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Deregulation and productivity: selection or within-firm effect?

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Abstract

In the literature, trade liberalization increases industry productivity through two channels. First, firms increase productivity due to better and wider choice of inputs. In addition, at least theoretically, the mechanism of selection eliminates the least productive firms from the industry. To disentangle the sources of industry productivity increase, we apply the recently developed quantile approach (Combes et al., 2012) to the episode of trade and services liberalization in Ukraine. We modify the methodology in order to study changes in productivity distribution within an industry over time. We start with the Melitz model of an industry with heterogeneous firms. Unlike in the original model, we allow for productivity distribution to change over time as a result of deregulation. By looking at changes in productivity distribution of manufacturing and services firms in Ukraine in 2001-2009, we estimate the left-truncation, dilation, and shift in distribution for each NACE 2 digit sector. We compare relative importance of the within firm channel of productivity increase vis-à-vis the selection channel. We further relate the estimates of the left-truncation, dilation, and shift to industry measures of trade and services liberalization that include input tariffs liberalization and input services liberalization.

Key words: selection, productivity, distribution, quantile method

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1 Introduction

In the literature, trade liberalization increase industry productivity through two channels. First, firms increase productivity due to better and wider choice of inputs. In addition, at least theoretically, the mechanism of selection eliminates the least productive firms from the industry. In the Melitz model (Melitz, 2003), the productivity distribution of firms is fixed. The effect of trade liberalization on productivity comes only through the selection and re-distribution of resources from less productive firms to more productive firms. However, the empirical literature documents a positive effect of trade Amiti & Konings (in Indonesia and India - 2007); Khandelwal & Topalova (in Indonesia and India - 2011) and services (in the Czech Republic, Chile, and Ukraine – Arnold et al. (2011), Fernandes & Paunov (2012a), and Shepotylo & Vakhitov (2012)) deregulation on productivity of manufacturing firms. Hence, in addition to the selection effect, the industry productivity may change due to a rightward shift of the productivity distribution. Therefore, a more realistic model would recognize that as the economy opens up, distribution of productivity changes. In particular, trade liberalization have a direct, positive effect on productivity within a firm, with exporting firms benefiting disproportionally more.

To disentangle the sources of industry productivity increase, we apply the recently developed quantile approach (Combes et al., 2012) to the episode of trade and services liberalization in Ukraine. An interesting feature of the Ukrainian trade and services liberalization is relatively small reduction in import tariffs in manufacturing sectors, but considerable liberalization of services sector. In addition, within services sector, not all subsectors have been liberalized. This feature gives the source of variation that we use in order to test the importance of various channels of industry productivity increase. We modify the methodology in order to study changes in productivity distribution within an industry over time. We start with the Melitz model of an industry with heterogeneous firms. Unlike in the original model, we allow for productivity distribution to change over time as a result of policy changes. By looking at changes in productivity distribution of manufacturing and services firms in Ukraine in 2001-2009, we estimate the left-truncation, dilation, and shift in distribution for each NACE 2 digit sector. We compare relative importance of the within-firm channel of productivity increase vis-à-vis the selection channel. We further relate the estimates of the left-truncation, dilation, and shift to industry measures of trade and services liberalization that include output tariffs liberalization, input tariffs liberalization and input services liberalization. An interesting feature of the Ukrainian trade and services liberalization is relatively small reduction in import tariffs in manufacturing sectors, but considerable liberalization of services sector. In addition, within services sector, not all sub-sectors have been liberalized. This feature gives the source of variation that we use in order to test the importance of various channels of industry productivity increase.

Our preliminary results are as follows. Over 2001-2009 the productivity of firms has increased substantially. Aggregate shift in productivity of all firms within an industry explained major part of the increase, while selection had small and sometimes negative effect. Also, there was increase in dispersion of the productivity distribution indicating that the gap between low and high-productive firms has increased in most industries. We also identified that the shift in distribution has been primarily associated with services liberalization episode that has occurred in Ukraine prior to its WTO accession. We failed to find a link between the selection and increase dispersion of productivity distribution on the one hand, and trade and services liberalization on the other hand, as predicted by theoretical models (i.e Melitz, 2003). However, this finding is consistent with the finding of Combes et al. (2012), who failed to find a significant selection effect in larger agglomerations relative to small agglomerations.

The rest of the paper is sctructured as follows. Section 2 describes the data. Section 3 describes the methodology. Section 4 presents the results of estimation of the production function and parameters of the change in productivity distribution. Section 5 links distributional change with trade

and services liberalization. Section 6 concludes.

2 Data

2.1 Firm-level data

The data for the study come from several statistical statements annually submitted to the National Statistics Office (Derzhkomstat) by all commercial firms in the country. The sample covers nine years from 2001 to 2009. We further excluded observations with zero or negative output, capital stock or employment assuming that they indicated non-operational firms in a year. As the measure of output, we use net sales after excise taxes from the Financial Results Statement. The Balance Sheet Statement is the source of the capital measure for which we used the end-of-year value of the tangible assets. For the production function estimation we used investments in tangible assets which come from the Enterprise Performance Statement. The same statement is also a source for our employment variable. It is measured as the "year-averaged number of enlisted employees", which is a rough estimate of the full time equivalent of labor used. The material costs come from the same statement in 2001-2004, whereas since 2005 they have been available from a separate Sectoral Expenditures Statement. All variables were deflated by the appropriate price deflators as described in the next sub-section.

2.2 Input-output table

We use Ukrainian Input-Output table in 2005 to link the changes into the distribution parameters with the changes in trade and services policies and outcomes in upstream industries. The 2005 IO table is more detailed than IO tables for other years, which allows to map our industries one-to-one with the industries in the IO table.

3 Related literature and methodology

The literature suggests at least three channels of industry productivity increase as a result of trade and services liberalization. The first two are selection mechanism and reallocation of resources from less productive firms to more productive firms highlighted in the Melitz (2003) model. The third one is within-firm increase in productivity. Within-plant increase in productivity occurs either due to the output effect of liberalization as access to the world market allows firms to expand output and move down the average cost curve (Helpman & Krugman, 1985), technical innovations caused by increased foreign competition (Grossman & Helpman, 1990), and learning-by-doing (Grossman & Helpman, 1991). It also can occure due to the input effects as liberalization increases variety, quality, and learning (Ethier, 1982; Markusen, 1989; Grossman & Helpman, 1991).

In empirical literature, the evidence on the within-firm positive effect of trade and services liberalization are abundant. The literature documents increase in productivity due to trade liberalization (Pavcnik, 2002; Amiti & Konings, 2007; De Loecker, 2007b; Khandelwal & Topalova, 2011), due to services liberalization (Javorcik, 2004; Arnold et al., 2011; Fernandes & Paunov, 2012b; Shepotylo & Vakhitov, 2012), due to learning-by-doing (De Loecker, 2007a).

Roberts & Tybout (1991) document the aggregate increase in productivit due to reallocation of resources towards more productive firms. Foster et al. (2001) document large-scale reallocation of resources within industries. Exit and entry play an important role in the reallocation. Olley & Pakes (1996) find that low productivity firms are more likely to exit. At the same time, the selection mechanism has not been found in the context of agglomeration externalities (Combes et al., 2012).

In our approach, we take on the theoretical insight and empirical methodology developed in Combes et al. (2012), and decompose the distributional change in productivity within an industry due to regulatory changes between period t and period t + k into increase in average productivity (shift A), reallocation (dilation D), and selection (S). As in Combes et al. (2012), we assume that there is an underlying distribution of firms' productivity in sector *s*, $\tilde{F}^s(\varphi) = 1 - G^s(e^{-\varphi})$. Due to changes in trade and services regulations, R_t^s , the resulting distribution of firms' productivity, $F_t^s(\varphi)$ may shift by A_t^s , dilate by D_t^s , and left-truncate by S_t^s . Ax ante we do not put any restrictions on the parameter space. Positive value of A indicates that the average productivity of firms has increased, value of D above 1 indicates that dispersion of productivity has increased, positive value of S indicates that the least productive firms dropped out of industry.

The underlying distribution $\bar{F}^{s}(\varphi)$ is not observed. However, the resulting distribution is observed and can be obtained from the underlying deistribution as

$$F_{t}^{s}(\varphi) = max\{0, \frac{\tilde{F}^{s}(\frac{\varphi - A_{t}^{s}}{D_{t}^{s}}) - S_{t}^{s}}{1 - S_{t}^{s}}\}$$

Applying lemma 1 of (Combes et al., 2012), we compare the observed resulting distributions $F_t^s(\varphi)$ and $F_{t-k}^s(\varphi)$ and estimate $A_{t,t-k}^s$, $D_{t,t-k}^s$, $S_{t,t-k}^s$ using the quantile approach.

4 Result

4.1 **Production function**

To recover the TFP measure, we estimate the production function for each industry (two-digit NACE classification) by the Olley-Pakes procedure (Olley & Pakes, 1996), controlling for the sub-industry-specific demand and price shocks as suggested by De Loecker (2011). We identify the demand and price shocks by exploiting variation in sub-industry (4-digit NACE classification) output at time *t* and by controlling for sub-industry and time fixed effects. Under the constant elasticity of substitution (CES) demand system, unobserved prices are picked up by the variation in inputs and by aggregate demand and do not reflect differences in technology within an industry.

Estimation of production function

We estimate

$$r_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_s y_{gt} + \omega_{it} + \xi_{it} + u_{it}, \tag{1}$$

separately, for each manufacturing and services sector *s* (two-digit NACE classification). In what follows we suppress the sector index for the clarity of presentation. Capital and materials are deflated by the production price index. Instead of using overall output of sector, y_{st} , we use more disaggregated output (four-digit NACE classification), y_{gt} , to add more variability to estimation of β_s . It is valid since we assume that the elasticity of substitution is constant within the manufacturing industry *s*.

We decompose the overall demand shock into the following components

$$\xi_{it} = \xi_t + \xi_g + \tilde{\xi}_{it},\tag{2}$$

where ξ_t is sector-specific shock common to all firms at time t, ξ_g is demand factor affecting only firms producing in sub-sector g, and ξ_{it} is an idiosyncratic shock. Plugging in (2) in (1), we have the following equation

$$r_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_s y_{gt} + \delta_t D_t + \delta_g D_g + \omega_{it} + \varepsilon_{it}$$
(3)

where D_t is a year fixed effect and D_g is sub-sector fixed-effect. $\varepsilon_{it} = \tilde{\zeta}_{it} + u_{it}$ is the error term which is not correlated with inputs and productivity.

We estimate (3) by the Olley-Pakes methodology using the sample of all firms in 2001-2009. Results are presented in Table 1. Total factor productivity net of price and demand effects is recovered as

$$\ln(TFP_{it}) = (r_{it} - \beta_l l_{it} - \beta_k k_{it} - \beta_m m_{it} - \beta_s y_{st}) \frac{\sigma_s}{\sigma_s + 1}.$$
 (4)

4.2 Selection, dilation, and shift in distribution

Figure 1 illustrates how the overall distribution of productivity in all sectors has changed between 2001 and 2009.

Industry	ln(1	K)	ln(L)	ln()	M)	ln()	()	Firms	Ν	χ^2
	β_K	se	β_L	se	β_M	se	β_S	se			
1	0.126***	(0.008)	0.155***	(0.006)	0.658***	(0.006)	0.0337	(0.022)	64991	66050	79233.0
2	0.0569	(0.052)	0.353***	(0.023)	0.474***	(0.020)	0.0220	(0.025)	3404	3512	3144.1
5	0.138*	(0.055)	0.338***	(0.051)	0.547***	(0.042)	-0.0343	(0.092)	1169	1206	954.9
10	0.123	(0.080)	0.0113	(0.055)	0.748***	(0.047)	0.0751	(0.134)	1531	1569	760.1
14	0.0715	(0.060)	0.326***	(0.043)	0.590***	(0.036)	0.104	(0.057)	2504	2572	2323.2
15	0.0363**	(0.013)	0.285***	(0.014)	0.647***	(0.011)	0.0589*	(0.027)	24465	25043	174902.4
17	0.00323	(0.035)	0.356***	(0.039)	0.565***	(0.027)	0.0226	(0.042)	2082	2149	4675.5
18	0.0928*	(0.040)	0.487***	(0.019)	0.454***	(0.013)	0.0346	(0.043)	4303	4526	7253.1
19	0.131	(0.072)	0.383***	(0.030)	0.550***	(0.022)	0.432*	(0.201)	1274	1311	2054.6
20	0.0751**	(0.025)	0.297***	(0.016)	0.619***	(0.013)	0.0841	(0.063)	6294	6535	8655.9
21	0.0834*	(0.038)	0.187***	(0.036)	0.588***	(0.042)	0.00482	(0.096)	1958	2015	2727.4
22	0.0899***	(0.015)	0.454***	(0.017)	0.453***	(0.012)	-0.0647*	(0.027)	12142	12782	17870.1
23	-0.0636	(0.049)	0.218*	(0.088)	0.491***	(0.049)	0.0243	(0.150)	615	644	448.4
24	0.105**	(0.032)	0.259***	(0.022)	0.563***	(0.019)	0.0645	(0.038)	4895	5085	5907.1
25	0.101***	(0.020)	0.282***	(0.021)	0.590***	(0.024)	0.0843*	(0.043)	5783	5929	8762.4
26	0.0272	(0.020)	0.285***	(0.022)	0.628***	(0.020)	0.0673*	(0.032)	8878	9105	31483.6
27	0.0405	(0.041)	0.212***	(0.033)	0.636***	(0.029)	0.156***	(0.039)	2113	2172	3620.0
28	0.0835***	(0.011)	0.302***	(0.022)	0.575***	(0.02)	0.0461	(0.030)	8189	8461	13578.6
29	0.0835***	(0.010)	0.406***	(0.011)	0.442***	(0.011)	0.0456	(0.000)	13255	13721	54415.8
30	0.129*	(0.011)	0.100	(0.010)	0.341***	(0.012) (0.028)	-0.480	(0.020)	1045	1136	734.2
31	0.0862**	(0.002) (0.031)	0.326***	(0.001)	0.456***	(0.020)	0.0448	(0.201) (0.038)	5149	5361	4316.5
32	0.166**	(0.001)	0.328***	(0.028)	0.100	(0.017)	-0.00976	(0.000) (0.123)	1793	1883	1430.8
33	0.100	(0.001) (0.031)	0.320	(0.040)	0.431***	(0.021) (0.015)	0.0683	(0.123) (0.084)	3170	3316	4660.8
34	0.159*	(0.031) (0.072)	0.417	(0.027) (0.044)	0.431	(0.013)	0.0000	$(0.00 \pm)$ (0.047)	1279	1316	1284.2
35	-0.0108	(0.072)	0.442***	(0.044)	0.040	(0.040)	0.0971	(0.047)	2414	2522	2706.3
36	-0.0108	(0.039)	0.442	(0.040)	0.400	(0.029) (0.018)	0.203	(0.074)	5500	5766	7130.5
37	0.0140	(0.022)	0.545	(0.024) (0.052)	0.378	(0.010)	0.103	(0.042) (0.113)	2150	2305	2008 7
40	0.0217	(0.003)	0.029	(0.032)	0.200	(0.029)	0.195	(0.113) (0.050)	7974	2303 8170	2090.7
40	0.0210	(0.027)	0.041	(0.049)	0.309	(0.052)	0.233	(0.030)	64247	69001	9000.0
45	0.120	(0.008)	0.300	(0.007)	0.403	(0.004)	0.0927	(0.010) (0.022)	14950	17649	12002 7
50	0.0032	(0.027)	0.764	(0.021)	0.203	(0.007)	0.125	(0.033)	102101	120200	13002.7
51	0.0930	(0.009)	0.774	(0.010) (0.011)	0.101	(0.004)	0.195	(0.020)	102191	130200	109126.2
52	0.120	(0.010)	0.072	(0.011)	0.175	(0.000)	-0.0455	(0.022)	12562	14522	14960.0
55	0.0603"	(0.024)	0.221***	(0.019)	0.272***	(0.010)	0.0256	(0.016)	15562	14533	14860.0
60	0.154	(0.021)	0.331	(0.010)	0.210***	(0.015)	0.136	(0.055)	13647 E20	10401	1/02/.2
61	0.00112	(0.068)	0.3/1***	(0.085)	0.310***	(0.045)	-0.0282	(0.206)	530	604 502	166.4
62	0.006/6	(0.090)	0.539***	(0.098)	0.385***	(0.044)	0.116	(0.259)	4/8	503 14200	
63	0.125***	(0.036)	0.653***	(0.019)	0.221***	(0.008)	0.0205	(0.050)	12177	14296	4874.1
64	0.220***	(0.046)	0.022	(0.041)	0.184***	(0.013)	0.479	(0.367)	4/83	5259 2007	2453.5
65	0.0533	(0.085)	0./16***	(0.069)	0.180***	(0.026)	0.4/6***	(0.083)	2284	2967	974.5
66	0.0819	(0.070)	0.429***	(0.054)	0.259***	(0.047)	0.0679	(0.314)	2092	2233	795.3
67	0.145	(0.094)	0.756***	(0.081)	0.125***	(0.032)	0.339***	(0.071)	2/10	3584	383.3
20	0.0479***	(0.008)	0.482***	(0.010)	0.246***	(0.006)	0.0767**	(0.026)	31435	37564	16396.0
71	0.254**	(0.084)	0.408***	(0.028)	0.192***	(0.017)	0.0359	(0.059)	2916	4072	2952.1
72	0.227***	(0.026)	0.682***	(0.020)	0.219***	(0.008)	0.285***	(0.032)	8594	10117	8961.8
73	0.134***	(0.031)	0.573***	(0.016)	0.268***	(0.008)	0.170	(0.127)	8533	9327	7076.5
74	0.104***	(0.019)	0.675***	(0.010)	0.237***	(0.005)	0.0770***	(0.018)	42703	50169	38430.4
75	0.103	(0.081)	0.578***	(0.082)	0.264***	(0.063)	0.0761	(0.065)	512	585	
80	0.0732**	(0.025)	0.644***	(0.027)	0.256***	(0.015)	0.141*	(0.057)	5159	5587	4625.2
85	0.0574	(0.033)	0.565***	(0.030)	0.394***	(0.021)	0.0736	(0.081)	6597	6982	6055.3
90	0.00737	(0.018)	0.474***	(0.023)	0.486***	(0.018)	-0.180*	(0.090)	4038	4172	8751.5
91	0.0873	(0.109)	0.546*	(0.245)	0.244	(0.136)	-0.537	(0.927)	125	163	
92	0.121*	(0.048)	0.589***	(0.028)	0.262***	(0.012)	0.0973**	(0.033)	7397	8500	6925.9
93	0.0533*	(0.024)	0.635***	(0.021)	0.326***	(0.015)	-0.0777	(0.084)	5372	5798	7603.9

Notes: * p<0.05, ** p<0.01, *** p<0.001. Bootstrap standard errors are presented in parentheses. Table reports point estimates of revenue function parameters, β for Ukrainian firms for 2001-2009. Each row in the table represents Olley-Pakes estimation of production function for each industry, defined according to two-digit NACE classification. Each estimation is performed with year and sub-industry dummies, which are not reported for brevity.

Table 1: Estimation of production function by Olley-Pakes procedure



Figure 1: Distribution of productivity in 2001 and 2009. All firms.

Over 2001-2009, the average productivity of firms has increased in most sectors. According to Table 2, on average, A = 0.57 that corresponds to 77 percent increase in productivity; D = 1.09 that indicates increased dispersion in productivity distribution; S = 0.02 that indicates truncation of the least productive firms between 2001 and 2009. This result is consistent with the Melitz story of the effect of trade liberalization on the distribution of productivity, but it also shows that the major change has occurred due to the rightward shift of the whole distribution that is not accounted for in the heterogeneous firms' model.

However, the picture is more nuanced when we look at results by sectors. Aggregate shift in productivity is mostly positive and significant, ranging from -0.64 in Water transportation, where services liberalization index has shown no progress, to 1.95 in Insurance and pension funding and 2.27 in Post and telecom, two services sectors where the liberalization has been has been quite dramatic. Business services have also experienced above the average shift in distribution. At the same time, sectors related to extraction of raw materials, production of basic metals, energy related sectors and utility sectors have experienced a negative shift in distribution. It is related to the negative shock to the energy prices that occurred in 2004-2009, when the prices of oil and gas more than doubled in real terms.

Most sectors have experienced an increase in dispersion of the productivity distribution indicating that the gap between low- and high-productive firms has increased in most sectors. However, the largest increase in dispersion has occurred in the utility sector (Electricity, gas, and steam sector) and construction that have not been liberalized, while the largest deconcentration occured in Insurance and pension funding that experienced a dramatic deregulation. Selection have small and sometimes negative effect, which is consistent with the result of Combes et al. (2012). At the same time the estimation procedure is able to identify the value of S with very great precision which is translated into mostly significant results. The largest negative truncation of the distribution has occured in Financial intermediation (meaning entrance of more firms with low productivity between 2001 and 2009). The largest positive truncation of distribution has occured in the utility sectors.

These findings go against the common view of the postive correlation between liberalization on the one hand and selection and productivity dispersion on the other hand. Of course, other factors could have contributed to distributional changes. We leave more rigorous analysis of the relationship between the liberalization epsiode and distributional changes to the next section.

How important are three parameters in explaining industry productivity growth? To answer this question we ran a Monte-Carlo simulations by generating a sample of $N_{s,2001}$ draws from the lognormal distribution $\ln(TFP_{i,2001}) \sim N(\mu_{s,2001}, \sigma_{s,2001}^2)$ for each sector *s* with parameters *N*, μ , and σ^2 matching the observed empirical counterparts from the sample in 2001. After this we perform three comparative statics experiments by lefttruncating the distrbution by S, shifting it by A, and dilating it by D and compare the means of the initial and resulting distributions. For 10 sectors, where selection parameter is negative, we draw the sample for 2009 from the distribution $\ln(TFP_{i,2009}) \sim N(\mu_{s,2009}, \sigma_{s,2009}^2)$ and left-truncating the distrbution by S, shifting it by -A, and dilating it by 1/D and compare the means of the initial and resulting distributions. The simulations are repeated 500 times for each sector and the resulting means are averaged. After that we compute the growth rate in average productivity resulting from selection, shift, or dilation of the initial distribution. The results are presented in Figure 2 for agricultural and manufacturing sectors and in Figure 3 for services sectors.

The shift dominates the other two sources of productivity growth for all sectors except Mining (10), Publishing and printing (22), Manufacturing of basic metals (27), Electricity, gas and steam (40), Sewage and refuse disposal (90).

Industry	Shift				Dilation			Selection		
	Coef.	S.e.	p-value	Coef.	S.e.	p-value	Coef.	S.e.	p-value	
Agriculture, hunting (01)	0.96	0.001	0.000	0.99	0.002	0.001	-0.03	0.000	0.000	
Forestry (02)	0.79	0.020	0.000	0.97	0.010	0.008	-0.04	0.003	0.000	
Fishing (05)	0.86	0.015	0.000	1.07	0.010	0.000	-0.02	0.004	0.000	
Mining, peat (10)	-0.02	0.017	0.375	1.44	0.020	0.000	0.06	0.007	0.000	
Other mining (14)	-0.22	0.005	0.000	1.01	0.007	0.065	0.00	0.001	0.001	
Mfg. food (15)	0.34	0.004	0.000	1.22	0.005	0.000	0.04	0.001	0.000	
Mfg. textiles (17)	0.73	0.015	0.000	1.08	0.009	0.000	0.06	0.002	0.000	
Mfg. apparel, fur (18)	1.08	0.005	0.000	0.97	0.004	0.000	0.00	0.001	0.005	
Mfg. leather, luggage (19)	1.59	0.069	0.000	1.00	0.010	0.662	0.09	0.005	0.000	
Mfg. wood, cork, straw pdct. (20)	0.51	0.002	0.000	1.08	0.004	0.000	0.00	0.000	0.000	
Mfg. paper, pulp (21)	1.00	0.023	0.000	0.85	0.010	0.000	0.03	0.005	0.000	
Publishing, printing (22)	0.13	0.018	0.000	1.27	0.006	0.000	0.03	0.004	0.000	
Mfg coke, ref. petrol, nuclear (23)	-0.37	0.075	0.000	0.95	0.015	0.001	0.01	0.010	0.395	
Mfg_chemicals (24)	0.29	0.010	0.000	1.02	0.008	0.041	0.00	0.001	0.620	
Mfg_rubber (25)	0.23	0.009	0.000	1 23	0.010	0.000	0.05	0.003	0.000	
Mfg. non-metal mineral (26)	0.13	0.004	0.000	1.08	0.004	0.000	0.00	0.000	0.067	
Mfg. hasic metal (27)	-0.02	0.004	0.000	1.00	0.004	0.000	0.00	0.001	0.007	
Mfg. fabricated metal (28)	-0.06	0.006	0.000	1.05	0.005	0.000	0.02	0.000	0.000	
Mfg. machinery agin noc (20)	0.72	0.000	0.000	1.05	0.003	0.000	0.02	0.001	0.000	
Mfg. office machinery (30)	0.72	0.000	0.000	1.02	0.003	0.000	0.01	0.001	0.000	
Mfg. electrical machinery (50)	0.21	0.001	0.000	1.05	0.014	0.000	0.02	0.003	0.000	
Mfg. radio ty communicación (22)	0.74	0.011	0.000	1.00	0.003	0.002	0.02	0.002	0.000	
Mfg. madical provision watch (22)	0.45	0.040	0.000	1.15	0.013	0.000	0.04	0.000	0.000	
Mfg. meter vehicles (24)	0.20	0.027	0.000	1.23	0.013	0.000	0.04	0.005	0.000	
Mfg. athen transport (25)	0.05	0.029	0.000	1.52	0.027	0.000	0.00	0.010	0.000	
Mfg. furmiture (26)	0.00	0.015	0.000	1.11	0.007	0.000	0.01	0.002	0.000	
Regueling (27)	0.10	0.007	0.000	1.07	0.000	0.000	0.02	0.001	0.000	
Electricites and stream (40)	0.20	0.009	0.000	1.00	0.009	0.000	0.00	0.002	0.247	
Construction (40)	0.60	0.017	0.000	1.71	0.013	0.000	0.32	0.009	0.000	
Auto anto managine facel anto (EQ)	-0.06	0.002	0.000	1.24	0.002	0.000	0.01	0.001	0.000	
Auto sale, rapair; fuel sale (50)	0.72	0.012	0.000	0.09	0.005	0.000	-0.01	0.005	0.002	
Patail trade (51)	0.73	0.002	0.000	1.00	0.001	0.000	0.00	0.000	0.000	
Retail trade, HH goods repair (52)	0.71	0.005	0.000	1.00	0.001	0.002	0.01	0.000	0.000	
Hotels and restaurants (55)	0.48	0.003	0.000	1.00	0.002	0.033	0.00	0.000	0.007	
Land transport; pipelines (60)	0.54	0.002	0.000	1.11	0.003	0.000	0.02	0.001	0.000	
Water transport (61)	-0.64	0.098	0.000	1.14	0.019	0.000	0.04	0.005	0.000	
Air transport (62)	0.51	0.053	0.000	1.09	0.022	0.000	-0.01	0.005	0.069	
Travel agency, transp. support (63)	0.21	0.024	0.000	1.18	0.006	0.000	0.01	0.004	0.001	
Post, telecom (64)	2.27	0.050	0.000	1.10	0.005	0.000	0.01	0.003	0.000	
Financial intermediation (65)	0.48	0.051	0.000	0.94	0.012	0.000	-0.08	0.017	0.000	
Insurance and pension funding (66)	1.95	0.050	0.000	0.72	0.009	0.000	-0.04	0.006	0.000	
Auxil. fin. intermediation (67)	0.98	0.029	0.000	1.13	0.007	0.000	-0.01	0.002	0.000	
Real estate (70)	0.42	0.004	0.000	1.26	0.002	0.000	0.00	0.000	0.000	
Renting machinery, equip., HH (71)	0.67	0.015	0.000	1.08	0.006	0.000	-0.01	0.001	0.000	
Computer and related (72)	1.19	0.007	0.000	1.09	0.003	0.000	0.00	0.000	0.763	
Research and development (73)	0.97	0.004	0.000	1.05	0.003	0.000	0.00	0.001	0.000	
Other business activities (74)	0.55	0.003	0.000	1.15	0.002	0.000	0.01	0.000	0.000	
Education (80)	0.81	0.004	0.000	0.96	0.003	0.000	-0.02	0.001	0.000	
Health and social work (85)	0.73	0.004	0.000	1.02	0.004	0.000	0.01	0.001	0.000	
Sewage and refuse disposal (90)	-0.34	0.032	0.000	1.30	0.009	0.000	0.01	0.004	0.151	
Recreational, cultural, sports (92)	1.26	0.025	0.000	1.08	0.009	0.000	0.01	0.006	0.081	
Other individual services (93)	1.02	0.025	0.000	0.93	0.007	0.000	0.00	0.008	0.757	
Average	0.57			1.09			0.02			

Notes: Standard errors are bootstrapped.

Table 2: Selection, Dilation, and Shift



Figure 2: Contribution of selection, dilation, and shift to the agricultural and manufacturing sectors productivity growth in 2001-2009



Figure 3: Contribution of selection, dilation, and shift to the services sectors productivity growth in 2001-2009

5 Selection, dilation, and shift in distribution under policy shock

5.1 Policy shock

We further investigate the effect of policy shock on changes in distribution of productivity over time. Liberalization of the services sector in Ukraine, first and foremost is linked to the WTO accession negotiations. Ukraine applied for accession on 30 November, 1993. The major obstacle on the way to the WTO accession was to bring the national legislation in compliance with the WTO rules and regulations. However, not much had been done till 2001. The major changes had occurred in 2001-2006, when the government had allowed to pass more than 20 new laws related to harmonization of the national laws and regulations with the WTO requirements in TV and broadcasting, information agencies, banks and banking activities, insurance, telecommunications, and business services.

In telecommunication services, the "Law on Telecommunications" of November 2003 provided the possibility for any legal person in Ukraine to operate, service or own telecommunications networks. The financial sub-sector has experienced a steady liberalization. In 2006, an amendment to the law "On Banks and Banking" permitted foreign banks to open branches in Ukraine, simplified the procedure for opening of banks and subsidiaries, and clearly defined under which circumstances the National Bank of Ukraine may turn down the application by a foreign bank to operate in Ukraine. A sequence of amendments to the law on insurance substantially liberalized the insurance sub-sector. In professional services, the laws "On auditing" and "On Bar" have been amended to remove the nationality requirements.

The legislative effort leveled the playing field for local and foreign services providers, improved market access, and made laws and regulations more transparent. The progress to a large extent was exogenously imposed on the Ukrainian government by external economic agents as a prerequisite to the WTO accession. There was no similar progress in equally important infrastructure, utilities, and transport, hotels and restaurants sub-sectors, for which no demand for improved market access had been made.

In parallel with services liberalization, WTO negotiations also led to further liberalization of trade in goods, which is positively linked to an increase in productivity in the literature (Pavcnik, 2002; Amiti & Konings, 2007; Khandelwal & Topalova, 2011). However, by 2001 Ukraine had already substantially liberalized its trade in goods. The average MFN tariff of Ukraine in 2002 was 7 percent and declined to 4.6 (XXX check) percent in 2009¹. In the analysis we control for both channels of liberalization.

Despite an unambiguously positive link between deregulation of services and manufacturing productivity, the endogeneity of services sector reforms makes it difficult to demonstrate that there is a direct causal effect of policy changes in services on productivity. For example, as pointed out by Francois & Hoekman (2010), the liberalization of the services sector in Eastern Europe coincided with a broad range of reforms carried out as the prerequisite for the EU accession. As a result, it is very difficult to disentangle the effect of the services deregulation from the reforms in other areas. With this regard, investigation of liberalization of services in Ukraine in 2001-2007 that was isolated from other major deregulatory changes and was driven by political pressure imposed by trading partners as a precondition for the Ukrainian WTO accession brings some advantages because the reform package was very limited and the effect of the EU integration was not present.

5.2 Effect of policy shock on distribution of productivity

To analyze the effect of the policy shock on distribution of productivity, we first calculate the annual changes in productivity distribution be estimating $A_{t,t-1}^s$, $D_{t,t-1}^s$ and $S_{t,t-1}^s$ for each sector k and t = 2002, 2002, ..., 2009. We further regress these variables on measures of services and trade liberalization, controlling for aggregate shocks, degree of openness to export and

 $^{^1\}mathrm{Data}$ on MFN tariffs are from UNCTAD - TRAINS (Trade Analysis and Information System) database.

import, and industry effects.

The index of services liberalization is industry-specific, reflecting the variation in sector-level intensity of usage of various services inputs. The index is computed according to the following formula

$$serv\,lib_{st} = \sum_{j} a_{s}^{j} \times index_{t}^{j} \tag{5}$$

where a_s^j is the share of input sourced from the services sub-sector j in the total input for a sector s taken from the input-output table for 2005, and $index_t^j$ is the measure of liberalization in the service sector j at time t. We proxy for $index_t^j$ by the structural change indicators provided by the European Bank for Reconstruction and Development (EBRD).² We also compute an index of input tariff liberalization following Amiti & Konings (2007):

$$input tariff_{st} = \sum_{j} b_s^j \times tariff_t^j$$
(6)

where *input tarif* f_{st} is the sector-specific input tariff measure, b_s^j is the share of input sourced from the two-digit NACE manufacturing sector j in the total input for sector s according to the 2005 input-output table, and $tarif f_t^j$ is the average MFN import tariff in sector j at time t. The data on the MFN tariffs is taken from UN TRAINS database. Shares of exporters (EXP) and importers (IMP) in sector s at time t has been computed as the ratio of exporting and importing firms to the total number of firms in sector s at time t.

We estimated the following regression

$$M_{kt,t-1} = \alpha_0 + \alpha_1 \triangle serv \, lib_{st,t-1} + \alpha_2 \triangle input \, tariff_{st} + \alpha_3 \triangle EXP_{st,t-1}$$
(7)
+ $\alpha_4 \triangle IMP_{st,t-1} + D_t t + D_s s + \epsilon_{it}$

²EBRD structural change indicators are available at http://www.ebrd.com/pages/research/economics/data/macro.shtml. The mapping from the structural change indicators to sub-sectors of services is explained in the appendix.

where $M_{st,t-1} = \{A^s_{t,t-1}, D^s_{t,t-1}, S^s_{t,t-1}\}.$

According to Panel A of Table 3, the shift in distribution, $A_{t,t-1}^s$, has been primarily associated with the services liberalization episode that has occurred in Ukraine prior to its WTO accession. The effect of trade liberalization is positive, but is not robustly significant. This result is consistent with the finding by Shepotylo & Vakhitov (2012) that a standard deviation increase in services liberalization within a firm is associated with a 9.2 percent increase in TFP. The weak effect of trade liberalization can be attributed to small reduction in the MFN tariffs. Unexpectedly, the increase in the share of exporters and importers is negatively associated with the shift in distribution.

As Panels B and C show, we failed to find a significant link between the selection, $S_{t,t-1}^k$, and increase dispersion, $D_{t,t-1}^k$, of productivity distribution on the one hand, and trade and services liberalization on the other hand, despite theoretical predictions (i.e Melitz, 2003). Share of exporters in the sector is positively associated with increase in selection and dilation but is significant only at 10 percent level, while reduction in input tariffs increases productivity dispersion and significant only at 10 percent level.

6 Conclusions

Over 2001-2009 the productivity of firms has increased. Aggregate shift in productivity of all firms within an industry explained major part of the increase, while selection had small and sometimes negative effect. Also, there was increase in dispersion of the productivity distribution indicating that the gap between low and high-productive firms has increased in most industries. We also identified that the shift in distribution has been primarily associated with services liberalization episode that has occurred in Ukraine prior to its WTO accession. We failed to find a link between the selection and increase dispersion of productivity distribution on the one hand, and trade and services liberalization on the other hand, as predicted by theoretical models (i.e Melitz, 2003). Our result on limited effect of the selection is consistent with findings of Combes et al. (2012), who failed to find a signif-

	(1)	(2)	(3)	(4)	(5)	(6)			
A. Dependent variable productivity shift A									
D.libind	0.322*	0.565**	0.572**	0.571**	0.563**	0.537*			
	(0.131)	(0.202)	(0.214)	(0.214)	(0.215)	(0.208)			
D.tarrifind				0.0855 +	0.0893+	0.0796			
				(0.0493)	(0.0495)	(0.0495)			
D.exp					-0.339+	-0.780**			
-					(0.187)	(0.282)			
D.imp						-0.603+			
1						(0.309)			
Year FE	No	Yes	Yes	Yes	Yes	Yes			
Industry FE	No	No	Yes	Yes	Yes	Yes			
Observations	408	408	408	408	406	406			
R^2	0.037	0.104	0.209	0.214	0.223	0.235			
B. Dependent variable productivity dilation D									
D.libind	0.0255	-0.0704	-0.0725	-0.0717	-0.0748	-0.0687			
	(0.0329)	(0.0464)	(0.0526)	(0.0532)	(0.0526)	(0.0529)			
D.tarrifind	(,	()	()	-0.0760+	-0.0773+	-0.0750+			
				(0.0415)	(0.0408)	(0.0403)			
D.exp				(0.0110)	0.0601	0.162 +			
Dienp					(0.0568)	(0.0949)			
Dimp					(0.0000)	0 139			
Dimp						(0.109)			
Year FE	No	Yes	Yes	Yes	Yes	Yes			
Industry FE	No	No	Yes	Yes	Yes	Yes			
Observations	408	408	408	408	406	406			
R^2	0.002	0.082	0 1 3 3	0.167	0.167	0 173			
<u>C Dependent variable productivity selection S</u>									
Dlibind	0.0156+	-0 000316	0 00138	0.00143	0.000775	0.00194			
	(0.0130+	(0.000010	(0.00130)	(0.00140)	(0.0113)	(0.01194)			
D tarrifind	(0.00799)	(0.00992)	(0.0114)	_0 00499	-0.00537	-0 00494			
				(0.00499	(0.00504)	(0.00494			
Devn				(0.00010)	0.00004)	(0.00007)			
Diexp					(0.0203)	(0.0235)			
Dimn					(0.0130)	0.0233			
Dimp						(0.0204)			
Voor EE	No	Vac	Vac	Vac	Vac	(0.0248) Vac			
iear FE	INO	res	res	res	ies	ies			
Industry FE	INO	N0	Yes	Yes	Yes	Yes			
Observations	408	408	408	408	406	406			
<i>K</i> ²	0.013	0.056	0.109	0.112	0.119	0.123			

Notes: + p<0.10, * p<0.05, ** p<0.01. Robust standard errors are presented in parentheses.

Table 3: Results

icant selection effect as well. Perhaps the mechanism of selection is more pronounced in the longer run, while the productivity shift occurs immediately when the regulatory environment positively affects productivity. To answer this question more research is required.

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