THE IMPACT OF TRADE LIBERALIZATION ON PRODUCTIVITY DISPERSION: EVIDENCE FROM UKRAINE

by

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Date ______________________________

Kyiv School of Economics

Abstract

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The paper investigates the effect of trade liberalization on productivity dispersion using a rich dataset that contains financial records of 57,734 Ukrainian manufacturing firms for 2001-2009. Productivity dispersion measures are obtained from the estimation of Cobb-Douglas production function applying Olley-Pakes approach to deal with simultaneity and selection biases. Then industry-level productivity dispersion measures are computed, and OLS regression is employed to evaluate the impact a change in import tariff.

The study shows that a reduction of tariff leads to a decrease in the dispersion. The results confirm the conclusion of Melitz (2003) model which predicts exit of the least productive firms after trade liberalization. However, the robust evidence is obtained only in specifications with the lagged values of the tariff variable. It implies that the reduction of tariff causes exit of inefficient firms not immediately, but in the next two years. The contribution of this paper is to provide rare evidence about the topic from a developing country where effect of reduction of trade barriers on productivity distribution may be more pronounced. The paper also suggests an explanation of the contradictory results that were found in previous studies, and provides empirical reasons for an extension of Melitz model.

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Chapter 1

INTRODUCTION

The last decade has witnessed dramatic liberalization of international trade all over the world. The world average equivalent uniform tariff for all goods decreased from 9.7 per cent in 2000-2004 to 7.17 per cent in 2006-2009 (WorldBank, 2010). Ukraine was not an exception. Between 2001 and 2009 average import tariff on manufactured goods decreased from 8.54 per cent to 6.15 per cent (UN Comtrade, 2012).

Trade liberalization is motivated by welfare gains from reallocation of resources. Evidence from empirical studies suggested that reduction of barriers to international trade resulted in general increase in productivity on industry level (Pavcnic, 2002; Bernard et all, 2006). Melitz (2003) provided a seminal theoretical explanation for such documented facts. According to the model, an increase in market exposure to international trade leads to reallocation of market shares between heterogeneous firms. More productive firms are more likely to become exporters. As foreign trade starts or expands the least productive firms are forced to exit their markets (their profits become negative since the real wages increase). As a result, aggregate productivity in a country increases. The effect for countries-importers is reciprocal.

The goals of the paper were (1) to ensure whether reduction of trade barriers has lead to an increase in productivity in Ukraine and (2) to test whether the natural selection mechanism as described above has worked. The link between trade liberalization and productivity dispersion was previously studied on microeconomic level using mainly data from developed countries

(Syverson, 2004, Del Gatto et al., 2008, Ito and Lechevalier, 2009). The evidence was contradictory: Del Gatto et al. (2008) showed that greater exposure to trade was associated with smaller productivity dispersion, whereas Syverson (2004) and Ito and Lechevalier (2009) reached the opposite conclusions.

The contribution of this paper was to provide rare evidence about the issue from a developing country. It was important because the potential of productivity growth was higher in developing countries than in developed ones, at least in terms of labor productivity. Therefore, it might be supposed that the effect of reduction of trade barriers on productivity distribution may be more pronounced in the former countries.

The analysis was performed in three steps. First, total factor productivity (TFP) and labor productivity (LP) indexes for each firm were constructed. Second, productivity dispersion at the industry level was computed. Third, the dispersion estimate was regressed on a trade liberalization variable (weighted average import tariff in a sector) and a set of controls (market concentration index, sunk cost index, investment to capital ratio). The Melitz model was based on the assumption that the productivity level of each firm was given exogenously and constant. Therefore, a decrease in dispersion can indicate an exit of low productive firms from the market. A rich dataset containing the data about 57,734 Ukrainian manufacturing firms was employed in the study. Data came from firms' annual financial statements submitted to the State Statistics Office.

Generally, the prediction of the Melitz model was confirmed: productivity dispersion shrank as a result of a decrease in import tariff. The impact was stronger for total factor productivity than for labor productivity. The conclusion was robust to different measures of productivity dispersion. The presented study suggested also an explanation of the contradictory results of previous study and provided empirical reasons for an extension of Melitz model.

The remaining part of the paper was organized as follows. The existing relevant literature was summarized in Chapter 2. The methodology was presented and discussed in Chapter 3. Description of the data was provided in chapter 4. Then, chapters 5 and 6 contain the main empirical results and robustness check. Conclusions and discussion were presented in chapter 7.

Chapter 2

LITERATURE REVIEW

The structure of the review is the following. First, the basic settings of the Melitz model were outlined. Second, the attention was paid to the empirical evidence about the basic implications, specifically whether exporters are more productive than non-exporters and whether the former became more efficient after they start exporting. Third, the literature concerning the link between productivity dispersion and the openness of the economy was discussed. Finally, existing studies that test Melitz model on Ukrainian data were considered and the contribution of the paper was emphasized.

The presented research was based on the model of intra-industry effects of international trade developed by Melitz (2003). According to the model, an increase in exposure to trade induces natural selection of heterogeneous firms which operate in the monopolistic competition environment. As an exposure of an industry to trade increases more productive firms become exporters and crowd out their less productive competitors. "The increased labor demand by the more productive firms and new entrants bids up the real wage and forces the least productive firms to exit" (Melitz, 2003). It can be shown that as a result the productivity dispersion will shrink.

Extensive empirical evidence about the link between productivity and international trade emerged in the last two decades after detailed micro-level data became available. They largely confirmed predictions of Melitz (2003) model. First, most studies have found that exporters were more productive than non-exporters. To mention just a few, Aw, Chung, and Roberts (2000) showed it using data from Taiwan and South Korea. Arnold and Hussinger (2005) provided evidence from German manufacturing sector.

Second, studies suggested that a decision to export was driven by self-selection mechanism. Using US data from manufacturing sector Bernard and Jensen (1999) showed that most efficient producers became exporters. The researchers have not found any strong evidence of exporters becoming more productive after entering foreign markets (as "learning-by-exporting" hypothesis suggested).

Third, empirical evidence confirmed that trade liberalizations led to productivity growth. Pavcnik (2002) showed that reduction of barriers to international trade resulted in general increase in efficiency in exporting sectors. Using industry-level US data, Bernard et all (2006) showed that reduction of trade costs in an industry (tariffs plus transportation costs) led to an increase in productivity in the industry through competitive pressure. Muendler (2004) used firm-level data from Brazilian manufacturing sector for 1996-1998 and argued that the same relationship was observed for a developing country as well. Similarly, Fernandes (2006) showed that trade liberalization induced higher productivity in Colombia in 1977-1991, based on plant-level data. According to Fernandes, the effect was found to be stronger for large plants and for less competitive sectors.

However, some important details on how an increase in aggregate productivity actually occurred, remained unclear. Bernard et al (2006) showed that survival probability for less productive firms was lower than for more efficient ones, i.e. less productive firms exit the market. But those authors did not find any correlation between the market share and trade costs, i.e. reduction of trade costs does not lead to an increase in the market share for more efficient firms, which contradicts the theory.

Furthermore, empirical evidence about productivity dispersion was mixed. The Melitz model unambiguously predicted that as trade costs go down efficient firms crowd out inefficient ones and the productivity dispersion must decrease. In an empirical study Del Gatto et al. (2008) confirmed this hypothesis. Using data from Italian industries, they found that dispersion of marginal costs was smaller in industries which were relatively more exposed to international trade.

On the other hand, some researchers have reached the opposite conclusions. Syverson (2004) used US data to find that greater exposure to trade was associated with larger productivity dispersion. Ito and Lechevalier (2009) came to the same conclusion for Japan. They found that productivity dispersion was greater in more open industries, i.e. an increase in either export or import share was associated with larger dispersion.

Syverson (2004) and Ito and Lechevalier (2009) proposed four possible explanations for this contradiction: 1) natural selection did not work, at least in the short run; 2) learning effect; i.e. an increase in productivity of some firms due to external competition, was stronger than selection effect; 3) product heterogeneity (for example, firms within a sector produce different goods and competitive pressure from abroad was weak for some goods); 4) possible reverse causality between import presence and productivity dispersion (import was attracted by high productivity dispersion in a country).

Del Gatto at al. (2008) offered another explanation. They argued that the results received by Syverson were biased since the estimates were affected by a systematic error in measurement of the dependent variable. The bias stems from the fact that researchers did not have data about real output and used instead a proxy – sales revenue, deflated by industry-level price index. However, the change in prices were idiosyncratic and, according to Melitz model, directly related to each firms' productivity. This results in a bias, which Del Gatto et al. called "omitted price bias".

Several researchers tested the conclusions of the Melitz model using Ukrainian firm-level data from manufacturing sector. Besedina (2008) found that exporters in steel sector in Ukraine were more productive, but, contrary to the theory, the distributions of the total factor productivity of exporters and non-exporters intersected. She offered a political economy explanation to the latter fact. Shevtsova (2010) studied whether "learning-by-exporting" hypothesis held using data from some industries (chemical industry, production of coke, minerals and machinery) and found that it was valid only in the long run. Poltavets (2005) studied how openness affects productivity differentials using the data from Ukrainian manufacturing and energy sector. He showed that an increase in import penetration led to a reduction of TFP dispersion.

The distinctive feature of the presented study is that it employs a rich firm-level dataset from a developing country to study the effect of reduction of barriers to trade on productivity dispersion. Syverson (2004), Del Gatto at al. (2008), Ito and Lechevalier (2009) used the data from developed countries. Poltavets (2005) used a dataset for the period from 1992 to 2000, when the process of transition to a market economy in Ukraine was at its height and market mechanisms did not work properly. Moreover, at that time a lot of firms had large non-productive assets, inherited from their socialist period predecessors, and widely used barter deals, which could negatively affect the quality of the data. Furthermore, the presented paper used a methodology of the production function estimation and measures of productivity dispersion that were different from the ones employed by Poltavets (2005). I should be noted that Besedina (2008) and Shevtsova (2010) focused on the effect of reduction of trade barriers on the performance of individual firms, not on productivity distribution.

The evidence of the effect of an increase in openness on productivity distribution at the industry level was rare. The contribution of the presented paper was to provide such an evidence. The basic hypothesis was in line with the Melitz model: the dispersion in productivity shrank as the economy became more open.

C h a p t e r 3

METHODOLOGY

Three steps were taken to test the prediction of the Melitz model. First, a production function was estimated in order to construct firm-level total factor productivity (TFP) indices. Second, dispersion of productivity at the industry level was computed. Third, a relationship between productivity and openness of the economy was evaluated.

1. Production function estimation

The Cobb-Douglas production function in logarithmic form can be estimated as a linear equation:

$$\ln Y_{it} = \mu + \alpha \ln K_{it} + \beta \ln L_{it} + \gamma \ln M_{it} + \delta_i + \varepsilon_{it} \quad (1)$$

where Y_{it} is log of output of a firm i in a period t, L_{it}, K_{it}, M_{it} are labor, capital and intermediate inputs, respectively; α, β, γ, μ are coefficients of the production function, δ_i captures individual time-invariant fixed effects or time-varying random effects, $\varepsilon_{it} \sim$ i.i.d. N $(0, \sigma^2)$ is an error term. The last two terms represent firm-specific effects on the log of output and are used as a proxy for total factor productivity.

However, at this stage problems with simultaneity and selection bias may arise (Marschak and Andrews, 1944). Productivity shocks are observed by firms' managers before they make decisions about the quantity of labor (which is the most easily variable input) to be employed, but unobserved by an econometrician.

Therefore, the correlation of the error term (which captures productivity) and one of the explanatory variables is not zero (the simultaneity bias). In addition, negative productivity shocks may induce some firms to exit the market, which causes the selection bias. The estimates of the standard OLS model will be inconsistent.

These issues can be addressed by using Olley and Pakes (1996) approach. The methodology is based on the assumption that firm's investment decisions depend on productivity shocks and a current stock of capital: when a firm observes a positive shock it increases investment taking into account the present capital stock. Therefore, an unobserved shock can be estimated as a function of investment and capital. Since the probability of survival is assumed to be dependent on unobserved shocks, it could be also estimated as a function of investment and capital.

Thus, Olley and Pakes approach could be implemented as a three stage procedure. At the first stage, the elasticities of labor and intermediate inputs could be obtained using OLS regression, in which capital and unobserved shocks were approximated through a quadratic function of capital and investment. At the second stage, the probability of exit for a firm could be estimated using probit regression. Finally, the elasticity of capital could be evaluated through nonlinear least squares method using results from the previous two stages.

2. Measuring dispersion

A common measure of dispersion was standard deviation. But this indicator is sensitive to outliers. Another two measures, which do not have this property, could be used:

1) inter-decile range, which was the difference between 90th percentile and 10th percentile of productivity distribution;

2) inter-quartile range, which was the difference between 75th percentile and 25th percentile of productivity distribution.

The main measure of interest was inter-decile range since it could capture systematical changes in the segment of the least productive firms. Inter-quartile range and standard deviation were used to check the robustness of the results. The use of multiple measures of dispersion was common in the literature (Del Gatto et al., 2008, Ito and Lechevalier, 2009). Each measure was computed for each combination of a year and an industrial sector. As the results, a new sample with industry-level observations was constructed for the second stage of regressions.

At this stage also labor productivity indices was computed as:

$$LP\ index = \ln((sales\text{-}materials)/employment) \quad (2)$$

For labor productivity dispersion were constructed the same measures as for TFP dispersion: the inter-decile range, the inter-quartile range and the standard deviation.

3. Evaluating the impact of trade liberalization

Finally, the dispersion estimates from the previous stage were regressed on the import tariff variable, which was used as a proxy for trade liberalization. Other determinants of productivity dispersion had to be controlled for in order to get unbiased estimates. Besides the openness of the economy, another two determinants were used in the literature: technical innovations and product market conditions.

Ito and Lechevalier (2009) used two proxies for innovations: (1) R&D intensity and (2) IT ratio, which was the ratio of information and communication technologies assets to the total capital stock. Such information was unavailable for Ukrainian manufacturing firms. But it did not cause a problem since only a small portion of Ukrainian firms invested in R&D and/or relied on information technologies. According to the data from the State Statistics Committee of Ukraine, in 2001-2009 on average 14 per cent of Ukrainian firms made any kind of investment related to innovations. In order to control for technical progress another variable was created: investment to capital ratio (IC ratio) which was the amount of total investment divided by the total sales in a sector.

Syverson (2004), Ito and Lechevalier (2009) employed a set of variables as proxies for product market conditions: (1) market concentration index, (2) product diversification index, (3) average shipment distance or value, (4) advertising intensity. Given the available information, only market concentration index was used in this study. It was computed as a sum of market shares of the five largest companies in a sector. In addition, a sunk cost index which was a proxy for the cost of entering the market and could capture some output market conditions, was included into the regression. As in Syverson (2004), sunk cost was calculated as "the market share of an industry's median-sized plant multiplied by the capital-output ratio for the industry".

To sum up, the impact of trade liberalization on productivity distribution was estimated as a linear equation:

$$D_{it} = \alpha + \beta X_{it} + \gamma Z_{it} + \delta_i + \varepsilon_{it} \quad (3)$$

where D_{it} was a measure of productivity dispersion, X_{it} was a tariff variable, Z_{it} was a vector of control variables (entry cost, market concentration index, investment to capital ratio), δ_i was industry fixed effects or random effects and ε_{it} was a usual error term. The choice between fixed effects or random effects was based on Hausman test.

The lagged values of tariff variable were also added to the regression in order to make a robustness check. The expected sign of the tariff variable was positive (reduction of tariffs led to a decrease in productivity dispersion), the expected sign of market concentration index was also positive (the more monopolized a market was the larger dispersion was). But the sign of sunk cost index was expected to be negative since lower entry cost can potentially lead to stronger competition and crowding out less productive firms).

Chapter 4

DATA DESCRIPTION

The main source of data was a comprehensive dataset of enterprise statistics collected by State Statistics Committee of Ukraine. It covered the period from 2001 to 2009. The dataset contained the information from annual financial statements of Ukrainian firms (Balance Sheet Statement, Financial Results Statement and "Enterprise performance" statement).

Since the data about physical quantities of production were unavailable, net sales were used as a proxy for output. The following variables were also employed: residual value of tangible assets (capital), expenditures on intermediate inputs (materials), number of workers employed (labor) and the amount of investment in tangible assets.

The sample was initially restricted to manufacturing firms (subsections 15 to 37 of Ukrainian Industrial Classification, KVED). Then the sample was cleaned in order to get rid of inactive firms. The observations with zero capital or employment or materials were dropped from the sample, as well as observations with missing values. Outliers, i.e. firms with top 1 per cent of values for capital or employment or materials, were also excluded from the sample (Table 1).

The final sample was unbalanced panel containing the data about 57,734 firms with 3.96 observations per firm on average. The total number of observations was 223,279. Output, capital, materials, investment variables were deflated using industry-level PPI. Main descriptive statistics is provided in Tables 2 and 3.

Table 1. Construction of the firm-level sample

#	Stage	Observa-tions	Firms	Obs. per firm
1	All manufacturing firms in the dataset	452,571	108,384	4.18
	Excluding inactive firms:			
2	- sales <= 0 or missing	331,704	80,647	4.11
3	- employment <= 0 or missing	288,972	74,102	3.90
4	- capital <= 0 or missing	250,552	62,581	4.00
5	- materials<= 0 or missing	236,911	58,964	4.02
6	Excluding outliers	228,348	57,734	3.96

Table 2. General descriptive statistics of the firm-level sample

Variable	Observa-tions	Mean	Median	Standard deviation
Net sales	228,348	3,729	327	38,285
Tangible assets	228,348	1,225	65	8,808
Number of workers	228,348	57.2	15	218
Expenditures on materials	228,348	2,350	131	26,857
Investment	112,212	522	42	3,601

In thousands, 2001 hryvnias, with the exception of the number of workers.

A study of the data revealed that two selection bias problems could arise. First, only 49 per cent of observations had non-missing and positive values for investment and, thus, could be used in Olley-Pakes estimation procedure. On average investing firms were larger than non-investing enterprises. But it was not known whether the former were different in terms of productivity distribution.

Table 3. Selected descriptive statistics of the firm-level sample (by year)

Year	Obs.	Output		Capital		Employment	
		Mean	St. dev.	Mean	St. dev.	Mean	St. dev.
2001	27,234	2,337	22,052	1,377	9,331	65	252
2002	28,639	2,329	21,809	1,196	8,016	55	204
2003	28,915	2,806	30,437	1,117	7,769	53	215
2004	29,249	3,378	44,687	979	6,137	52	208
2005	29,262	3,560	39,803	991	6,275	52	203
2006	29,086	3,831	37,276	1,013	6,480	50	202
2007	28,641	4,134	40,326	1,055	7,683	50	200
2008	12,969	9,090	69,669	2,194	13,332	93	279
2009	14,353	6,222	42,357	2,082	17,227	74	224
Total	228,348	3,729	38,285	1,225	8,808	57	218

In thousands, 2001 hryvnias, with the exception of employment.

In order to check it a separate set of productivity measures was created using only the observations with non-missing and positive values for investment (Olley-Pakes sample). Then, an additional set of regressions was run with the obtained measures as dependent variables. Coefficients that were similar to the ones from the main set of regressions might indicate that the selection bias was not present.

The second data issue was related to incomplete information for 2008 and 2009. The observations were distributed across years more or less evenly in the raw dataset. But in the final dataset the number of observations in 2008 and in 2009 was approximately half the quantity for the preceding years. The reason was incomplete information about employment for 2008 and 2009. A method similar to described above was used to check whether the productivity distribution the firms that were active in 2008 and/or 2009 was different. All steps starting from constructions of productivity dispersion measures were repeated for the sample that consisted of the firms that were presented in 2008 and/or 2009 ("2008-2009 sample"). The sample contained observations for those firms for all years.

The import tariff variable was extracted from UN Comtrade database. The variable was constructed as an average import tariff for all products in a sector weighted by the value of goods imported. After construction of the tariff variable a recycling industry (KVED code 37) was dropped from the industry-level sample since special tariffs for recycled products did not exist. The main statistics about the simple average tariff in manufacturing (which illustrated trade liberalization policy), and about the weighted average tariff (which was used as a proxy for trade cots) is represented in Table 4 and depicted in Figure 1.

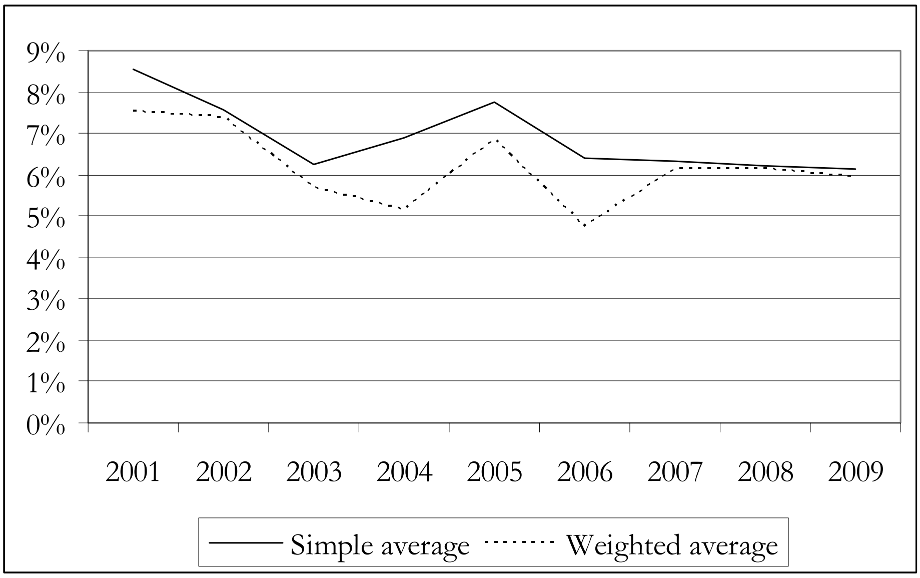


Figure 1. Average import tariffs in Ukrainian manufacturing sector in 2001-2009

Table 4. Average import tariffs in Ukrainian manufacturing sector in 2001-2009, per cent

Year	Simple average		Weighted average	
	Mean	St. dev.	Mean	St. dev.
2001	8,54	6,98	7,52	3,62
2002	7,56	6,78	7,37	4,85
2003	6,25	6,47	5,68	6,19
2004	6,88	6,13	5,17	5,26
2005	7,74	5,59	6,84	4,74
2006	6,41	5,61	4,73	5,86
2007	6,33	5,13	6,14	3,91
2008	6,22	5,26	6,14	4,00
2009	6,15	5,40	5,93	3,33
Average	6,89	5,98	6,17	4,72

Chapter 5

EMPIRICAL RESULTS

First, production function was estimated using OLS regressions and Olley-Pakes methodology. All obtained coefficients were statistically significant and had positive signs (Table 5). The coefficients of labor from Olley-Pakes estimation was significantly lower than the corresponding coefficient from OLS regression. That was in line with usual result of Olley-Pakes estimation and confirmed that the coefficients of labor in OLS regression were biased upward. The coefficients from model (4) were used then to compute firm-specific productivity indices.

Table 5. Production function coefficients

Explanatory variables	Fixed effects regression		Olley-Pakes method	
	(1)	(2)	(3)	(4)
	Coef./SE	Coef./SE	Coef./SE	Coef./SE
Log of capital	0.058***	0.057***	0.058***	0.077***
	(0.002)	(0.002)	(0.009)	(0.010)
Log of employment	0.451***	0.478***	0.331***	0.351***
	(0.003)	(0.003)	(0.008)	(0.009)
Log of materials	0.466***	0.460***	0.548***	0.530***
	(0.001)	(0.001)	(0.005)	(0.005)
Year dummy		Yes		Yes
Industry dummy		Yes		Yes
R^2	0.612	0.620		
Observations	228,348	228,348	112,152	112,152

The analysis of productivity indices showed that the average productivity increased over time (see Figure 2).

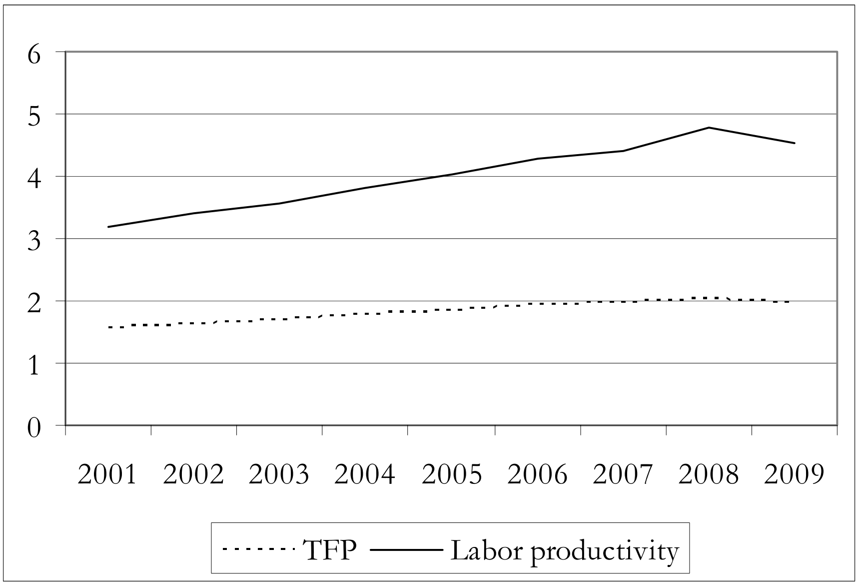


Figure 2. Average productivity change in 2001-2009

A look at the distribution of productivity indices (Figures 3 and 4) suggested that (1) the dispersion of labor productivity was higher than the dispersion of total factor productivity and (2) the productivity differentials became smaller over time. The shape of the distribution curve was narrower in 2009 than in 2001.

The conclusions were confirmed after the construction of industry-level productivity indices, which was the second step in the analysis. The inter-decile range was the measure that changed to the greatest extent. In 2001-2009 ID range of TFP distribution decreased by 3.71 per cent, the same measure of LP distribution shrank by 31.99 per cent (Fugures 3 and 4, Tables 4 and 5). The only measure that did not decreased in 2001-2009 was the standard deviation of TFP distribution. The reason was a sharp spike in that measure in 2009, in the period of economic crises in Ukraine. Just before the crises, the standard deviation of TFP dispersion was shrinking (in 2007-2008 it decreased by 9.64 per cent).

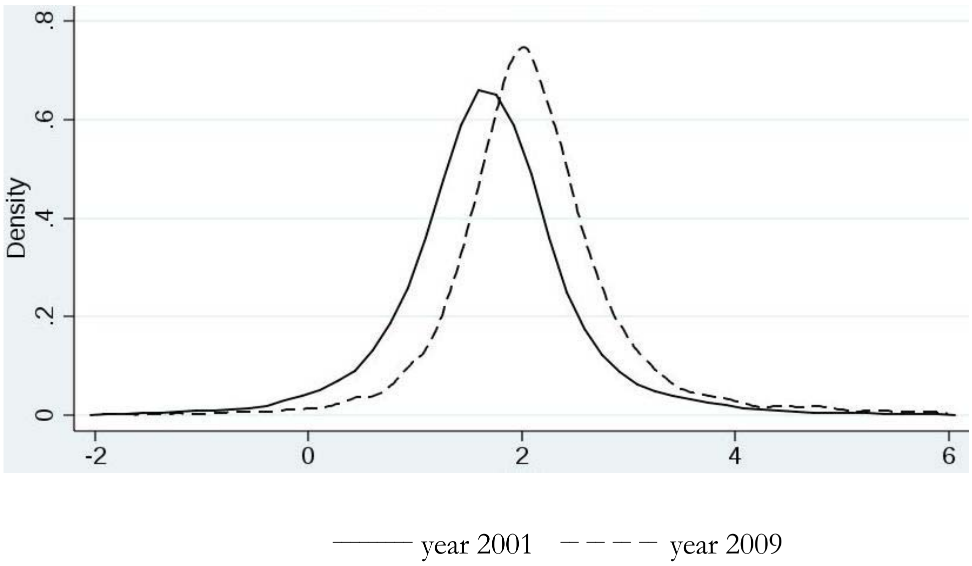


Figure 3. The distribution of TFP indices

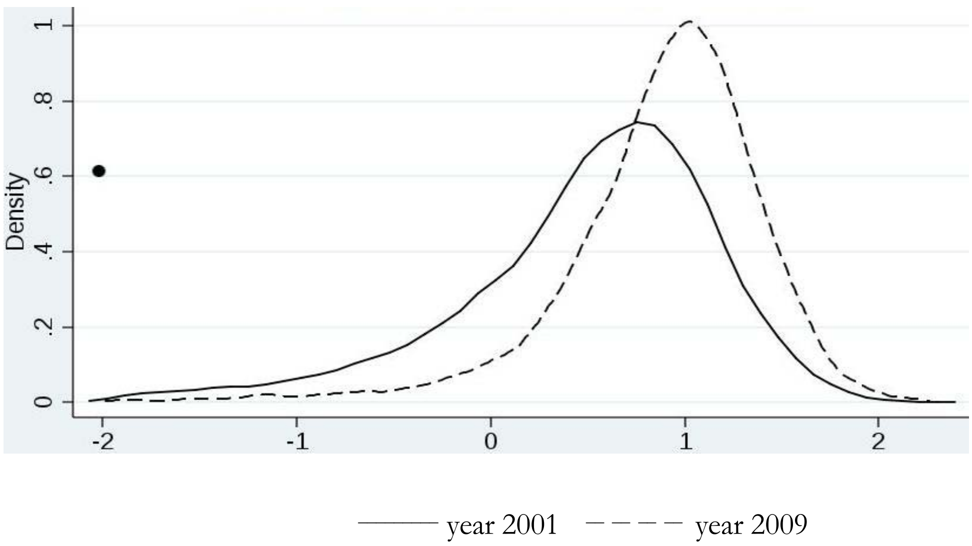


Figure 4. The distribution of labor productivity indices

It should be mentioned that the LP distribution was mostly gradually decreasing in 2001-2008, whereas the trend of change in TFP dispersion was more volatile.

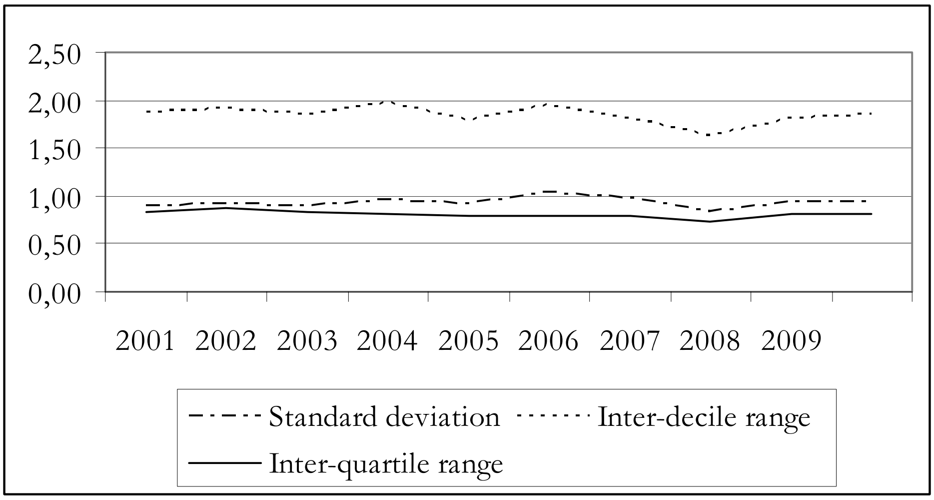
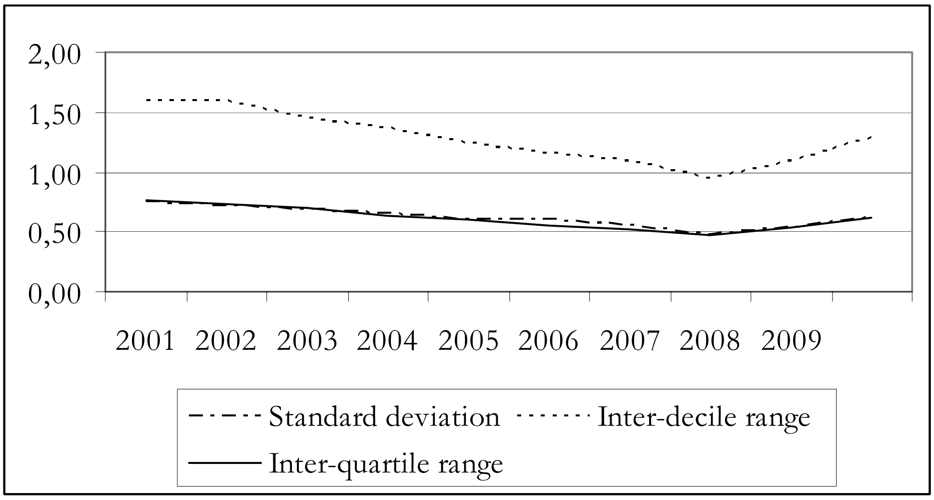


Figure 5. TFP dispersion change in 2001-2009

Table 6. TFP dispersion change in 2001-2009

Year	Standard deviation	Inter-decile range	Inter-quartile range
2001	0,90	1,88	0,84
2002	0,91	1,90	0,88
2003	0,90	1,85	0,84
2004	0,95	1,98	0,82
2005	0,92	1,79	0,79
2006	1,03	1,95	0,80
2007	0,97	1,82	0,79
2008	0,84	1,63	0,72
2009	0,93	1,81	0,81
Average	0,93	1,84	0,81



F igure 6. Labor productivity dispersion change in 2001-2009

Table 7. Labor productivity dispersion change in 2001-2009

Year	Standard deviation	Inter-decile range	Inter-quartile range
2001	0,74	1,59	0,77
2002	0,72	1,60	0,74
2003	0,68	1,44	0,69
2004	0,65	1,36	0,64
2005	0,61	1,23	0,60
2006	0,60	1,16	0,56
2007	0,55	1,10	0,53
2008	0,48	0,94	0,47
2009	0,54	1,08	0,54
Average	0,62	1,28	0,61

The Spearman rank correlation test showed that all measures of productivity dispersion were highly correlated.

Table 8. Spearman rank correlation coefficients for TFP measures

Dispersion measures	Standard deviation	Inter-decile range	Inter-quartile range
Standard deviation	1,00		
Inter-decile range	0,88	1,00	
Inter-quartile range	0,72	0,85	1,00

Table 9. Spearman rank correlation coefficients for LP measures

Dispersion measures	Standard deviation	Inter-decile range	Inter-quartile range
Standard deviation	1,00		
Inter-decile range	0,83	1,00	
Inter-quartile range	0,76	0,88	1,00

Third, the measures of total factor productivity dispersion were regressed on tariff and a set of control variables. Generally, the regressions results confirmed the prediction of the Melitz model. Tariff change was positively correlated with two out of three measures of total factor (TFP) productivity dispersion – standard deviation and inter-decile range. On average a 1 percent decrease in import tariff led to 1.51 per cent (or 0.014 unit) decrease in standard deviation of productivity distribution in a sector. Per cent were measured from the mean value of each measure. The effect on inter-decile range was almost the same. A 1 per cent tariff reduction was associated with decrease of the range by 1.52 per cent

(0.028 units). The effect on inter-quartile range was not statistically different from zero. The regressions results are shown in Table 10.

The impact on labor productivity measures was found to be more intense (Table 11). On average a 1 percent decrease in import tariff resulted in 3.23 per cent (or 0.020 unit) decrease in standard deviation of productivity dispersion. The effect for inter-decile range was 2.27 per cent (0.29 units), the effect on inter-quartile range was 2.12 per cent (0.013 units).

In addition, the regression results showed that increase in relative level of investment (investment to capital ratio) led to decrease in productivity dispersion (in five out of six specifications). Most of the coefficients of the other control variables were statistically insignificant.

However, the Breusch-Pagan test indicated that the heteroskedasticity was present. Therefore, the regressions were repeated with heteroskedasticity-robust critical values of standard errors.

Table 10. The impact of import tariff change on TFP dispersion (full sample)

Ind. variables (Coef./SE)	Dependent variable		
	Standard deviation	Inter-decile range	Inter-quartile range
tariff	0.014***	0.028**	0.002
	(0.004)	(0.011)	(0.004)
entry	-0.172**	-0.265	0.000
	(0.083)	(0.212)	(0.076)
mkt_5	0.250	0.041	-0.084
	(0.218)	(0.554)	(0.199)
ic_ratio	0.119	-1.528	-1.012***
	(0.406)	(1.032)	(0.369)
R^2	0.093	0.056	0.044
Observations	198	198	198

* p<0.10, ** p<0.05, *** p<0.01. All regressions were run with fixed effects

Table 11. The impact of import tariff change on LP dispersion (full sample)

Ind. variables (Coef./SE)	Dependent variable		
	Standard deviation	Inter-decile range	Inter-quartile range
tariff	0.020***	0.029***	0.013***
	(0.004)	(0.010)	(0.005)
entry	-0.105	-0.150	0.055
	(0.083)	(0.194)	(0.093)
mkt_5	-0.263	-1.044**	-0.404*
	(0.216)	(0.507)	(0.243)
ic_ratio	-1.119***	-3.190***	-1.216***
	(0.403)	(0.944)	(0.452)
R^2	0.158	0.128	0.109
Observations	198	198	198

* p<0.10, ** p<0.05, *** p<0.01. All regressions were run with fixed effects

Chapter 6

ROBUSTNESS CHECK

1. Regressions with lags

The main model was based on assumption that changes in tariffs had immediate effect on productivity distribution, i.e. firms' managers knew about new tariffs in advance and could take exit decision immediately. But the effect could also be postponed. A set of regressions which included lagged values of the tariff variable and their combinations was used to check that idea.

In general, the additional regressions also confirmed the prediction of the Melitz model: in most specifications a reduction of tariff led to decrease in productivity dispersion. The results of the estimation with the tariff variable of lags 0, 1, 2 were the following. On average a 1 percent decrease in import tariff led to 1.83 per cent (or 0.017 unit) decrease in standard deviation immediately (in year t), by 1.72 per cent (0.016 unit) decrease in the next year (t+1) and by 1.40 per cent (0.013 unit) in the following year (t+2).

In the specification with ID range, a change in tariff had no immediate impact on dispersion. But the significant effect was found for the lags (decrease by 3.04 per cent in year t+1 and by 2.11 per cent in year t+2). The only negative sign was found in regression with IQ range of TFP dispersion as a dependent variable, which implied that reduction of import duties led to an increase in productivity dispersion. But that effect was offest in the next two years (Table 12).

The conclusions for LP dispersion were almost the same as for TFP dispersion, but the effects in the former case were in general slightly stronger (Table 13).

Table 12. The impact of import tariff change on TFP dispersion (with lags)

Ind. variables (Coef./SE)	Dependent variable		
	Standard deviation	Inter-decile range	Inter-quartile range
Tariff	0.017***	0.016	-0.010**
	(0.005)	(0.013)	(0.004)
L.tariff	0.016***	0.056***	0.013***
	(0.005)	(0.013)	(0.004)
L2.tariff	0.013***	0.039***	0.007*
	(0.005)	(0.012)	(0.004)
Controls	Yes	Yes	Yes
Effects	FE	FE	FE
R^2	0.245	0.253	0.156
Observations	154	154	154

* p<0.10, ** p<0.05, *** p<0.01

Table 13. The impact of import tariff change on LP dispersion (with lags)

Ind. variables (Coef./SE)	Dependent variable		
	Standard deviation	Inter-decile range	Inter-quartile range
tariff	0.011***	-0.001	0.004
	(0.004)	(0.008)	(0.004)
L.tariff	0.015***	0.042***	0.017***
	(0.004)	(0.008)	(0.004)
L2.tariff	0.021***	0.051***	0.024***
	(0.004)	(0.007)	(0.004)
Controls	Yes	Yes	Yes
Effects	FE	FE	FE
R^2	0.342	0.420	0.335
Observations	154	154	154

* p<0.10, ** p<0.05, *** p<0.01

2. Different samples

The regressions were repeated for (1) the Olley-Pakes sample and (2) for the sample of firms which were presented in 2008 and/or 2009 ("2008-2009 sample").

As in the full-sample regressions, all coefficients statistically significant were positive. The list of statistically significant coefficients from the regressions using Olley-Pakes sample was almost the same as in the full sample one. "2008-2009 sample" also allowed to mimic the result of the full sample regressions with the exception of the one with standard deviation as a dependent variable. The latter set of regressions produced only insignificant coefficients (Table 14). The only negative coefficient in the baseline results was not statistically different from zero in the results of the additional estimation.

However, the substantial difference was in values of the coefficients. Only a few coefficients using the Olley-Pakes sample and "2008-2009 sample" lie within the confidence interval of the corresponding coefficients from the full sample regressions. The difference between most corresponding coefficients from different samples did not exceed 50 per cent of their absolute value (or 3 standard deviations). It should be added that the results of the regressions using Olley-Pakes sample were much closer to the basic results. The coefficients from the regressions that employed "2008-2009 sample" were greater in value up to 2 times comparing to the respective coefficients from the full-sample regression (for specifications with ID range or IQ range) or insignificant (for models with standard deviation as a dependent variable).

To sum up, the different samples produced the same outcome in terms of the sign of coefficients. The results of the regressions suggested that selection bias was not a problem. The conclusions for LP dispersion was the same (Table 15).

Table 14. The impact of import tariff change on TFP dispersion (samples comparison)

Indep. variab-les	Dependent variable					
	Standard deviation			Inter-decile range		
	Full sample	Olley-Pakes sample	2008-2009 sample	Full sample	Olley-Pakes sample	2008-2009 sample
tariff	0.017***	0.010	-0.000	0.016	0.023*	0.081***
	(0.005)	(0.006)	(0.006)	(0.013)	(0.013)	(0.022)
L. tariff	0.016***	0.028***	-0.002	0.056***	0.077***	0.082***
	(0.005)	(0.006)	(0.006)	(0.013)	(0.013)	(0.023)
L2. tariff	0.013***	0.010*	0.004	0.039***	0.029**	0.047**
	(0.005)	(0.006)	(0.006)	(0.012)	(0.012)	(0.020)
entry	-0.442***	-0.559***	-0.397***	-1.035***	-1.115***	-0.541
	(0.113)	(0.135)	(0.129)	(0.279)	(0.280)	(0.478)
mkt_5	0.278	0.146	0.863***	-0.729	-0.916	1.518
	(0.286)	(0.343)	(0.105)	(0.707)	(0.711)	(1.213)
ic_ratio	-0.255	0.577	-0.777	-2.168*	-0.367	1.059
	(0.486)	(0.582)	(0.581)	(1.202)	(1.208)	(2.062)
Effects	FE	FE	RE	FE	FE	FE
R^2	0.245	0.229		0.253	0.286	0.198
Obs.	154	154	154	154	154	154

* p<0.10, ** p<0.05, *** p<0.01

Table 15. The impact of import tariff change on LP dispersion (samples comparison)

Indep. variab-les	Dependent variable					
	Standard deviation			Inter-decile range		
	Full sample	Olley-Pakes sample	2008-2009 sample	Full sample	Olley-Pakes sample	2008-2009 sample
tariff	0.011***	0.013***	0.002	-0.001	0.006	0.052***
	(0.004)	(0.004)	(0.004)	(0.008)	(0.006)	(0.011)
L.tariff	0.015***	0.012***	-0.003	0.042***	0.024***	0.053***
	(0.004)	(0.004)	(0.004)	(0.008)	(0.006)	(0.012)
L2.tariff	0.021***	0.015***	0.016***	0.051***	0.037***	0.064***
	(0.004)	(0.003)	(0.004)	(0.007)	(0.005)	(0.010)
entry	-0.361***	-0.331***	-0.271***	-0.616***	-0.262**	-0.805***
	(0.088)	(0.080)	(0.084)	(0.164)	(0.129)	(0.233)
mkt_5	-0.241	-0.292	0.252***	-0.792*	-0.751**	-0.427
	(0.223)	(0.202)	(0.073)	(0.415)	(0.328)	(0.592)
ic_ratio	0.156	0.295	-0.078	0.549	0.545	-0.274
	(0.378)	(0.344)	(0.380)	(0.706)	(0.558)	(1.051)
Effects	FE	FE	RE	FE	FE	FE
R^2	0.342	0.310		0.420	0.356	0.426
Obs.	154	154	154	154	154	154

* p<0.10, ** p<0.05, *** p<0.01

3. Heteroskedasticity-robust standard errors

The regressions were repeated once more using heteroskedasticity-robust standard errors. All coefficient of tariff variable in the base model became insignificant at any convenient level. But more than 70 per cent coefficients of interest in the extended model (with the lagged tariff variables) remained significant at most at 10 per cent level. The most robust results were obtained in regressions with inter-decile range and inter-quartile range for lagged tariffs. The regression results are presented in tables A1 and A2 in the Appendix).

Chapter 7

DISCUSSION AND CONCLUSIONS

The presented paper investigated the effect of trade liberalization on productivity dispersion. The study was based on a dataset containing financial reports of 57,734 Ukrainian manufacturing firms. The total factor productivity (TFP) indices were obtained from Cobb-Douglas production function estimates using Olley-Pakes approach to deal with simultaneity and selection biases. Then, industry-level productivity dispersion measures were computed, and OLS regression was employed to evaluate the impact a change in import tariff on the estimated measures.

The study showed evidence that a reduction of tariff led to a decrease in the dispersion. It was found that the dispersion shrank by 1 to 5 per cent in most specifications after 1 per cent decrement in import duties. The effect was stronger for labor productivity than for TFP. The impact was robust to different measures of productivity dispersion. However, the effect on inter-decile range, i.e. the difference between the 90th and the 10th percentiles, was more intense than the effect on the other measures (inter-quartile range and standard deviation).

The obtained evidence was in line with prediction of Melitz (2003) model, a dynamic model of an economy with heterogeneous firms operating in monopolistic competition environment. According to the model, an increase in exposure to international trade led to reallocation of market shares to more productive firms, whereas the least productive firms were forced to exit their markets. As a consequence, productivity dispersion must decrease. That conclusion corresponded to the obtained results.

The inference of the presented study was in line with the results of Del Gatto et al. (2008). However, some researchers (Syverson, 2004, Ito and Lechevalier, 2009) reached the opposite conclusion: an increase in exposure to trade resulted in greater dispersion. The data from developed countries were analyzed in those studies. The contribution of the presented paper was to provide evidence from a developing country, where the effect of trade liberalization on productivity dispersion might be more pronounced.

Various explanations to the contradictory results were given in the previous studies. The explanations varied from the idea that the model was not correct at all to misspecification or measurement errors. The presented study suggests another explanation of the contradiction that was not present in the above mentioned studies, at least in details. The explanation provides empirical reasons for an extension of Melitz model.

The model has two stages: a dynamic stage and an equilibrium. At the dynamic stage, firms face uncertainty about their relative efficiency and can enter the market even if their productivity is too low to survive. As a result, productivity dispersion can increase when trade costs go down. But in equilibrium all the least efficient firms (whose productivity is below a cutoff point) exit the market. And since the productivity distribution remains constant in equilibrium, the dispersion shrinks as a consequence of trade liberalization.

According to Melitz, the equilibrium can be approximated as a long run. However, in empirical papers that tested the mentioned above implication of the model the usual period of analysis is one year (i.e. effect of a tariff change on dispersion is analyzed for each year separately). It is difficult to use substantially longer periods since in real life the productivity distribution can be supposed not to be constant over time. The results of the presented paper showed that the upper bound of productivity was significantly higher in 2009 than in 2001).

And the decrease in productivity dispersion existed only due to the fact that the lower bound of the distribution increased to the greater extent than the upper one.

In the one-year period productivity distribution is de facto constant given data available. The question is whether this period is long enough to be used as an approximation of the equilibrium to explore the effect of trade liberalization on productivity dispersion. If it is short the effects of both stages of Melitz model can be captured in the analysis: a massive exit of low productive firms combined with entry of similar new firms. Depending on what effect prevails the studies can show decrease or increase in dispersion. The presented study provided evidence in the support of the fact that the one-year period is not long enough. Robust casual relationship between reduction of tariffs and decrease in dispersion was found only for the lagged values of the import tariff variable (i.e. a decrement in tariff lead to decrease in dispersion not in the same year, but only in the two following years).

It is a reason for further extension of the Melitz model so that it could separate the effects of firms' exit and entry.

Further study can also include use other proxies for determinants of productivity dispersion. Import tariff variable can be replaced with import penetration ratio and export to production ratio as a measure of trade liberalization and trade costs. More reliable measure of market concentration may be used.

The presented paper also shows that the reduction of trade barriers has lead to an increase in productivity in Ukraine in 2001-2009. The study has practical implication. It provided evidence in the support of the idea that trade liberalization forced the least productive firms to exit the market and, thus, contributed to the increase in productivity. It implies that a reversal of that policy may have negative impact on productivity.

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APPENDIX

Table A1. The impact of import tariff change on TFP dispersion (heteroskedasticity-robust standard errors)

Indep. variab-les	Dependent variable					
	Standard deviation			Inter-decile range		
	Full sample	Olley-Pakes sample	2008-2009 sample	Full sample	Olley-Pakes sample	2008-2009 sample
tariff	0.017	0.010	-0.000	0.016*	0.023*	0.081*
	(0.010)	(0.007)	(0.004)	(0.009)	(0.011)	(0.044)
L. tariff	0.016*	0.028*	-0.002	0.056*	0.077*	0.082
	(0.009)	(0.015)	(0.004)	(0.031)	(0.043)	(0.049)
L2. tariff	0.013	0.010	0.004	0.039**	0.029**	0.047
	(0.010)	(0.007)	(0.008)	(0.017)	(0.012)	(0.037)
entry	-0.442**	-0.559***	-0.397**	-1.035**	-1.115**	-0.541*
	(0.157)	(0.103)	(0.173)	(0.459)	(0.505)	(0.284)
mkt_5	0.278	0.146	0.863***	-0.729	-0.916	1.518
	(0.276)	(0.288)	(0.129)	(0.541)	(0.599)	(1.197)
ic_ratio	-0.255	0.577	-0.777	-2.168	-0.367	1.059
	(0.551)	(0.630)	(0.798)	(1.714)	(1.181)	(2.893)
Effects	FE	FE	RE	FE	FE	FE
R^2	0.245	0.229		0.253	0.286	
Obs.	154	154	154	154	154	154

* p<0.10, ** p<0.05, *** p<0.01

Table A2. The impact of import tariff change on LP dispersion (heteroskedasticity-robust standard errors)

Indep. variab-les	Dependent variable					
	Standard deviation			Inter-decile range		
	Fu l sample	Olley-Pakes sample	2008-2009 sample	Full sample	Olley-Pakes sample	2008-2009 sample
tariff	0.011	0.013	0.002	-0.001	0.006	0.052
	(0.007)	(0.008)	(0.004)	(0.005)	(0.006)	(0.035)
L.tariff	0.015***	0.012***	-0.003	0.042***	0.024***	0.053***
	(0.003)	(0.002)	(0.007)	(0.010)	(0.005)	(0.013)
L2.tariff	0.021***	0.015***	0.016***	0.051***	0.037***	0.064***
	(0.004)	(0.002)	(0.004)	(0.006)	(0.005)	(0.017)
entry	-0.361***	-0.331***	-0.271***	-0.616***	-0.262	-0.805***
	(0.083)	(0.058)	(0.085)	(0.183)	(0.178)	(0.206)
mkt_5	-0.241	-0.292*	0.252***	-0.792*	-0.751**	-0.427
	(0.226)	(0.161)	(0.080)	(0.385)	(0.321)	(0.465)
ic_ratio	0.156	0.295	-0.078	0.549	0.545	-0.274
	(0.565)	(0.435)	(0.305)	(0.865)	(0.687)	(1.154)
Effects	FE	FE	RE	FE	0.769***	FE
R^2	0.342	0.310		0.420	0.356	0.426
Obs.	154	154	154	154	154	154

* p<0.10, ** p<0.05, *** p<0.01