kortum, Sam. 1999. Plants and Productivity in International Trade: A Ricardian Reconciliation, *mimeo*, 1999.

Besedina, Elena. 2003. Exploring International Trade from Below: A Survey of Firm Heterogeneity and Productivity Dynamics, *Micro-Dyn Working paper* No 01/07.

Bleaney, M., Filatovchev, I., Demina, N., and Wakelin, K. 2000. Learning by exporting: evidence from three transition countries, *GEP Research Paper*, 2000/06.

Bond, Steve, and Söderbom, Måns. 2005. Adjustment Costs and the Identication of Cobb-Douglas Production Functions, The Institute for Fiscal Studies, *Working Paper Series* No. 05/04.

Castellani, Davide, Serti, Francesco, and Tomasi, Chiara. 2008. Firms in International Trade: Importers and Exporters Heterogeneity in Italian Manufacturing Industry", *mimeo*, 2008.

Clerides, S., Lach, S., and Tybout, J. 1998 Is Learning by Exporting Important? Micro-Dynamic Evidence from Columbia, Mexico and Morocco, *Quarterly Journal of Economics*, 113, 903-47.

Elliott, Robert J. R., and Virakul, Supreeya. 2008. Firm Heterogeneity, Origin of Ownership and Export Participation, *Discussion Papers* 09-16, Department of Economics, University of Birmingham.

Engle, Robert F., Granger, C. J. Rice, and Weiss, A. 1986. Semi-parametric estimates of the relation between weather and electricity demand, *Journal of American Statistical Association*, 81, 310-320.

Farinas, José C. and Ana Martin-Marcos. 2003. Exporting and Economic Performance: Firm-Level Evidence for Spanish Manufacturing. Universidad Complutense and UNED, Madrid, *mimeo*, April

Forlani, Emanuele. 2009. Competition in the Service Sector and the Performances of Manufacturing Firms: Does Liberalization Matter?, *CESifo Working Paper Series* CESifo Working Paper No. , CESifo Group Munich.

Kasahara, Hiroyuki, and Lapham, Beverly. 2008. Productivity and the Decision to Import and Export: Theory and Evidence", *Journal of International Economics*, forth.

Kraay, Aart. 2002. Exports and economic performance: evidence from a panel of Chinese enterprises. *In Mary-Francoise Renard (Ed.)*, China and its Regions. Economic Growth and Reform in Chinese Provinces. Cheltenham etc.: Elgar, 278-299.

Levinsohn, James, and Petrin, Amil. 2003. Estimating Production Functions Using Inputs to Control for Unobservables, *Review of Economic Studies*, Blackwell Publishing, vol. 70(2), pages 317-341, 04.

Manova, Kalina, and Zhang, Zhiwei. 2009. China's Exporters and Importers: Firms, Products and Trade Partners, *NBER Working Paper* No. 15249, August. NBER Program.

Marschak, Jacob, and Andrews, William H. 1944. Random Simultaneous Equations and the Theory of Production, *Econometrica*,12, 143-205.

Muûls, Mirabelle, and Pisu, Mauro. 2005. Imports and Exports at the Level of the Firm: Evidence from Belgium, *Working Paper* No. 114, National Bank of Belgium.

Nesterenko, Anna. 2003. The determinants of firm export behavor. KSE MA Thesis.

Newey, William. K. 1994. The asymptotic variance of semiparametric estimation, *Econometrica* 62: 1349-1382.

Olley, Steven G. and Pakes, Ariel. 1996. The Dynamics of Productivity in the Telecommunications Equipment Industry, *NBER Working Papers* 3977, National Bureau of Economic Research, Inc.

Pavcnik, Nina. 2002. Trade Liberalization, Exit, and Productivity Improvements: Evidence from Chilean Plants, *Review of Economic Studies* 69: 245-76.

Roberts, Mark J. and Tybout, James R. 1997. The Decision to Export in Colombia: An Empirical Model of Entry with Sunk Costs, *American Economic Review*, American Economic Association, vol. 87(4), pages 545-64, September.

Robinson, Peter M. 1998. Root- N-Consistent Semiparametric Regression, *Econometrica*, Econometric Society, vol. 56(4), 931-54, July.

Wedervang, Frencis. 1965. Development of a population of industrial firms, Scandinavian University Books.

APPENDIX

Table A. Production function estimation, OLS

Ind	Labor	St. errors	Materials	St.errors	Capital	St. errors	Obs
1	0.342***	(0.0167)	0.632***	(0.00776)	0.0613***	(0.00824)	5,936
2	0.301***	(0.0245)	0.635***	(0.0106)	0.0520***	(0.0123)	2,105
3	0.319***	(0.0196)	0.652***	(0.00870)	0.0320***	(0.00923)	3,817
4	0.609***	(0.0341)	0.405***	(0.0143)	0.123***	(0.0164)	1,606
5	0.478***	(0.0255)	0.473***	(0.0110)	0.0963***	(0.0114)	3,223
6	0.353***	(0.0270)	0.584***	(0.0132)	0.0519***	(0.0125)	2,328
7	0.365***	(0.0188)	0.576***	(0.00878)	0.0467***	(0.00884)	4,012
8	0.421***	(0.00722)	0.548***	(0.00363)	-0.0375***	(0.00347)	22,158
9	0.473***	(0.0222)	0.449***	(0.00880)	0.0852***	(0.0106)	4,349
10	0.281***	(0.0394)	0.529***	(0.0182)	0.0436**	(0.0197)	1,321
11	0.610***	(0.0339)	0.399***	(0.0139)	0.0787***	(0.0166)	2,762
	Standard errors in parentheses						
	*** p<0.01, ** p<0.05, * p<0.1						

Table B. Production function estimation, FE

Ind	Labor	St. errors	Materials	St.errors	Capital	St. errors	Obs
1	0.343***	(0.0230)	0.417***	(0.0102)	0.0985***	(0.0146)	2,490
2	0.295***	(0.0358)	0.316***	(0.0160)	0.0492**	(0.0210)	841
3	0.376***	(0.0271)	0.470***	(0.0122)	0.0740***	(0.0183)	1,641
4	0.427***	(0.0510)	0.372***	(0.0190)	0.126***	(0.0312)	699
5	0.489***	(0.0350)	0.349***	(0.0134)	0.133***	(0.0192)	1,367
6	0.393***	(0.0407)	0.442***	(0.0182)	0.0492**	(0.0234)	1,032
7	0.345***	(0.0267)	0.433***	(0.0113)	0.0843***	(0.0144)	1,802
8	0.465***	(0.00982)	0.429***	(0.00445)	0.0711***	(0.00606)	6,471
9	0.475***	(0.0296)	0.318***	(0.0105)	0.127***	(0.0155)	1,797
10	0.372***	(0.0564)	0.329***	(0.0231)	0.175***	(0.0332)	516
11	0.592***	(0.0381)	0.368***	(0.0144)	0.0897***	(0.0216)	1,232
	Standard errors in parentheses						
	*** p<0.01, ** p<0.05, * p<0.1						

Table C. Production function estimation, OP

Ind	Labor	St. errors	Materials	St.errors	Capital	St. errors	Obs
1	0.359***	(0.0328)	0.529***	(0.0221)	0.0706***	(0.0199)	3,027
2	0.255***	(0.0534)	0.538***	(0.0227)	0.0936	(0.0592)	723
3	0.260***	(0.0442)	0.561***	(0.0247)	0.139**	(0.0348)	1,518
4	0.630***	(0.0833)	0.340***	(0.0441)	0.0602	(0.108)	688
5	0.398***	(0.0438)	0.375***	(0.0337)	0.188***	(0.0481)	1,806
6	0.302***	(0.0510)	0.512***	(0.0325)	0.0478**	(0.018)	1,166
7	0.342***	(0.0333)	0.503***	(0.0261)	0.0803*	(0.0272)	2,127
8	0.396***	(0.0175)	0.444***	(0.0111)	0.0800***	(0.0175)	11,331
9	0.415***	(0.0425)	0.331***	(0.0218)	0.177**	(0.0692)	2,141
10	0.264***	(0.0835)	0.386***	(0.0516)	0.102	(0.120)	752
11	0.632***	(0.0555)	0.285***	(0.0432)	0.0538***	(0.019)	1,407
	Standard errors in parentheses						
	*** p<0.01, ** p<0.05, * p<0.1						

Table D. Production function estimation, LP

Ind	Labor	St. errors	Materials	St.errors	Capital	St. errors	Obs
1	0.364***	(0.0263)	0.790***	(0.131)	0.0630**	(0.0249)	5,936
2	0.329***	(0.0304)	0.307**	(0.102)	0.115**	(0.0561)	2,105
3	0.325***	(0.0257)	0.328***	(0.113)	0.0889**	(0.0297)	3,817
4	0.596***	(0.0523)	0.264*	(0.152)	0.111	(0.0722)	1,606
5	0.455***	(0.0389)	0.254***	(0.0946)	0.194***	(0.0640)	3,223
6	0.320***	(0.0375)	0.310*	(0.162)	0.059***	(0.010)	2,328
7	0.365***	(0.0228)	0.703***	(0.177)	0.0704*	(0.028)	4,012
8	0.410***	(0.0117)	0.330***	(0.0457)	0.100***	(0.0281)	22,158
9	0.511***	(0.0381)	0.220**	(0.107)	0.172***	(0.0655)	4,349
10	0.260***	(0.0522)	0.788***	(0.158)	0.091	(0.121)	1,321
11	0.633***	(0.0498)	0.295*	(0.153)	0.116**	(0.038)	2,762
	Standard errors in parentheses						
	*** p<0.01, ** p<0.05, * p<0.1						

Table E. The effect of trade diversification by product on exporters' productivity

VARIABLES	tfp_ols	tfp_fe	tfp_op	tfp_lp
Lag of tfp_ols	0.0566**			
	(0.0271)			
Lag of tfp_fe		0.0623**		
		(0.0258)		
Lag of tfp_op			0.0643**	
			(0.0262)	
Lag of tfp_lp				0.0874***
				(0.0237)
Lag of exI_p	0.0418***	0.0361***	0.0388***	0.0350**
	(0.0134)	(0.0123)	(0.0126)	(0.0137)
Lag of 2-way status	-0.0710**	-0.0482	-0.0604*	-0.0413
	(0.0354)	(0.0325)	(0.0335)	(0.0363)
Lag of foreign own.	0.187*	0.188*	0.194*	0.252**
	(0.105)	(0.0962)	(0.0992)	(0.108)
Lag of employment	-0.0781**	-0.0896***	-0.0700**	-0.0656**
	(0.0312)	(0.0284)	(0.0291)	(0.0315)
year_2003	-0.457***	-0.471***	-0.465***	-0.476***
	(0.0435)	(0.0400)	(0.0412)	(0.0446)
year_2004	-0.340***	-0.342***	-0.347***	-0.371***
	(0.0402)	(0.0371)	(0.0381)	(0.0412)
year_2005	-0.263***	-0.258***	-0.262***	-0.285***
	(0.0372)	(0.0341)	(0.0352)	(0.0382)
year_2006	-0.274***	-0.268***	-0.270***	-0.286***
	(0.0351)	(0.0322)	(0.0332)	(0.0360)
year_2007	-0.153***	-0.160***	-0.160***	-0.165***
	(0.0333)	(0.0305)	(0.0315)	(0.0341)
Constant	-0.875**	0.0171	-0.464	-1.771***
	(0.344)	(0.315)	(0.325)	(0.352)
Observations	2,580	2,580	2,580	2,580
R-squared	0.194	0.214	0.201	0.410
Number of firms	1,214	1,214	1,214	1,214
Standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

Table F. The effect of trade diversification by geographical market on exporters' productivity

VARIABLES	tfp_ols	tfp_fe	tfp_op	tfp_lp
Lag of tfp_ols	0.0583**			
	(0.0270)			
Lag of tfp_fe		0.0664***		
		(0.0257)		
Lag of tfp_op			0.0684***	
			(0.0262)	
Lag of tfp_lp				0.0886***
				(0.0236)
Lag of exI_c	-0.0225***	-0.0205***	-0.0201***	-0.0212***
	(0.00578)	(0.00530)	(0.00547)	(0.00593)
Lag of 2-way status	-0.0411	-0.0216	-0.0337	-0.0139
	(0.0357)	(0.0328)	(0.0338)	(0.0367)
Lag of foreign own.	0.192*	0.192**	0.198**	0.255**
	(0.105)	(0.0959)	(0.0990)	(0.107)
Lag of employment	-0.0655**	-0.0780***	-0.0581**	-0.0548*
	(0.0310)	(0.0283)	(0.0290)	(0.0313)
year_2003	-0.480***	-0.490***	-0.485***	-0.496***
	(0.0432)	(0.0397)	(0.0409)	(0.0442)
year_2004	-0.355***	-0.355***	-0.360***	-0.384***
	(0.0399)	(0.0368)	(0.0379)	(0.0408)
year_2005	-0.275***	-0.268***	-0.273***	-0.295***
	(0.0370)	(0.0340)	(0.0351)	(0.0380)
year_2006	-0.283***	-0.275***	-0.278***	-0.293***
	(0.0349)	(0.0320)	(0.0331)	(0.0358)
year_2007	-0.157***	-0.163***	-0.163***	-0.168***
	(0.0332)	(0.0304)	(0.0314)	(0.0340)
Constant	-0.610*	0.258	-0.224	-1.526***
	(0.348)	(0.318)	(0.329)	(0.356)
Observations	2,580	2,580	2,580	2,580
R-squared	0.197	0.218	0.203	0.413
Number of firms	1,214	1,214	1,214	1,214
Standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

Table G. The effect of trade diversification by product on importers' productivity

VARIABLES	tfp_ols	tfp_fe	tfp_op	tfp_lp
Lag of tfp_ols	0.0580			
	(0.0374)			
Lag of tfp_fe		0.0756**		
		(0.0355)		
Lag of tfp_op			0.0882**	
			(0.0364)	
Lag of tfp_lp				0.0978***
				(0.0350)
Lag of .imI_p	-0.0336	-0.0183	-0.0323	-0.0478
	(0.0329)	(0.0289)	(0.0296)	(0.0313)
Lag of 2-way status	-0.0196	-0.00752	-0.0175	0.00382
	(0.0573)	(0.0502)	(0.0514)	(0.0545)
Lag of foreign own.	0.00512	0.00329	-0.00784	-0.0196
	(0.0999)	(0.0876)	(0.0897)	(0.0949)
Lag of employment	-0.148***	-0.0761*	-0.0943**	-0.0746
	(0.0502)	(0.0439)	(0.0450)	(0.0477)
year_2003	0.165**	0.140**	0.153**	0.146**
	(0.0664)	(0.0581)	(0.0596)	(0.0631)
year_2004	0.303***	0.244***	0.273***	0.308***
	(0.0699)	(0.0611)	(0.0628)	(0.0663)
year_2005	0.331***	0.257***	0.280***	0.265***
	(0.0693)	(0.0608)	(0.0624)	(0.0657)
year_2006	0.464***	0.338***	0.375***	0.357***
	(0.0699)	(0.0613)	(0.0629)	(0.0663)
year_2007	0.526***	0.394***	0.428***	0.404***
	(0.0774)	(0.0680)	(0.0697)	(0.0735)
Constant	-0.342	-0.317	-0.329	-0.806*
	(0.450)	(0.394)	(0.404)	(0.427)
Observations	1,488	1,488	1,488	1,488
R-squared	0.181	0.238	0.148	0.335
Number of firms	817	817	817	817
Standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

Table H. The effect of trade diversification by geographical markets on importers' productivity

VARIABLES	tfp_ols	tfp_fe	tfp_op	tfp_lp
Lag of tfp_ols	0.0547			
	(0.0376)			
Lag of tfp_fe		0.0713**		
		(0.0356)		
Lag of tfp_op			0.0829**	
			(0.0366)	
Lag of tfp_lp				0.0897**
				(0.0352)
Lag of imI_c	0.00187	0.00176	0.00207	0.00520
	(0.00397)	(0.00348)	(0.00357)	(0.00378)
Lag of 2-way status	-0.0278	-0.0123	-0.0254	-0.00884
	(0.0569)	(0.0498)	(0.0511)	(0.0542)
Lag of foreign own.	0.00343	0.00123	-0.00968	-0.0277
	(0.100)	(0.0879)	(0.0901)	(0.0952)
Lag of employment	-0.152***	-0.0772*	-0.0973**	-0.0769
	(0.0501)	(0.0438)	(0.0450)	(0.0476)
year_2003	0.165**	0.143**	0.153**	0.154**
	(0.0675)	(0.0591)	(0.0606)	(0.0642)
year_2004	0.294***	0.243***	0.266***	0.306***
	(0.0701)	(0.0613)	(0.0630)	(0.0663)
year_2005	0.328***	0.259***	0.279***	0.271***
	(0.0704)	(0.0619)	(0.0635)	(0.0667)
year_2006	0.464***	0.341***	0.376***	0.365***
	(0.0709)	(0.0623)	(0.0640)	(0.0673)
year_2007	0.524***	0.396***	0.429***	0.411***
	(0.0781)	(0.0687)	(0.0705)	(0.0742)
Constant	-0.365	-0.339	-0.355	-0.864**
	(0.453)	(0.396)	(0.406)	(0.429)
Observations	1,488	1,488	1,488	1,488
R-squared	0.180	0.238	0.147	0.334
Number of firms	817	817	817	817
Standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				