

Effect of deregulation on productivity and wages with heterogeneous firms and workers

Impact of services deregulation

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April 7, 2012

- 1 Literature
- 2 Policy changes and data
 - Advantages of Ukrainian data
 - Policy changes
 - Data
- 3 Productivity, wages, and services liberalization
- 4 Methodology and results
 - Productivity and services liberalization
 - Productivity and wages
 - Wages across industries and regions
- 5 Conclusions

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- Trade liberalization and productivity
 - Deregulation increase *within* firm productivity in import-competing sectors by 3-10 percent more than in non-traded good sectors (Pavcnik, 2002)
- Services liberalization and productivity
 - A standard deviation increase in the foreign presence in services is associated with a 3.8 percent increase in TFP in downstream manufacturing firms (Arnold et al., 2011)
 - forward linkages from foreign direct investment in services to downstream manufacturing industries account for almost 5 percent of the observed increase in the Chilean manufacturing productivity growth (Fernandes and Paunov, 2011)
- Technological changes and dispersion of productivity and wages
 - Effect of computers on distribution of productivity and wages (Dunne et al, 2004)

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Why Ukraine?

- Rapid liberalization of services in 2001-2007
 - More competition, FDI, and trade in services
 - Labor productivity of services increased by more than 40 percent
 - Services sectors accounts for 48 percent of GDP in 2007 and growing
- Push for services liberalization was mostly imposed externally
 - WTO accession requirements
 - Exogenous shock for Ukraine

Reforming services in Ukraine

- Telecommunications – 2003
- Insurance – 2003 and 2005
- Banking sector – 2006

- 2001-2007 statistical statements 400,000 firms per year
 - 50,000 manufacturing firms per year
 - 12,000 firms per year have information on use of services inputs (large firms)
- EBRD index of reforms for each services sub-sector
- Ownership: domestic, foreign
- Export status: exporter, non-exporter

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Variance decomposition



Figure: Variance decomposition of wages, TFP, and trade liberalization

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- Endogeneity of reforms
- Separate the effect of services reform from the effect of other reforms
- Separate the effect of services liberalization on TFP from the effect of the liberalization on inputs
 - Use two stage methodology (Pavcnik 2002, Arnold et al 2007b)

Estimating production function

- Endogeneity of input selection and firm entry and exit – (Olley and Pakes, 1996)
- Market structure and industry-specific price deflators – use CES demand structure, control for industry overall input, and sub-industry-year fixed effects (De Locker, 2012)

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

$$Y_{it} = L_{it}^{\alpha_l} K_{it}^{\alpha_k} M_{it}^{\alpha_m} \exp(\tilde{\omega}_{it} + \tilde{u}_{it}) \quad (1)$$

- Constant elasticity of substitution demand system

$$Y_{it} = Y_{st} \left(\frac{p_{it}}{P_{st}} \right)^{\sigma_s} \exp(\tilde{\xi}_{it}), \quad (2)$$

- Revenue function

$$R_{it} = (Y_{it})^{\frac{\sigma_s+1}{\sigma_s}} (Y_{st})^{-\frac{1}{\sigma_s}} P_{st} \left(\exp(\tilde{\xi}_{it}) \right)^{-\frac{1}{\sigma_s}} \quad (3)$$

- Estimate production function to get TFP

$$r_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_{y_{st}} y_{st} + \delta_t D_t + \delta_s D_s + \omega_{it} + \varepsilon_{it} \quad (4)$$

- Recover TFP

$$\ln(TFP_{it}) = (r_{it} - \beta_l l_{it} - \beta_k k_{it} - \beta_m m_{it} - \beta_s y_{st}) \frac{\sigma_s}{\sigma_s + 1} \quad (5)$$

- Productivity is first-order Markov process

$$p(\omega_{it+1} | \{\omega_{it}\}_{\tau=0}^t, l_{it}) = p(\omega_{it+1} | \omega_{it})$$

- Investment demand function $i_{it} = i_t(k_{it}, m_{it}, \omega_{it})$ is strictly increasing in $\omega_{it} \Rightarrow$ productivity $\omega_{it} = h_t(k_{it}, m_{it}, i_{it})$

- Estimate the effect of services sector liberalization on TFP
- i a manufacturing firm, s manufacturing sector, j services sector

$$\begin{aligned} \ln(TFP_{it}) = & \alpha + \text{serv lib}_{it}\beta + \text{exporter}_{it}\gamma \\ & + \text{exporter}_{it} \cdot \text{serv lib}_{it}\delta + D_i\mu + D_{st}\lambda + \varepsilon_{it} \end{aligned}$$

where

$$\text{serv lib}_{it} = \sum_j a_{ijt} \cdot \text{index}_{jt} \quad (6)$$

O-P estimation of production function

	ln(K)		ln(L)		ln(M)		ln(Y)	Firms	N
	β_K	α_K	β_L	α_L	β_M	α_M	β_s		
Food and Tobacco	0.043*	0.043	0.204***	0.204	0.751***	0.752	0.001	2567	11253
	(0.018)		(0.014)		(0.012)		(0.024)		
Textile and Leather	0.107***	0.104	0.445***	0.434	0.469***	0.458	-0.025	816	3104
	(0.029)		(0.025)		(0.019)		(0.045)		
Wood and Paper	0.052	0.064	0.154***	0.189	0.712***	0.876	0.187*	513	2025
	(0.029)		(0.026)		(0.035)		(0.090)		
Printing	0.084***	0.079	0.402***	0.377	0.497***	0.467	-0.065	848	3363
	(0.023)		(0.033)		(0.021)		(0.053)		
Coke, chemistry	0.107**	0.118	0.156***	0.172	0.697***	0.767	0.091**	798	3662
plastics	(0.036)		(0.019)		(0.027)		(0.030)		
Non-metallic minerals	0.041	0.040	0.170***	0.166	0.784***	0.764	-0.026	758	3269
	(0.027)		(0.021)		(0.016)		(0.042)		
Metallurgy	0.074**	0.079	0.179***	0.192	0.670***	0.717	0.066	747	2999
	(0.028)		(0.030)		(0.043)		(0.035)		
Machinery and	0.025	0.024	0.365***	0.355	0.570***	0.554	-0.029	1033	4291
equipment	(0.021)		(0.021)		(0.022)		(0.030)		
High-tech machinery	0.060	0.061	0.207***	0.209	0.594***	0.600	0.010	705	3111
	(0.037)		(0.032)		(0.020)		(0.055)		
Vehicles and transport	-0.015	-0.017	0.279***	0.314	0.551***	0.620	0.111*	305	1355
	(0.050)		(0.057)		(0.051)		(0.053)		
Furniture and others	0.095*	0.090	0.312***	0.294	0.536***	0.505	-0.061	555	2159
	(0.038)		(0.042)		(0.041)		(0.075)		

- Within a firm effects
 - An increase in services liberalization index by a standard deviation leads to a 9 percent increase in productivity among manufacturing firms.
 - A standard deviation increase in the foreign presence in services sector leads to a 5.5 percent increase in productivity.
 - Effect is more pronounced for domestic and small firms.
 - Allowing services liberalization dynamically influence productivity generates even higher productivity gains.
- Industry effects (Melitz, 2003)
 - Effect is stronger at industry level
 - Low productive firms are more likely to exit.

Key results

	(1)	(2)	(3)	(4)	(5)	(6)
A. Main results						
Serv. lib.	0.135*** (0.014)	0.137*** (0.014)	0.127*** (0.016)			
Serv. lib. (FDI)				0.082*** (0.019)	0.083*** (0.019)	0.065** (0.020)
Exporter		0.100*** (0.011)	0.091*** (0.012)		0.098*** (0.011)	0.083*** (0.013)
Serv. Lib. × Exporter			0.028 (0.025)			0.049 (0.031)
R^2	0.65	0.66	0.66	0.64	0.65	0.65
B. Main results. IV						
Serv. lib.	0.153*** (0.015)	0.155*** (0.015)	0.144*** (0.017)			
Serv. lib. (FDI)				0.106*** (0.013)	0.108*** (0.013)	0.099*** (0.015)
Exporter		0.100*** (0.011)	0.089*** (0.012)		0.100*** (0.011)	0.091*** (0.012)
Serv. Lib. × Exporter			0.033 (0.028)			0.027 (0.024)
R^2	0.65	0.66	0.66	0.65	0.65	0.65
Firms	11057	11057	11057	11057	11057	11057
N	40440	40440	40440	40440	40440	40440

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Dependent variable is $\ln(TFP)$ estimated by Olley-Pakes procedure. Robust standard errors are reported in parentheses. Each estimation is performed with industry-time cross-effects and firms' fixed effects, which are not

Sub-samples

	(1)	(2)	(3)	(4)	(5)	(6)
	2001-2004	2005-2007	Domestic	Foreign	Small	Large
Serv. lib.	0.146*** (0.021)	0.115*** (0.028)	0.131*** (0.016)	0.151 (0.082)	0.167*** (0.024)	0.102*** (0.019)
Exporter	0.113*** (0.016)	0.031 (0.021)	0.084*** (0.012)	0.125* (0.055)	0.086 (0.044)	0.075*** (0.011)
Serv. Lib. × Exporter	0.018 (0.035)	0.043 (0.049)	0.043 (0.029)	-0.056 (0.082)	0.145 (0.094)	0.019 (0.024)
Firms	8813	8174	10444	948	5752	7290
N	25710	14730	37418	3022	12041	28399
R ²	0.60	0.74	0.64	0.76	0.60	0.69

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Column (1) is estimated for 2001-2004. Column (2) is estimated for 2005-2007. Column (3) is estimated for domestic firms with share of FDI less than 10 percent. Column (4) is estimated for foreign-owned firms, with share of FDI above 10 percent. Column (5) is estimated for firms with employment below 50 workers. Column (6) is estimated for firms with employment 50 workers and above

- The estimated model

$$\ln(w_{it}) = \alpha + \ln(TFP_{it})\beta + exporter_{it}\gamma + D_s\mu + D_t\lambda + D_r r + \varepsilon_{it} \quad (7)$$

- 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. The index is computed according to the following formula

$$serv\ lib^m_{it} = \sum_j a_{ijt} \cdot m_{jt} \quad (8)$$

Wages and productivity

	TFP				Labor productivity			
	(1) OLS	(2) FE	(3) IV	(4) IV lagged	(5) OLS	(6) FE	(7) IV	(8) IV lagged
Productivity measure	0.259*** (0.006)	0.137*** (0.007)	0.081** (0.025)	0.114*** (0.026)	0.226*** (0.002)	0.166*** (0.003)	0.029 (0.030)	0.077** (0.029)
Exporter	0.121*** (0.006)	0.044*** (0.007)	0.159*** (0.009)	0.133*** (0.003)	0.011* (0.005)	0.030*** (0.007)	0.167*** (0.020)	0.133*** (0.004)
$\ln(L_{it})$	0.131*** (0.002)	0.029*** (0.007)	0.122*** (0.003)	0.123*** (0.008)	0.191*** (0.002)	0.078*** (0.005)	0.121*** (0.004)	0.116*** (0.017)
Constant	-0.079*** (0.021)	0.284** (0.094)	0.171*** (0.034)	0.928*** (0.034)	-0.512*** (0.014)	1.258*** (0.083)	0.221*** (0.066)	0.896*** (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

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. 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: Wages and productivity

Robustness checks

	(1)	(2)	(3)	(4)	(5)	(6)
	Basic	Private	Urban	Large	Domestic	Single-plant
$\ln(TFP_{i,t-1})$	0.114*** (0.026)	0.130*** (0.025)	0.112*** (0.028)	0.155*** (0.035)	0.083** (0.027)	0.111*** (0.027)
$\ln(L_{i,t-1})$	0.133*** (0.003)	0.142*** (0.003)	0.109*** (0.004)	0.088*** (0.004)	0.136*** (0.003)	0.137*** (0.003)
$Exporter_{i,t-1}$	0.123*** (0.008)	0.120*** (0.009)	0.095*** (0.010)	0.110*** (0.009)	0.105*** (0.008)	0.123*** (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: Wages and productivity: sub-samples

- Aggregate firm level variables to the level of industry/region (weighted average and standard deviation)
- Accounts for reallocation of market shares, exit, and entry

Industry: Services liberalization and average wage

	(1)	(2)	(3)	(4)
Services liberalization	1.243*** (6.32)	1.249*** (6.64)	1.249*** (6.62)	1.216*** (6.38)
Mean ln(TFP)		-0.352*** (-3.72)	-0.354*** (-3.62)	-0.380*** (-3.80)
Share of exporters			0.0176 (0.08)	0.131 (0.53)
Mean ln(L)				-0.118 (-1.21)
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 $\ln(\text{wage})$ in industry i at time t . Includes industry fixed-effects

Table: Services liberalization and average wage across industries

Industry: Services liberalization and dispersion of wages

	(1)	(2)	(3)	(4)
Services liberalization	-0.267*** (-4.64)	-0.306*** (-5.46)	-0.307*** (-5.47)	-0.308*** (-5.46)
Std. dev TFP		0.119*** (3.77)	0.123*** (3.80)	0.126*** (-3.80)
Std. dev ln(L)			-0.027 (-0.57)	-0.028 (-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 $\ln(\text{wage})$ in industry i at time t . Includes industry fixed-effects

Table: Services liberalization and standard deviation of wages across industries

Region: Services liberalization and average wage

	(1)	(2)	(3)	(4)
Services liberalization	0.250*** (9.41)	0.269*** (10.16)	0.263*** (10.01)	0.273*** (10.40)
Mean ln(TFP)		-0.109*** (-6.87)	-0.111*** (-7.06)	-0.112*** (-7.19)
Share of exporters			0.203*** (7.99)	0.176*** (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 $\ln(\text{wage})$ in region r at time t .

Table: Services liberalization and average wage across regions

Region: Services liberalization and dispersion of wages

	(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 $\ln(\text{wage})$ in region r at time t .

Table: Services liberalization and standard deviation of wages across regions

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- Services liberalization increase productivity on manufacturing firms
- Wages respond positively to increase in productivity
- Services liberalization is associated with increased wages and reduced inequality of wages within industry/region

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