Productivity and wages

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Abstract

Based on the model of heterogeneous firms by Melitz (2003) and important extension towards incorporating market rigidities by Helpman, Itshoki, and Redding (2010), we explore the changes in the distribution of productivity and wages of Ukrainian firms after a significant policy impact, such as liberalization reform. Firms that use liberalized services more extensively benefit disproportionally more, which is reflected both in changes in productivity and wages dispersion among all manufacturing firms, as well in the expansion of exporting activity. The model is tested using a very rich firm-level data set collected over 2001 – 2007.

1 Introduction

Growing empirical literature robustly finds the positive effect of services liberalization on within firm productivity and on industry-wide productivity aggregates. Looking at the services liberalization episode in the Czech Republic in 1998-2003, Arnold et al. (2011) establish that a one-standard-deviation increase in foreign presence in services sector is associated with 7.7 percent

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increase in total factor productivity (TFP) of manufacturing firms depending on services inputs. The effect of services liberalization on distribution of wages is less well-known.[1] According to the fair wage hypothesis, which recently acquired considerable attention (Egger & Kreickemeier, 2012; Felbermayr et al., 2011; Helpman et al., 2010), liberalization of services should have a positive effect on the level of wages in the downstream manufacturing industries due to increased productivity. The effect on the dispersion of wages is not so clear. On the one hand, evidence suggests that services liberalization has a larger impact on small firms relying on services more extensively, which tends to reduce dispersion. On the other hand, large exporting firms, which are among the most productive before the liberalization, can get additional boost in productivity from better organization of production, which tend to increase dispersion.

These article attempts to shed light on the effect of services liberalization on the distribution of wages. To our best knowledge, this is the first work that studies the effect of services liberalization on distribution of wages within a manufacturing industry, populated by heterogeneous firms relying on services inputs. In our work we draw upon recent theoretical literature that link wages and profitability. Trade liberalization in the model with heterogeneous firms (Melitz, 2003) leads to higher dispersion of revenues, profits, and firm sizes. However, it has no implications on distribution of wages. Helpman et al. (2010, hereafter HIR) formulate a framework that explains how heterogeneity in productivity across firms within a narrowly-defined industry, combined with heterogeneity of workers, and labor market rigidities shape the distribution of wages. It allows more realistic description of the labor market in the model with heterogeneous firms. The HIR model generates a set of predictions related to the within an industry distribution of wages.

[1]The literature on the effect of trade liberalization on wages are more developed. The effect of trade liberalization on wages has been studied, among others, by Amiti & Davis (2012); Attanasio et al. (2004); Goldberg & Pavcnik (2005).

First, wages are positively linked to productivity.[2] As a result, there is a positive correlation between wages, revenues, profits, and firm sizes. Second, in the closed economy, wage inequality is increasing with firm productivity dispersion. Third, when economy opens up, the firm productivity dispersion goes up and the wage inequality increases, conditional on the assumption that the share of exporting firms is not close to 1, which is the case in the data.

Testing these predictions is hard, because the wage-productivity relationship is plagued with endogeneity. Not only distribution of wages respond to changes in the distribution of productivity, but productivity can also depend on distribution of wages.[3] As one of the possible solutions, a source of exogenous variation that change distribution of productivity is required to estimate the effect of productivity on wages. Recent studies of services liberalization (Arnold et al., 2011; Fernandes & Paunov, 2011) find positive effect of the liberalization on productivity of manufacturing firms. The size of the effect varies across firms because of differences in intensity with which firms use liberalized goods and services as inputs. This variation can be used as an instrument to pin down the causal effect from increased productivity to increased wages.

We use the episode of the Ukrainian services liberalization in 2001-2007, isolated from other major deregulatory changes and driven by political pressure imposed by trading partners as a precondition for the Ukrainian WTO accession, which led to differentiated but positive effect on productivity of downstream manufacturing firms (Shepotylo & Vakhitov, 2012), as the source

[2]The wage dispersion has been studied among others by Dunne et al. (2004). They report an increased role of between plant wage dispersion in US data relative to within plant wage dispersion and across industries wage dispersion. The wage dispersion can be explained either in the framework of competitive labor market with heterogeneous workers and firms with different composition of labor force or in the framework of profit-sharing wage set in a bargain between workers and owners, when more productive firms pay higher wages.

[3]Lazear & Rosen (1981)on the effect of wage dispersion within a firm on the level of effort

of exogenous variation to study the effect of productivity on wages. As a starting point, our analysis use a firm-specific indicator of services liberalization as an instrumental variable in the empirical model that estimate the effect of productivity on wages within an industry. We further investigate how liberalization of services influenced within industry dispersion of wages by aggregating productivity to the level of industries. The effect of services liberalization at industry level might differ from the firm level effect due to within-industry reallocation of market shares and firm turnover caused by services liberalization.

Our main results are as follows. An increase in productivity leads to increase in average wage, but the effect is not as strong as the OLS results suggest. Trying to resolve a puzzling trend of increased wages and reduced dispersion in manufacturing industries in Ukraine, we find some evidence that the trend is linked to the services liberalization episode. Our conjecture on the mechanism at work is as follows. Since services sector is more skill intensive, the reallocation of workers from manufacturing firms to services firms led to reduced wage dispersion across manufacturing firms. At the same time, increased efficiency caused by reallocation allowed increasing wages of workers involved in manufacturing, which is consistent with the "fair-wage" hypothesis.

The rest of the paper proceeds as follows. Section 2 discusses a theoretical mechanism that links liberalization of services and wages in manufacturing industries. Section 3 discusses the services liberalization episode in Ukraine in 2001-2007. Section 4 describes the data. Section 5 outlines the identification strategy. Section 6 presents results. Section 7 concludes.

2 Productivity, wages, and services liberalization

2.1 Productivity, wages, and liberalization of services

Services are often characterized by network externalities, stringent regulations, and barriers to entry. The market power in services leads to loss in competitiveness of the economy as a whole and requires services deregulation. Such services as transportation, insurance, professional, or financial services play very important role in determining export competitiveness of manufacturing firms. In turn, expansion of exports due to lower price margins in services could increase productivity through economies of scale. Importantly, trade liberalization without services liberalization lowers competitiveness of domestic firms and causes their exit, which leads to negative employment dynamics in the short run (Francois & Hoekman, 2010).

In the Melitz model (Melitz, 2003), the productivity distribution of firms is fixed. The effect of trade liberalization on productivity comes only through the re-distribution of resources from less productive firms to more productive firms. However, the literature documents a positive effect of services deregulation on productivity of manufacturing firms in the Czech Republic (Arnold et al., 2011), in Chile (Fernandes & Paunov, 2011), and in Ukraine (Shepotylo & Vakhitov, 2012)[4]. Importantly, firms that use services more intensively gain more. Hence, in addition to the redistribution effect, there is a shift in the whole distribution of productivities.

Therefore, a more realistic model would recognize that as the economy develops, distribution of productivity changes. In particular, trade liberalization have a direct, positive effect on productivity within a firm, with exporting firms benefiting disproportionally more. If more productive, exporting firms also use services more intensively, then services liberalization

[4]Trade liberalization has a similar effect (Amiti & Konings, 2007; Khandelwal & Topalova, 2011).

would lead to even more dispersed distribution of productivity and more dispersed wages. However, if productivity gains from services liberalization go to small firms, then it would lead to more equal distribution of productivity and more equal distribution of wages.

Shepotylo & Vakhitov (2012) find a positive effect of services liberalization on productivity in manufacturing industries in Ukraine in 2001-2007. The results indicate that a standard deviation increase in services liberalization is associated with a 9 percent increase in TFP. Importantly, the effect is more pronounced for small firms. The index of services liberalization is firm-specific, reflecting the variation in firm-level intensity of usage of various services inputs. Following Arnold et al. (2011), the index is computed according to the following formula

$$serv\,lib_{it} = \sum_{j} a_{ijt} \cdot index_{jt} \tag{1}$$

where $serv\,lib_{it}$ is the firm-specific index of services liberalization, a_{ijt} is the share of input sourced from the services sub-sector j in the total input for a firm i at time t, and $index_{jt}$ is the EBRD measure of liberalization in the service sub-sector j at time t.

What firms benefit the most from services liberalization? Table 1 presents firm characteristics by quintiles of the services liberalization index. There is a non-linear relationship between services liberalization and firm size, measured by employment L_{it}, capital K_{it}, use of materials M_{it}, wage bill $w_{it}L_{it}$ or revenues R_{it}. The largest firms are the median users of the most liberalized services, while smaller firms are either do not use those services or use them very intensively. Firms within the fifth quintile are smaller, but have almost the same proportion of exporters as in the third and fourth quintiles. Ex ante, we expect that services liberalization have a larger effect on productivity and wages of the fifth quintile firms, which would tend to reduce dispersion of wages at within an industry.

Services liberalization quintile	1st	2nd	3rd	4th	5th
L_{it}	193	300	368	351	266
K_{it}	4616	7973	11022	9430	7454
M_{it}	18286	28973	33494	24810	10851
$Exporter_{it}$	0.244	0.341	0.401	0.432	0.396
$Wagebill_{it}$	1011	1863	2749	2729	1903
R_{it}	16913	24582	31754	25978	17774

Table 1: Firm's characteristics by quantiles of services liberalization

3 Services liberalization and labor market

3.1 Liberalization of Ukrainian services sector in 2001-2007

Liberalization of services sector in Ukraine, first and foremost is linked to the WTO accession negotiations. Ukraine has applied for the 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 has been done till 2001, when the president L. Kuchma has "instructed his government to speed up all technical work related to accession negotiations"[5]. The favorable political situation – the coalition government had the majority in the Parliament – allowed to pass more than 20 new laws related to harmonization of the national laws and regulations with the WTO requirements in 2001-2003. Concerning services, the government developed new laws and amended existing ones that regulate activities of TV and Broadcasting, Information agencies, Banks and banking activities, insurance, telecommunications, and business services.

In telecommunication services, "Law on Telecommunications" of November 2003 provided the possibility for any legal person in Ukraine to operate, service or own telecommunications networks. A National Committee

[5]Report of the working party on the accession of Ukraine to the world trade organization, 25 January 2008, WT/ACC/UKR/152

for Communication Regulation (NCCR), established according to the law, became the regulatory authority in telecommunications which made the sector more transparent and open to competition. The law declared principles of equal access and fair competition; introduced the policy towards standardization and harmonization with the world standards; specified detailed procedures for frequency auctions and rules for licensing. The financial subsector 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 can turn down the application by the foreign bank to operate in Ukraine. The law also defined limiting terms for accreditation of the foreign banks (up to 3 months). 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 law on auditing allowed the competition from foreign services providers.

3.2 Performance of services in 2001-2007

Liberalization of Ukrainian services sector in 2001-2007 was accompanied by increased share of services in GDP, relocation of workers to services sector, and a surge of FDI in services sector. Between 2000 and 2007, the share of services in GDP has increased from 35 percent to 42 percent. As Figure 1 shows, labor force has shifted towards services, increasing from 23.8 percent of total employment in 2001 to 31.3 percent in 2007. During the same period, the share of labor force employed in manufacturing sector has declined from 27.9 percent in 2001 to 26.4 percent in 2007.

Services liberalization was accompanied with a surge of FDI in services sector. As Figure 2 shows, in 2001, 48 percent of total FDI stock in Ukraine was in manufacturing. By 2007, the share of FDI in manufacturing had

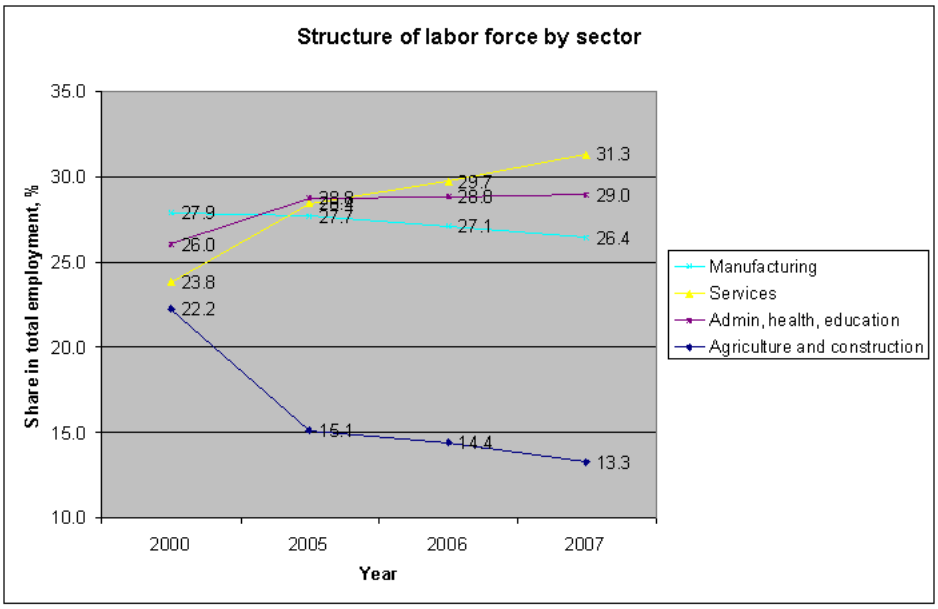

Figure 1: Structure of labor force by sector

declined to 30 percent, while the share of FDI in services sector (excluding utilities) had reached 53 percent.

3.3 Productivity and wage dispersion

In 2001-2007 in Ukraine, average wage in manufacturing industries has experienced rapid growth, but declining dispersion. We present detailed summary statistics of wages by manufacturing industries in Ukraine in 2001-2007 in the appendix. To understand whether the variation is driven by differences across or within industries, we decompose the variance of $\ln(wage)$, $\ln(TFP)$ and services liberalization index into variance within and between industries:

$$V^m = V^m_{BI} + V^m_{WI}$$

for $m = \{wage, TFP, liberalization\}$. We also decompose the variance of $\ln(wage)$, $\ln(TFP)$ and our measure of services liberalization reform into

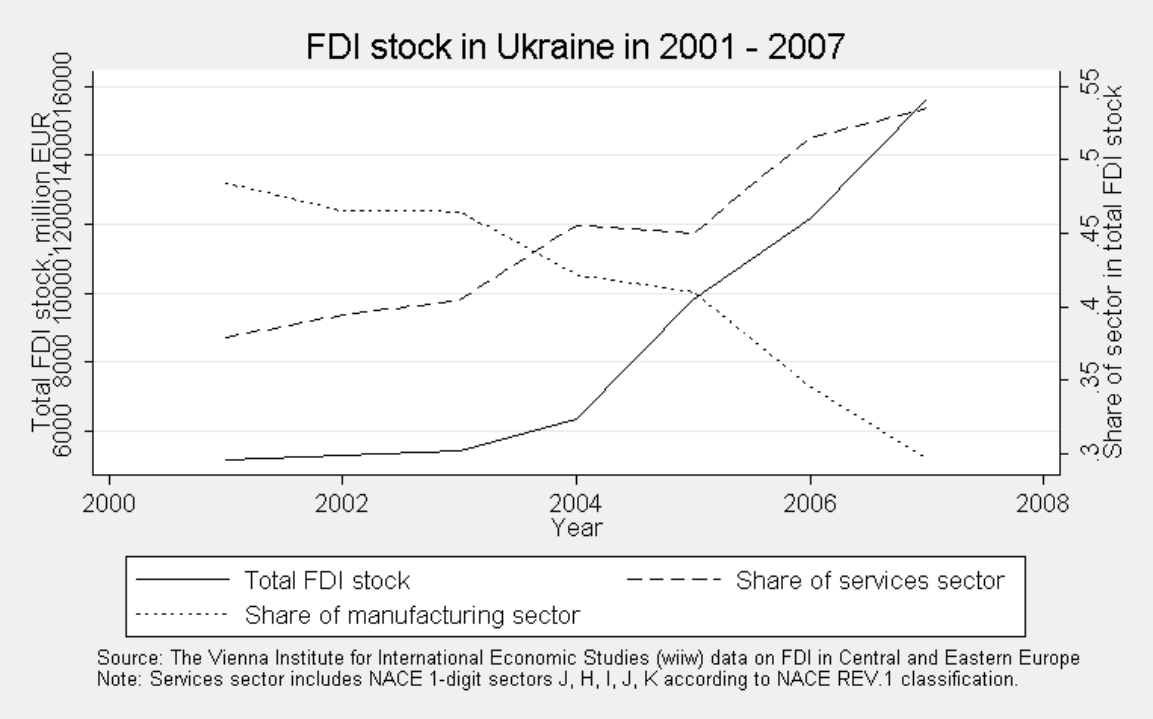

Figure 2: FDI stock in Ukraine in 2001-2007

variance within and between regions:

$$V^m = V^m_{BR} + V^m_{WR}$$

for $m = \{wage, TFP, liberalization\}$.

The results from the decompositions are reported in Figure 3. To correct for the scale effect, the components are reported in terms of the coefficients of variation. The within variance is presented with the dotted lines, the between variance is presented with the dashed lines, and the total variance is presented with the solid lines. The results for industry decomposition are presented in the first column, the results for regional decomposition are presented in the second column.

Variance of wages is mostly determined by the within industry variation in wages. Variance of services liberalization is also primarily the within industry phenomenon. Reduction of the variance of wages and services liberalization mostly comes from the decline in the within industry variance. At the same time, the variance of TFP mostly comes from the between industry variance and its increase comes from diversion of productivities across industries. Regional decomposition of variance reveals similar patterns for wages and services liberalization, while for TFP the regional variation mostly comes from within the region.

4 Data and productivity measure

4.1 Sample

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 data are restricted and not available for public use. The sample covers seven years from 2001 to 2007. The total number of firms in the data set exceeds 400,000 per year and covers all sectors except

Figure 3: Variance decomposition of wages, TFP, and services liberalization

budgetary organizations (public schools, public hospitals, museums, etc.) and banks. We start with the sample of manufacturing firms (NACE Section "D") which never switched to another sector over the period of study. Since the Sectoral Expenditures Statement, required to construct the firm-specific service liberalization index, is submitted by only relatively large firms, our sample is restricted to the firms with more than 150 employees on average. We further excluded observations with zero or negative output, capital stock or employment assuming that they indicated non-operational firms in a year. Based on the files accompanying the Enterprise Performance Statement and the Balance Sheet Statement, we have created a comprehensive profile for every firm which includes the industry (KVED/NACE) and territory codes, as well as exporting status in every year which were used as controls. The industry codes were used to assign manufacturing firms into one of eleven sub-industries. In every sub-industry, we cut off the top 1 percentile of the sample (measured by employment, capital and output) to exclude outliers.

As the measure of output, we used 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. The statement provides detailed information about the firm's expenditures on purchases from 22 manufacturing sectors and 15 service sectors. Data from this statement were used to construct an individual firm-specific index of services liberalization as we explain in the Appendix. All variables were deflated by the appropriate price deflators available from the National Statistical Office. The descriptive

Variable	N	Mean	Std. Dev.	Min	Max
R,thd.hryvnas	40440	8001.91	16948.02	0.08	548158.70
L, workers	40440	171.57	265.52	1	6779
K,thd.hryvnas	40440	3111.47	6964.35	0.07	183732.00
M,thd.hryvnas	40440	6971.82	17583.37	0.1	706991.3
I,thd.hryvnas	30357	693.39	2112.28	0	89370.69
Serv. Lib.	40440	0.36	0.57	0	4.85
Serv. Lib. (FDI)	40440	0.34	0.64	0	29.31
Exporter, Yes=1	40440	0.34	0.47	0	1

Table 2: Descriptive statistics

statistics for the sample are presented in Table 2.

4.2 Productivity measure

To recover the TFP measure, we estimate the production function for each manufacturing industry (1-digit NACE classification) by the Olley-Pakes procedure (Olley & Pakes, 1996), controlling for sub-industry-specific demand and price shocks as suggested by De Loecker (2011). We identify 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.

Technology and market structure

Consider a production technology of a single-product firm i at time t described by a production function

$$Y_{it} = L_{it}^{\alpha_l} K_{it}^{\alpha_k} M_{it}^{\alpha_m} \exp(\tilde{\omega}_{it} + \tilde{u}_{it}), \tag{2}$$

where Y_{it} units of real output are produced using L_{it} units of labor, K_{it} units of capital, deflated by producer-price deflator, and M_{it} units of material and services inputs. Since we have a breakdown of inputs by sector, each component of M_{it} is deflated by the corresponding sector-specific price deflator. $\tilde{\omega}_{it}$ is firm-specific productivity, unobservable by an econometrician, but known to the firm before it chooses variable inputs. $\tilde{u}_{it}$ is idiosyncratic shock to production that also captures measurement error. Y_{it} is not observable, because we do not observe firm-specific prices, p_{it}, but sales, $R_{it} = p_{it}Y_{it}$, are known. Use of R_{it} as the dependent variable in estimation of production function parameters, without controlling for prices, determined among other things by market structure and demand shocks, would bias estimates of the production function if prices are correlated with inputs. Even more importantly, generating productivity estimates containing demand variation introduces a relationship between services liberalization and measured productivity through the impact of the liberalization on prices and demand.

To separate the direct effect of services liberalization on productivity from the indirect effect on demand, we introduce a constant elasticity of substitution demand system

$$Y_{it} = Y_{st} \left(\frac{p_{it}}{P_{st}} \right)^{\sigma_s} \exp(\tilde{\xi}_{it}), \tag{3}$$

where Y_{st} is total expenditures on goods produced by manufacturing industry s, in which firm i operates. P_{st} is industry-wide price at time t. $\tilde{\xi}_{it}$ is demand shock which is not observed by the firm when it chooses variable inputs in production. Assuming monopolistic competition, this demand structure implies a constant mark-up price-setting rule, which depends on the industry-specific elasticity of substitution σ_s. It further implies the following expression for the revenue function

$$R_{it} = (Y_{it})^{\frac{\sigma_s+1}{\sigma_s}} (Y_{st})^{-\frac{1}{\sigma_s}} P_{st} \left(\exp(\tilde{\xi}_{it}) \right)^{-\frac{1}{\sigma_s}}. \tag{4}$$

Substituting (2) into (4) and taking logs yields

$$r_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_s y_{st} + \omega_{it} + \xi_{it} + u_{it}, \tag{5}$$

where $r_{it} = \ln(R_{it}/P_{st})$ is log of revenue deflated by corresponding industry price deflator, and other lower-case letters represent upper-case variables in the log form. $\beta_f = \frac{\sigma_s+1}{\sigma_s}\alpha_f$, where $f = \{l, k, m\}$. The elasticity of substitution in industry s can be retrieved as $\sigma_s = -1/\beta_s$. Finally, $\omega_{it} = \frac{\sigma_s+1}{\sigma_s}\tilde{\omega}_{it}$, $\xi_{it} = -\frac{1}{\sigma_s}\tilde{\xi}_{it}$, and $u_{it} = \frac{\sigma_s+1}{\sigma_s}\tilde{u}_{it}$ are error terms.

Estimation of production function

We estimate

$$r_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_s y_{gt} + \omega_{it} + \xi_{it} + u_{it}, \tag{6}$$

separately, for each industry s, keeping in mind our ultimate goal of measuring TFP net of price and demand shocks. In what follows we suppress index s for clarity of presentation. Instead of using overall output of industry s, we use more disaggregated sub-industry g output, y_{gt}, to add more variability to estimation of σ_s. It is valid since we assume that the elasticity of substitution is constant within the industry.

We decompose the overall demand shock into the following components

$$\xi_{it} = \xi_t + \xi_g + \bar{\xi}_{it}, \tag{7}$$

where ξ_t is industry-specific shock common to all firms at time t, ξ_g is demand factor affecting only firms producing in sub-industry g, and $\bar{\xi}_{it}$ is an idiosyncratic shock. Plugging in (7) in (6), we have

$$r_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta y_{gt} + \delta_t D_t + \delta_g D_g + \omega_{it} + \varepsilon_{it} \tag{8}$$

where $D_t = \xi_t$ is a shock common to all firms in the industry at time t and

D_g is a dummy variable that takes the value of one if a firm i operates in sub-industry g and zero otherwise. $\varepsilon_{it} = \bar{\xi}_{it} + u_{it}$ is the error term which is not correlated with inputs and productivity. We further estimate (8) by the Olley-Pakes methodology. Total factor productivity net of price and demand effects is recovered as

$$\ln(TFP_{it}) = (r_{it} - \beta_l l_{it} - \beta_k k_{it} - \beta_m m_{it} - \beta_s y_{st}) \frac{\sigma_s}{\sigma_s + 1}. \tag{9}$$

5 Results

5.1 Productivity and wages

Our first objective is to test whether higher productivity is associated with higher average wage across firms in the same industry (1 digit NACE classification). We regress average wage at firm level on productivity, controlling for export status, industry-year, and region fixed effects. The estimated regression takes the following parametric form

$$\begin{aligned} ln(w_{it}) = \alpha + \ln(TFP_{it})\beta + exporter_{it}\gamma \\ + D_{st}\mu + D_r r + \epsilon_{it} \end{aligned} \tag{10}$$

where w_{it} is firm $i's$ average wage at time t, TFP_{it} is firm $i's$ level of total factor productivity at time t, $exporter_{it}$ is the dummy variable that takes the value of one if firm i exported in year t and zero otherwise, D_{st} are industry-year fixed effects, and D_r are region fixed effects. Results, reported in the first column of Table 3, confirms the "fair-wage" hypothesis. Elasticity of average wage with respect to productivity is 0.259. However, this model does not control for firm-specific effects that can be correlated with our productivity measure and export status.

We add firm level fixed effects and report *within* a firm effect of increase in productivity on average wage in column (2). The wage elasticity declines

to 0.137. However, adding fixed effects does not address the endogeneity problem. Not only productivity influences wages, but wages have an impact on productivity[6]. We use the instrumental variable (IV) technique to establish a causal effect from productivity to wages. We instrument TFP by the firm-specific indices of services liberalization, reflecting the variation in the effect of the firm-level intensity of usage of various services inputs on productivity. Following Arnold et al. (2011), the index is computed according to the following formula

$$serv\,lib^{m}{}_{it} = \sum_{j} a_{ijt} \cdot m_{jt} \tag{11}$$

where $serv\,lib^{m}{}_{it}$ is the firm-specific index of services liberalization, a_{ijt} is the share of input sourced from the services sub-sector j in the total input for a firm i at time t, and m_{jt} is either the EBRD measure of liberalization in the service sub-sector j at time t or the share of output produced by the firms with foreign ownership in the service sub-sector j at time t. The two measures of services liberalization complement each other because the first measures the regulatory changes, while the second measures the effect of those changes on competition in the services sub-sectors.

The results are presented in column (3) of Table 4. We confirm that wages positively and significantly respond to changes of TFP, but not as strongly as model (1) suggests; the effect declines to 0.081. Finally, long-term contracts and labor market rigidities make wages respond to changes in productivity and economic environment with some lag. Using the lagged value of productivity and other explanatory variables in column (4), produces an economically larger effect. When we check our results for robustness, we use the model in column (4) as the baseline regression model. The overiden-

[6]Literature has established that incentives matter for productivity of workers (Lazear & Rosen, 1981). Also, wages can influence our measured TFP due to the fact that we observe revenues, $R = pQ$, and wages can be correlated with markups and prices at firm level.

tification test reported at the bottom of the table indicates validity of our instruments.

Export status has positive effects on wages as consistent with the HIR model. As results without firm fixed effect suggest, exporter pay between 12 to 16 percent wage premia relative to non-exporters. Switching from non-exporter to exporter is associated with 4.4 percent increase in average wage as column (2) reports. Firm size measured by employment is strongly and positively correlated with the average wage. Both results are well in accord with theoretical models and empirical findings.

To check how sensitive our results are to the measure of productivity, the columns (5)-(8) of table 3 report results of the same models, but with labor productivity, R_{it}/L_{it}, as the productivity measure. In general, the results are similar to the results in the columns (1)-(4), with the exception that the IV method in column (7) reports a non-significant coefficient for labor productivity. Still, the lagged version in column (8), which in our opinion is better suited to measure the effect, shows a positive and significant coefficient.

5.2 Robustness checks

We further consider slices of the data along various dimensions and report results in table 4. The baseline model from column (4) of Table 3 is reproduced in the column (1) of Table 4 for comparison. Since state-owned firms have more rigid labor regulations, we expect that the productivity is stronger related with wages for private-owned firms, which is confirmed in column (2) of the table. In column (3) we report results for firms located in urban areas, which does not change our results. In column (4) we report results for firms with employment above 50 workers, and find a strong effect. In column (5) we report results for domestic firms, which is considerably smaller than for the whole sample. In column (6) we present the results for single-plant firms with no changes in our conclusion of the positive effect of productivity on wages.

	TFP				Labor productivity			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	FE	IV	IV lagged	OLS	FE	IV	IV lagged
Productivity measure	0.259***	0.137***	0.081**	0.114***	0.226***	0.166***	0.029	0.077**
	(0.006)	(0.007)	(0.025)	(0.026)	(0.002)	(0.003)	(0.030)	(0.029)
Exporter	0.121***	0.044***	0.159***	0.133***	0.011*	0.030***	0.167***	0.133***
	(0.006)	(0.007)	(0.009)	(0.003)	(0.005)	(0.007)	(0.020)	(0.004)
$\ln(L_{it})$	0.131***	0.029***	0.122***	0.123***	0.191***	0.078***	0.121***	0.116***
	(0.002)	(0.007)	(0.003)	(0.008)	(0.002)	(0.005)	(0.004)	(0.017)
Constant	-0.079***	0.284**	0.171***	0.928***	-0.512***	1.258***	0.221***	0.896***
	(0.021)	(0.094)	(0.034)	(0.034)	(0.014)	(0.083)	(0.066)	(0.071)
Firm FE	No	Yes	No	No	No	Yes	No	No
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hansen J statistic			1.684	1.144			0.831	0.965
Chi-sq(1) P-val =			0.194	0.285			0.362	0.326
R^2	0.420	0.437	0.429	0.399	0.460	0.334	0.426	0.451
N	57731	57731	40437	35718	127233	127233	31948	26171

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Robust standard errors are presented in parentheses.

Notes: Dependent variable in all regressions is $\ln(w_{it})$. Instruments are EBRD and FDI based indices of services liberalization

Table 3: Wages and productivity

	(1)	(2)	(3)	(4)	(5)	(6)
	Basic	Private	Urban	Large	Domestic	Single-plant
$\ln(TFP_{i,t-1})$	0.114***	0.130***	0.112***	0.155***	0.083**	0.111***
	(0.026)	(0.025)	(0.028)	(0.035)	(0.027)	(0.027)
$\ln(L_{i,t-1})$	0.133***	0.142***	0.109***	0.088***	0.136***	0.137***
	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)
$Exporter_{i,t-1}$	0.123***	0.120***	0.095***	0.110***	0.105***	0.123***
	(0.008)	(0.009)	(0.010)	(0.009)	(0.008)	(0.009)
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Hansen J statistic	1.144	0.905	0.534	0.251	3.368	1.138
Chi-sq(1) P-val =	0.285	0.342	0.465	0.616	0.066	0.286
R^2	0.399	0.412	0.367	0.390	0.405	0.401
N	35718	31840	23665	24166	33851	33815

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Standard errors are presented in parentheses.

Notes: Dependent variable in all regressions is $\ln(wage_{i,t})$. Instruments are EBRD and FDI based indices of services liberalization

Table 4: Wages and productivity: sub-samples

	(1)	(2)	(3)	(4)
Services liberalization	1.243***	1.249***	1.249***	1.216***
	(6.32)	(6.64)	(6.62)	(6.38)
Mean ln(TFP)		-0.352***	-0.354***	-0.380***
		(-3.72)	(-3.62)	(-3.80)
Share of exporters			0.0176	0.131
			(0.08)	(0.53)
Mean ln(L)				-0.118
				(-1.21)
Industry FE	Yes	Yes	Yes	Yes
N	161	161	161	161

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. t-statistics are presented in parentheses. Dependent variable is average wage in industry i at time t. Includes industry fixed-effects

Table 5: Services liberalization and average wage across industries

5.3 Services liberalization and wage dispersion within an industry

Having confirmed the positive causal effect from productivity to wages, we further test predictions of Helpman et al. (2010). First, we test how the average wage and wage dispersion within an industry is influenced by the extent to which the industry was exposed to services liberalization. Second, we interact the exposure to services liberalization with the share of exporters within the industry to test the hypothesis that conditional on services liberalization, the effect depends on the share of exporters in the industry: it increases when the share of exporters is small and declines when the share of exporters is large. The results with average wage as the dependent variable are presented in Table 5.

The results with standard deviation of wage as the dependent variable are presented in Table 6.

Services liberalization is positively associated with the average wage and negatively with its dispersion, which points that the services liberalization can be a factor that explains puzzling dynamics of declining wage dispersion

	(1)	(2)	(3)	(4)
Services liberalization	-0.267***	-0.306***	-0.307***	-0.308***
	(-4.64)	(-5.46)	(-5.47)	(-5.46)
Std. dev TFP		0.119***	0.123***	0.126***
		(3.77)	(3.80)	(-3.80)
Std. dev ln(L)			-0.027	-0.028
			(-0.57)	(-0.60)
Share of exporters				-0.029
				(-0.44)
Industry FE	Yes	Yes	Yes	Yes
N	161	161	161	161

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. t-statistics are presented in parentheses.
Notes: Dependent variable is std. dev of ln(Average wage) in industry i at time t. Includes industry fixed-effects

Table 6: Services liberalization and standard deviation of wages across industries

in Ukraine, shown in Figure 3.

5.4 Services liberalization and wage dispersion across regions

We also looked at interaction of services liberalization in region r at time t with the average wage and its dispersion across regions of Ukraine. Results are presented in Tables 7 and 8. The results are consistent with industry level regressions.

6 Conclusions

We find that increase in productivity leads to increase in average wage, but the effect is not as strong as the OLS results suggest. Trying to resolve a puzzling trend of increased wages and reduced dispersion in manufacturing industries in Ukraine, we find some evidence that the trend is linked to the

	(1)	(2)	(3)	(4)
Services liberalization	0.250***	0.269***	0.263***	0.273***
	(9.41)	(10.16)	(10.01)	(10.40)
Mean ln(TFP)		-0.109***	-0.111***	-0.112***
		(-6.87)	(-7.06)	(-7.19)
Share of exporters			0.203***	0.176***
			(7.99)	(6.80)
Mean ln(L)				0.0742***
				(5.52)
Region FE	Yes	Yes	Yes	Yes
N	4046	4046	4046	4046

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. t-statistics are presented in parentheses.
Notes: Dependent variable is std. dev of ln(Average wage) in region r at time t.

Table 7: Services liberalization and average wage across regions

	(1)	(2)	(3)	(4)
Services liberalization	-0.0193*	-0.0257**	-0.0245**	-0.0235**
	(-2.13)	(-2.84)	(-2.75)	(-2.64)
Std. dev TFP		0.0714***	0.0548***	0.0537***
		(7.76)	(5.91)	(5.80)
Std. dev ln(L)			0.0964***	0.0984***
			(9.03)	(9.21)
Share of exporters				-0.0284**
				(-3.28)
Region FE	Yes	Yes	Yes	Yes
N	4046	4046	4046	4046

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. t-statistics are presented in parentheses.
Notes: Dependent variable is std. dev of ln(Average wage) in region r at time t.

Table 8: Services liberalization and standard deviation of wages across regions

services liberalization episode. Our conjecture on the mechanism at work is as follows. Since services sector is more skill intensive, the reallocation of workers from manufacturing firms to services firms led to reduced wage dispersion across manufacturing firms. At the same time, increased efficiency caused by reallocation allowed increasing wages of workers involved in manufacturing, which is consistent with the "fair-wage" hypothesis. Unfortunately, our data, which does not have the information on composition of the workforce within the firm, does not allow investigating whether our conjecture is correct more rigorously. We leave it for the further research.

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	2001	2002	2003	2004	2005	2006	2007	Total
	Labor productivity							
Food and Tobacco	1.882	2.096	1.78	1.827	1.85	1.931	1.94	1.905
Textile and leather	1.163	1.242	1.435	1.555	1.741	1.883	2.015	1.554
Wood and Paper	1.796	1.761	1.74	1.72	1.637	1.593	1.639	1.71
Printing	2.237	2.372	2.325	2.295	2.387	2.439	2.383	2.348
Coke, chemistry, plastics	2.564	2.618	2.516	2.237	2.388	2.169	2.165	2.427
Non-metallic minerals	1.65	1.85	2.051	1.918	1.719	1.339	1.204	1.774
Metallurgy	1.911	1.983	1.927	1.312	1.42	1.449	1.673	1.753
Machinery and equipment	1.81	1.852	2.017	1.963	1.952	1.92	1.986	1.921
High-tech machinery	1.931	2.122	2.252	2.236	2.207	2.293	2.31	2.185
Vehicles and transport	1.903	2.225	2.267	1.969	2.129	2.114	2.094	2.102
Furniture and others	1.883	1.956	1.876	1.483	1.594	1.386	1.559	1.738
Total	1.861	1.999	1.969	1.893	1.942	1.96	2.032	1.944
	ln Average wage							
Food and Tobacco	0.734	0.972	1.06	1.181	1.383	1.521	1.599	1.184
Textile and leather	0.47	0.661	0.825	1.009	1.181	1.311	1.396	0.964
Wood and Paper	0.743	0.911	0.992	1.141	1.339	1.465	1.519	1.165
Printing	1.091	1.284	1.314	1.37	1.514	1.647	1.672	1.42
Coke, chemistry, plastics	1.129	1.308	1.408	1.498	1.656	1.805	1.839	1.532
Non-metallic minerals	0.869	1.114	1.274	1.447	1.644	1.81	1.939	1.421
Metallurgy	0.958	1.16	1.311	1.436	1.639	1.772	1.865	1.458
Machinery and equipment	0.934	1.15	1.272	1.426	1.627	1.748	1.853	1.401
High-tech machinery	0.914	1.157	1.304	1.456	1.628	1.755	1.857	1.435
Vehicles and transport	1.118	1.373	1.454	1.651	1.782	1.908	2.007	1.605
Furniture and others	0.754	0.957	1.058	1.166	1.355	1.464	1.548	1.176
Total	0.839	1.058	1.17	1.304	1.49	1.627	1.703	1.303

Table 9: Average wage and labor productivity in 2001-2007

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Appendix

Table 10 reports average labor productivity and average wage over time and by industry.

	2001	2002	2003	2004	2005	2006	2007	Total
				Labor productivity				
Food and Tobacco	1.323	1.225	1.409	1.418	1.372	1.398	1.655	1.368
Textile and leather	1.205	1.195	1.188	1.083	1.039	0.98	1.018	1.148
Wood and Paper	1.251	1.293	1.248	1.289	1.402	1.356	1.584	1.33
Printing	1.042	0.953	1.044	1.067	1.137	1.069	1.097	1.061
Coke, chemistry, plastics	1.303	1.376	1.36	1.479	1.334	1.397	1.731	1.411
Non-metallic minerals	1.224	1.192	1.091	1.108	1.156	1.427	1.67	1.225
Metallurgy	1.374	1.361	1.287	1.517	1.6	1.553	1.688	1.449
Machinery and equipment	1.187	1.18	1.206	1.214	1.247	1.292	1.332	1.228
High-tech machinery	1.475	1.399	1.381	1.436	1.335	1.349	1.455	1.409
Vehicles and transport	1.313	1.25	1.333	1.271	1.138	1.434	1.462	1.309
Furniture and others	1.392	1.32	1.236	1.51	1.518	1.566	1.448	1.419
Total	1.318	1.28	1.303	1.33	1.31	1.336	1.414	1.321
				ln Average wage				
Food and Tobacco	0.666	0.611	0.607	0.554	0.534	0.511	0.51	0.644
Textile and leather	0.747	0.707	0.652	0.602	0.544	0.523	0.542	0.7
Wood and Paper	0.697	0.662	0.712	0.554	0.51	0.507	0.48	0.65
Printing	0.649	0.625	0.605	0.563	0.578	0.547	0.533	0.615
Coke, chemistry, plastics	0.742	0.685	0.649	0.655	0.629	0.558	0.535	0.679
Non-metallic minerals	0.651	0.582	0.581	0.58	0.519	0.554	0.549	0.677
Metallurgy	0.734	0.662	0.615	0.578	0.519	0.538	0.52	0.668
Machinery and equipment	0.653	0.599	0.599	0.585	0.537	0.513	0.52	0.654
High-tech machinery	0.81	0.686	0.636	0.643	0.621	0.57	0.573	0.722
Vehicles and transport	0.652	0.595	0.573	0.513	0.565	0.526	0.478	0.63
Furniture and others	0.744	0.677	0.64	0.604	0.557	0.563	0.544	0.676
Total	0.72	0.665	0.645	0.607	0.577	0.558	0.554	0.685

Table 10: Standard deviation of wages and labor productivity in 2001-2007

Standard deviations of labor productivity and wages by industry and over time are presented in Table 11.