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DISCUSSION PAPER SERIES

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of manufacturing firms: evidence from
Ukrainian firm-level data**

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DP# 45

December 2011

Impact of services liberalization on productivity of manufacturing firms: evidence from Ukrainian firm-level data

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December 5, 2011

Abstract

This paper brings new evidence on the impact of services liberalization on performance of manufacturing firms. Using a unique database of Ukrainian firms in 2001-2007, we utilize an external push for liberalization in services sector as a source of exogenous variation to identify the impact of services liberalization on total factor productivity (TFP) of manufacturing firms.

Results indicate that a standard deviation increase in services liberalization is associated with a 9 percent increase in TFP. Allowing services liberalization to dynamically influence TFP through the investment channel leads to even higher effect. The effect is robust to different estimation methods and to different sub-samples of the data. In particular, it is more pronounced for domestic and small firms.

Key words: services liberalization, productivity, trade

JEL codes: F14, G28, L80

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1 Introduction

In 2000's, services sector in transition countries experienced rapid development due to major regulatory changes. Deregulation allowed new firms to enter the market resulting in rapid expansion of services as a share of GDP. The focus of this paper is on analyzing the impact of those changes on productivity of manufacturing firms. This question has recently got considerable attention due to importance of services in global economy and due to the ongoing debates on the Doha Agenda (Hoekman et al., 2010). The literature documents a positive effect of services deregulation on productivity of manufacturing firms in the Czech Republic (Arnold et al., 2011) and in Chile (Fernandes and Paunov, 2011). Still, as pointed by Francois and Hoekman (2010), works that try to establish a causal link from services to increase in productivity, are plagued with the endogeneity problem and with the problem of disentangling the effect of services liberalization reform from the effect of other reforms. We look at the episode of services liberalization in Ukraine in 2001-2007, which 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.

We exploit rich data on Ukrainian manufacturing firms, which allows us to construct a firm-specific index of the services use intensity and interact it with sub-sector and time-varying indices of services liberalization provided by the European Bank for Reconstruction and Development (EBRD). We adopt the standard two-stage approach in the literature of estimating the effect of a policy change on productivity (Pavcnik, 2002; Javorcik, 2004; Amiti and Konings, 2007; Khandelwal and Topalova, 2011). At the first stage, we estimate the production function using the Olley-Pakes methodology (Olley and Pakes, 1996), controlling for demand shocks as suggested by De Loecker (2007b), to extract total factor productivity (TFP) of manufacturing firms. At the second stage, we regress TFP on the firm-specific index of services liberalization, controlling for firm-specific heterogeneity and market structure of manufacturing industries. As a new contribution, we also implement a one-stage procedure of estimating the effect of the services liberalization on productivity, which takes into account

a dynamic effect of liberalization on investment decisions and, as a result, on exit and entry of firms.

Using the standard method, we find that a standard deviation increase in our measure of services liberalization is associated with a 9 percent increase in productivity. The size of the effect is stronger than in previous studies, probably reflecting the fact that the Ukrainian services sector before the reform was less developed than in the Czech Republic and Chile. The effect is stronger for domestic and small firms, which makes services liberalization a very useful tool for local policymakers interested in promoting growth of domestic small and medium enterprises. Allowing for the dynamic effect of services liberalization on current investment decisions and on future productivity further reinforces the effect of services liberalization on productivity in manufacturing industries. We also document the uniformly positive but heterogeneous in size impact of the reform across manufacturing industries.

We find that the effect of the reform is stronger for more aggregated data, reflecting the two sources of increase in productivity at industry level. First, the reform increases *within* firm productivity as described in the previous paragraph. Second, the reform leads to exit of low productivity firms and induces entrance of new competitors due to the general equilibrium effect of liberalization (see Olley and Pakes, 1996; Melitz, 2003), which further increases industry productivity.

The structure of the paper is as follows. Section 2 places this study within the existing literature. Section 3 describes progress of the services sector liberalization in Ukraine in 2001-2007 and its impact on services sector. Section 4 discusses data, methodology and results. Section 5 concludes.

2 Services liberalization and productivity in manufacturing

Competitiveness of manufacturing firms in open economy hinges on availability of low-cost, high-quality producer services (Francois and Hoekman, 2010). Literature mentions several theoretical links from services liberalization to growth in productivity. Increased specialization of producer services leads to gains from trade in services due to increased variety and expanded markets (Markusen, 1989). Lower price, better quality, and wider choice of services allow more complex organization of a manufacturing firm through further fragmentation of production activities. In turn, fragmentation of production requires support from internationally competitive transportation, communication, professional and financial services providers (Deardorff, 2001). Higher variety of services also generates knowledge, increase its diffusion and exchange (Burgess and Venables, 2004). Outsourcing of services by productive firms in non-stagnant sectors results in more efficient factor allocation that expands output and production (Oulton, 2001).

Since services are often a 'margin' sector, 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 and Hoekman, 2010). Competition and further specialization in professional services could reduce transaction and contracting costs, which are quite substantial. Lower transaction costs, in turn, encourage more outsourcing activities and arm-length trade (Williamson, 1973).

Mounting empirical evidence shows a positive impact of services deregulation on productivity in downstream manufacturing industries. Arnold et al. (2011) establish a positive link between TFP of manufacturing firms and liberalization of the services sector by analyzing the impact of liberalization of services on the performance of approximately ten thousand manufacturing firms in the Czech Republic in 1998-2003. The link is stronger for the firms that use services inputs more intensively. A standard deviation increase in the foreign presence in services is associated with a 3.8 percent increase in TFP. Fernandes and Paunov (2011) find that 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. Deregulation and liberalization policies that increase competition among intermediate services providers are linked to increased export competitiveness for high-tech industries (Fink et al., 2005).

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 by Francois and Hoekman (2010), the liberalization of 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 a particular reform that was a part of the broader reform package. With this regard, investigation of liberalization of services in Ukraine brings some advantages because the reform package was very limited and the effect of the EU integration was not present.

3 Services liberalization in Ukraine

Services sector in Ukraine

Services sector has been generally neglected under the central planning (Ofer, 1973). Overemphasis on the accelerated development of the producer goods industry, as the main driver

of economic growth, led to crowding out of investment in services connected to final consumption (retail trade, hotels and restaurants, personal services). Organization of central planning and abolishing of private ownership of productive assets resulted in underdevelopment in wholesale trade, financial and business services. For instance, the state-owned banking system and central planning of investment decisions resulted in only 1 percent of employment allocated to banking and insurance (Bićanić and Škreb, 1991).

Transition from the centrally-planned to market-based economic system required larger and better developed services sector, which has been growing quite impressively. Figure 1 reports dynamic of the services sector and financial and business sub-sector as the share of GDP of Ukraine in 1991-2009. By 2007, the share of services in the Ukrainian GDP has reached 42 percent. Still, the share was well below the average for the middle income countries, which was equal to 60 percent in 2007 (Francois and Hoekman, 2010) and much lower than the average for the EU countries, which had reached 65.5 percent in 2007¹.

The whole period could be split into two sub-periods. Ukraine has entered its independence in 1991 with the share of services to GDP of 20.5 percent, with only 5.5 percent attributed to financial and business services. In the first decade since the independence, the services sector grew primarily due to expansion of telecommunication, retail and wholesale trade sub-sectors. Between 1991 and 2000, the share of financial and business services increased only marginally. Between 2001 and 2009, on the other hand, the financial and business services expanded from 6.7 to 18.8 percent of GDP.

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

¹The WTO database on services reports the profile of the EU services sector in 2007.

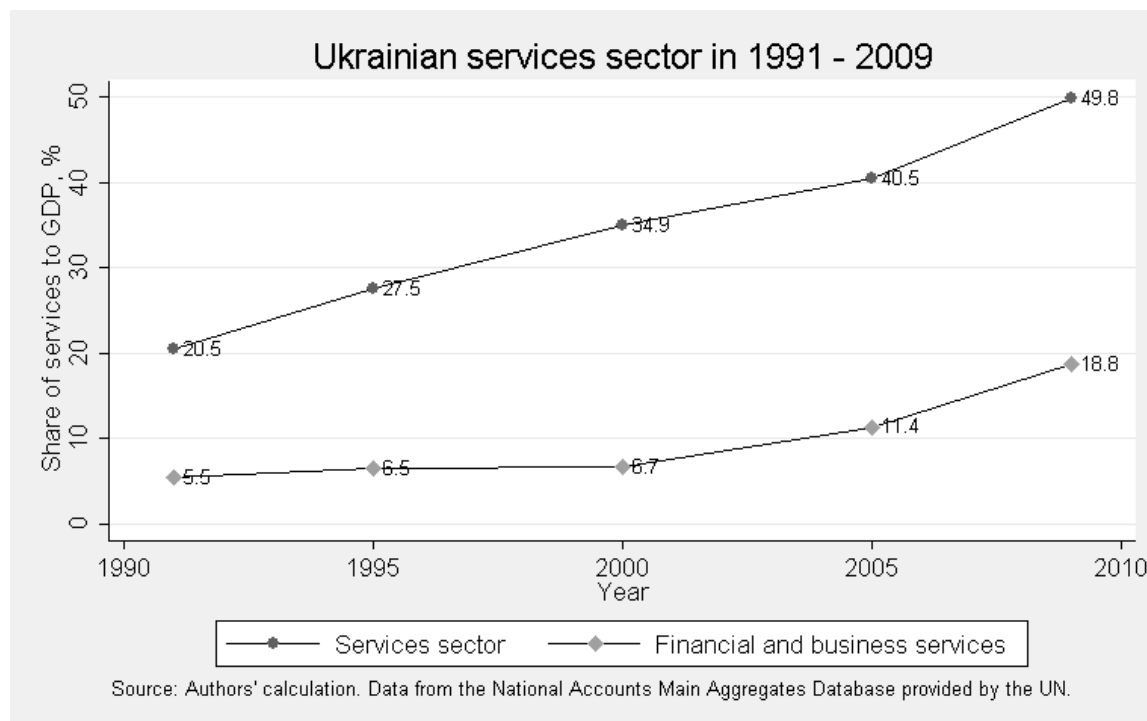


Figure 1: Evolution of services in Ukraine in 1991-2009

Notes: Data from the the National Accounts Main Aggregates Database provided by the UN.

president L. Kuchma has “instructed his government to speed up all technical work related to accession negotiations”². 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.

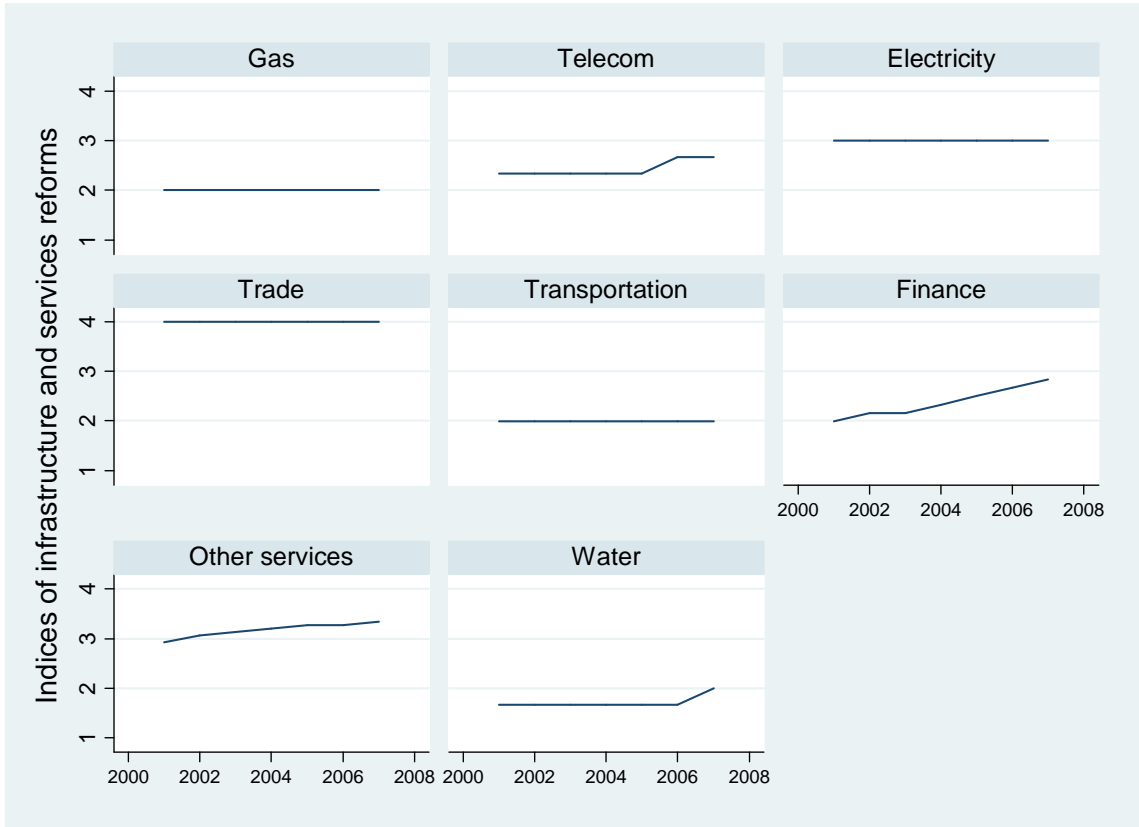
In telecommunication services, “Law on Telecommunications” of November 2003 provided the possibility for any legal person in Ukraine to operate, service or own telecommunications networks. A National Committee for Communication Regulation (NCCR), established according to the law, became the regulatory authority in telecommunications which made the

²Report of the working party on the accession of Ukraine to the world trade organization, 25 January 2008, WT/ACC/UKR/152

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 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 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.

The evidence on legislative improvements in the services sector regulations are supported by improvements in EBRD indices of services. According to Figure 2, reporting the progress of Ukraine in reforms of the services sub-sectors, Ukraine has substantially liberalized services in a number of the services sub-sectors. The market access has been improved and the barriers to entry considerably reduced in financial, telecommunication, and business services.

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 has been made. A noticeable exception that illustrates the rule was the process of harmonization of rail transportation tariffs that began in April 2005 after some WTO members asked Ukraine to apply railway tariffs in conformity with the WTO obligations. By June 2007, railway tariffs for most commodities have been equalized. In infrastructure sub-sectors, a state program for reforming and development



Notes: The progress of reforms in infrastructure and services is based on EBRD indices of infrastructure and transition indicators. Mapping from EBRD indices to services sub-sectors is discussed in Appendix. Progress of reforms in Gas sub-sector is based on the index for Gas sector developed by Institute of Economic Research which is compatible with EBRD index by methodology and scale. Other services category includes business services, hotels and restaurants, real estate, rent, information technologies, research and development

Figure 2: Services sub-sectors liberalization in Ukraine in 2000-2009

of utilities in 2005-2010 has been accepted in 2004. The program foresaw dissolution of monopolies operating in the utilities sub-sectors in the long run, but the actual progress of the de-monopolization has been very limited.

In parallel with the services liberalization, the WTO negotiations also led to further liberalization of trade in goods. As mentioned earlier, it could have created a problem of disentangling the effects of services liberalization on productivity from the effect of trade liberalization, which is positively linked to an increase in productivity in the literature (Pavcnik, 2002; Amiti and Konings, 2007; Khandelwal and Topalova, 2011). However, by 2001 Ukraine has already substantially liberalized its trade in goods. The average MFN tariff of Ukraine in 2002 was 7 percent and declined to 4.7 percent in 2008³. The view that the effect of trade liberalization for Ukraine had a limited impact can be further backed by the results of a computable general equilibrium analysis of the potential gains of WTO accession provided by Rutherford et al. (2005), who concluded that more than 70 percent of welfare gains of the WTO accession for Russia – an economy that closest to Ukraine in many respects – would come from liberalization of services. Taking into account the similarities of two economies and the fact that Russia is less trade-liberalized relative to Ukraine⁴, it is reasonable to assume that the effect of services liberalization for Ukraine was even more pronounced. Still, in the empirical analysis we control for the effect of exporting on productivity and interact it with the effect of services liberalization to control for potential complementarities.

Performance of services in 2001-2007

Liberalization of Ukrainian services sector in 2001-2007 was accompanied by increased share of output produced by private and foreign-owned firms. The privatization process was limited by the fact that, by 2001, most services sub-sectors in Ukraine had already had a high share of output produced by private firms, including more than 90 percent of output produced by the private firms in retail trade, financial, insurance, and business services sub-sectors.

³Data on MFN tariffs are from UNCTAD - TRAINS (Trade Analysis and Information System) database.

⁴The average Russian MFN tariff in 2002 was 9.6 percent.

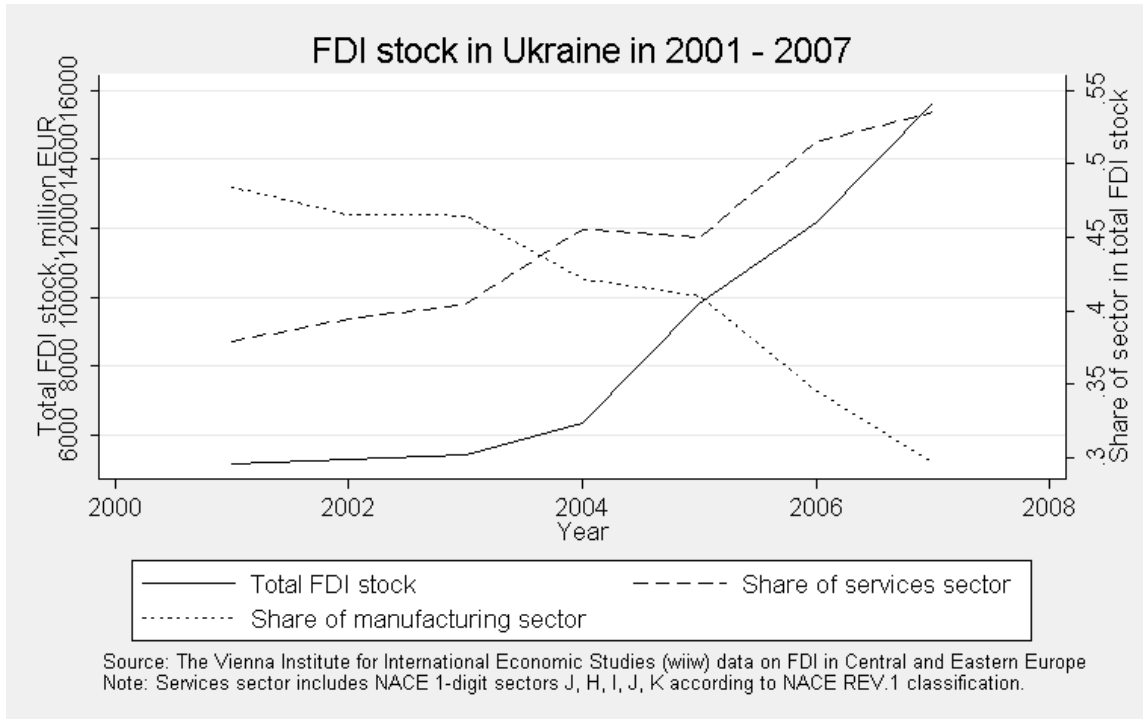


Figure 3: FDI stock in Ukraine in 2001-2007

Utilities, land transport, and supporting transport activities sub-sectors, on the other hand, were largely state-owned in 2001 and remained state-owned in 2007. The period has been characterized by a surge of FDI in services sector. Figure 3 shows that in 2001, 48 percent of inward FDI stock in Ukraine was in manufacturing. By 2007, the share of FDI stock in services sector (excluding utilities) had reached 53 percent, while the share of FDI stock in manufacturing had declined to 30 percent. As a result, the output produced by foreign-owned services providers⁵ has been growing in almost all services sub-sectors, increasing from 5 percent of services sector output in 2001 to 11 percent in 2007.

Labor productivity in services sector more than doubled between 2001 and 2007. What factors correlate with productivity of services firms? Table 1 reports labor productivity “premia” for services sector firms depending on size, ownership, exporter status, sub-sector,

⁵Foreign-owned services providers are defined as firms with at least 10 percent of foreign ownership.

and year. The table reports the point estimates of the coefficients of the following regression

$$\begin{aligned} \ln(Y_{it}/L_{it}) = & \alpha + \beta \cdot FDIshare_{it} + \gamma \cdot Exporter_{it} + \\ & + \zeta \cdot \ln(L_{it}) + \theta D_j + \vartheta D_t + \delta D_r + \epsilon_{it} \end{aligned} \quad (1)$$

where Y_{it} is value added of services sector firm i in year t deflated by the sub-sector specific price deflator, L_{it} is the firm's employment, $FDIshare_{it}$ is the share of the equity owned by foreigners, $Exporter_{it}$ is the dummy variable taking one if the firm exports and zero otherwise, and D_j , D_t , and D_r are sub-sector, time, and region fixed effects. The regression is estimated by the ordinary least square; significance levels are reported based on robust standard errors. Large services sector firms with foreign ownership and export activities have the highest labor productivity. Elasticity of labor productivity with respect to size is 0.11. Firms with 10 percent higher foreign ownership are also 9.2 percent more productive. Exporting services firms have 206 percent higher value added per worker. There is substantial heterogeneity of services firms across sub-sectors. For instance, post and telecommunications are three times more productive, while air transport is 77 percent more productive than electricity, gas, and steam sub-sector.

The evidence on opening up of services to foreign competition and on improvement in performance of services providers support our claim about substantial regulatory changes in Ukrainian services sector and give us a source of variation in services sector to analyze the impact of the deregulation on performance of manufacturing firms. The rest of the paper analyzes this question in more details.

Variable	Coefficient	Variable	Coefficient
ln(Employment)	0.11**	Insurance	1.06**
FDI share [0,1]	0.92**	Auxiliary fin. activities	0.40**
Exporter, Yes=1	1.12**	Real estate activities	0.19**
Sub-Sector. Base = Electricity, gas, and steam		Renting of equipment	0.43**
Water	-1.03**	IT	0.50**
Sale of motor vehicles	1.59**	R & D	0.14**
Retail trade	1.13**	Other services	0.42**
Hotels and restaurants	-0.39**	Year, Base = 2001	
Land transport	0.10**	2002	0.12**
Water transport	1.03**	2003	0.23**
Air transport	0.57**	2004	0.38**
Auxiliary transp. activities	0.78**	2005	0.52**
Post & telecom	1.12**	2006	0.62**
Financial intermediation	0.83**	2007	0.72**
N=501797			

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

Notes: Table reports labor productivity premium conditional on size, foreign ownership, sub-sector, and year. Regional fixed effects are included but not reported. Results are based on OLS regression with robust standard errors. The dependent variable is log of value added per worker deflated by sub-sector specific price deflator.

Table 1: Labor productivity premium depending on firm ownership, export status, sub-sector, and year

4 Data, methodology, and results

4.1 Sample

The data for the study comes 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 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 firm-specific service liberalization index, is submitted by only relatively large firms, our sample is restricted to the firms with above 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

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

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 one top 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 the Appendix. All variables were deflated by the appropriate price deflators available from the National Statistical Office. The descriptive statistics for the sample are presented in Table 2.

4.2 Methodology

Following an insight from Rajan and Zingales (1998), who use variation in industries' financial dependency and countries' financial development to investigate the effect of financial liberalization on economic growth, several recent papers adopted this idea to investigate effects of trade (Amiti and Konings, 2007; Pavcnik, 2002; Khandelwal and Topalova, 2011) and services (Arnold et al., 2011; Fernandes and Paunov, 2011) liberalization on productivity. We follow a similar identification strategy. The strategy relies on assumption that manufacturing firms that use services more intensively gain more from services liberalization. For each period t , we construct a firm-specific index of services liberalization by interacting a sub-sector-specific index of services liberalization with firm- and sub-sector-specific intensity of services use. We further look at the *within* firm variation in TFP and relate it to the changes in the firm-specific index of services liberalization. To recover the TFP measure, we estimate the production function for each manufacturing industry (1-digit NACE classification) by the Olley-Pakes procedure (Olley and Pakes, 1996), controlling for sub-industry-specific demand and price shocks as suggested by De Loecker (2007b). 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. If this assumption fails, we still are able to estimate the impact of services liberalization on productivity because our identification strategy relies on within firm variation in services intensity and time invariant differences in technology are not important.

Technology and market structure

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

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

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 break down 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

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

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

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

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

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

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 from $\sigma_s = -1/\beta_s$. 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

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

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

$$\xi_{it} = \xi_t + \xi_g + \tilde{\xi}_{it}, \quad (7)$$

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 $\tilde{\xi}_{it}$ is an idiosyncratic shock. Plugging in (7) in (6), we have

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

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 value of one if a firm i operates in sub-industry g and zero otherwise. $\varepsilon_{it} = \tilde{\xi}_{it} + u_{it}$ is the error term which is not correlated with inputs and productivity.

We estimate (8) by the Olley-Pakes methodology, which is described in the appendix. The point estimates of the coefficients of the production function are presented in Table 3. Total factor productivity net of price and demand effects is recovered as

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

We do not factor out sub-industry and time effects because we control for those effects in the second stage of the estimation described in the next subsection.

4.3 Main Results

Impact of services liberalization on TFP of manufacturing firms

The estimated TFP is further regressed on the index of services liberalization that is firm-specific, reflecting the variation in firm-level intensity of usage of various services inputs. The index is computed according to the following formula

$$serv\ lib_{it} = \sum_j a_{ijt} \cdot index_{jt} \quad (10)$$

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 . Mapping from the EBRD indices to services sub-sectors is described in the appendix.

The constructed index of services liberalization takes into account liberalization of services sub-sectors and weights more heavily services sub-sectors used by the firm i more intensively. The assumption here is that the liberalization of the sub-sector used by the firm more

	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 equipment	0.025	0.024	0.365***	0.355	0.570***	0.554	-0.029	1033	4291
	(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)		

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 and production function parameters $\alpha = \frac{\sigma_s}{\sigma_s+1}\beta$, where $\sigma_s = -1/\beta_s$ for Ukrainian manufacturing firms for 2001-2007. Each row in the table represents Olley-Pakes estimation of production function for eleven manufacturing industries, defined according to NACE Revision 1 classification. Each estimation is performed with year and sub-industry dummies, which are not reported for brevity.

Table 3: Estimation of production function by Olley-Pakes procedure

intensively is more important and has a higher impact on firm's performance. We also control for export status of the firm by including an indicator variable that takes value of 1 if the firm i has exported at time t . We control for industry-time specific fixed effect to take into account unobservable industry characteristics such as market structure, cost and demand shocks, and technological changes. Finally, we include firm-specific fixed effects to control for unobservable managerial abilities and other firm-specific characteristics that can be correlated with intensity of services use and productivity. The estimated regression takes the following parametric form

$$\begin{aligned} \ln(TFP_{it}) = & \alpha + servlib_{it}\beta + exporter_{it}\gamma \\ & + exporter_{it} \cdot servlib_{it}\delta + D_i\mu + D_{st}\lambda + \epsilon_{it} \end{aligned} \quad (11)$$

where TFP_{it} is the firm's i level of total factor productivity at time t , $exporter_{it}$ is the dummy variable that takes value of one if the firm i exported in year t and zero otherwise, D_i are firm-specific fixed effects, and D_{st} are industry-time specific fixed effects capturing market structure of industry s , and industry-specific macroeconomic shocks at time t .

Results are presented in panel A of Table 4 in columns (1) - (3). In column (1), the $\ln(TFP)$ estimated by Olley-Pakes method is regressed on the index of services liberalization, controlling for firm's and industry-time fixed effects. Hence, we estimate *within* firm effect of liberalization on productivity, removing any impact of current market structure and demand shocks within the industry. The coefficient of the services liberalization is positive and significant. Increase in the index of services liberalization by a standard deviation is associated with 9 percent increase in productivity. In column (2), we add the export status of the firm to capture the fact that exporters are both more productive (see, for example, Bernard et al., 2003) and use services more intensively in order to coordinate their overseas activities. Inclusion of the export status only marginally changes the point estimate of the coefficient of the services liberalization. At the same time, we find that firms that change

	(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. \times Exporter			0.028 (0.025)			
Serv. Lib. (FDI) \times Exporter						0.049 (0.031)
Firms	11057	11057	11057	11057	11057	11057
N	40440	40440	40440	40440	40440	40440
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. \times Exporter			0.033 (0.028)			
Serv. Lib. (FDI) \times Exporter						0.027 (0.024)
Firms	11057	11057	11057	11057	11057	11057
N	40440	40440	40440	40440	40440	40440
R^2	0.65	0.66	0.66	0.65	0.65	0.65

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

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 reported for brevity.

Table 4: Services liberalization and total factor productivity in Ukraine in 2001-2007.

their status from non-exporters to exporters are about 10 percent more productive relative to firms that operate only domestically. In column (3), our preferred specification, we add an interaction between the exporter status and the services liberalization to see whether the exporters respond differently to services liberalization as discussed in the literature (Dear-dorff, 2001; Francois and Woerz, 2008; Francois and Hoekman, 2010). We find that exporters additionally gain in TFP due to services liberalization, but the effect is not significant.

Alternative measure of services liberalization

The EBRD measure of services liberalization can be criticized for being subjective, because the indices are based on experts' judgment. To check whether the subjectivity drives the result, we introduce an alternative measure of services sub-sector liberalization based on the share of employment of services providers with foreign ownership in total employment in the sub-sector⁶. This measure is an outcome based and it proxies the degree of openness of services sub-sectors to foreign competition. The FDI based index of services liberalization is computed as

$$serv\ lib(FDI)_{it} = \sum_j a_{ijt} \cdot FDIshare_{jt} \quad (12)$$

where $serv\ lib(FDI)_{it}$ is the firm-specific index of services liberalization, a_{ijt} is the share of input sourced from service sub-sector j in the total input of firm i at time t , and $FDIshare_{jt}$ is the share of labor of majority foreign-owned companies in sub-sector j at time t . The results with the alternative measure of services liberalization are presented in columns (4) - (6) of Table 4. In terms of the direction and significance of the effect of services liberalization, the results are similar to the results with EBRD indices. A standard deviation increase in the services liberalization measured by foreign presence is associated with an increase in productivity by 5.5 percent. Arnold et al. (2011) find that a standard deviation increase in foreign presence in the services sectors in the Czech republic is associated with a 3.8 percent

⁶A measure based on output produced by the foreign services providers gives very similar results.

increase in the productivity of manufacturing firms, which is in line with our findings.

Endogeneity issues

Industries may lobby the government to liberalize services. More productive firms that are larger and better politically connected have a stronger influence on the government's decision which services sub-sectors to liberalize. Hence, the positive link between services liberalization and productivity may be due to reverse causality. To address the concern, we instrument $index_{jt}$ and $FDIshare_{jt}$ by the log of the sub-sector specific outward services FDI of the EU to the rest of the world, $\ln(FDI_{jt})$ ⁷. The argument goes as follows. The EU has been a major bilateral negotiator over the WTO accession of Ukraine. We expect that the EU put more pressure on liberalization of those services sub-sectors in which there are large FDI outflows from the EU. Results of the first stage IV regression, presented in the appendix indicate the EU FDI outflows are good predictors for both the EBRD index of liberalization and for the FDI share of employment.

In the second stage we replace our indices of services liberalization with the indices of services liberalization instrumented with outward FDI in services sub-sectors and report the results in panel B of Table 4.

4.4 Sub-sample results

We further test robustness of our results by looking at sub-samples of data along the time, ownership and size dimensions. The results are presented in Table 5.

Services liberalization before and after 2005

We split the sample into two sub-periods – 2001-2004 and 2005-2007 – to control for possible effect of the political regime switch, because Ukrainian governments before and after the Orange revolution of 2005 represented interests of different financial and industrial groups.

⁷Data is available from Eurostat

	(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: Dependent variable is $\ln(TFP)$ estimated by Olley-Pakes procedure. Robust standard errors are reported in parenthesis. Each estimation is performed with year dummies, industry-time cross-effects, and firm fixed effects, which are not reported for brevity. 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

Table 5: Results for different sub-samples

Also, there was a constitutional reform that shifted political power from the president to the Parliament. The first period was characterized by a more coordinated legislative effort between the president and the Parliament, but the privatization process was non-transparent, resulting in poor investment climate⁸. In addition, the government has been indecisive on the integration strategy for the country. There was a discussion on benefits of EU vs. Commonwealth of Independent States (CIS) integration. The second period was characterized by the surge of FDI due to improvements in investment climate and clearly-stated strategy of integration into the EU structures. However, the legislative effort has been stalled due to less effective coordination between the branches of government.

The results of the baseline regression for the two sub-periods, presented in columns (1) and (2) of the table, indicate that the effect of services liberalization on productivity was positive and significant in both sub-periods, ruling out the possibility that our main result

⁸Privatization of the Kryvorozhstal, Ukraine's largest and most modern steelworks, illustrates the irregularities in pre-2005 privatization procedures. In 2004 it has been privatized for 800 million US dollars by Ukrainian oligarchs Akhmetov and Pinchuk in an auction that left out international bidders due to highly protectionist conditions of the tender. In 2005, the steelworks has been re-privatized by Arcelor Mittal for 4.8 billion US dollars.

was driven by the shift in the political environment. We also can not reject the test that the point estimates for the services liberalization were different in the two sub-periods.

Ownership type

We further split the sample into domestic- and foreign-owned firms, defining foreign ownership threshold at 10 percent . Since the foreign-owned firms often have better access to services from the international services providers, we expect that the services liberalization should have smaller impact on them. The results are presented in columns (3) and (4) of the table. Indeed, only the coefficient of services liberalization for the domestic sub-sample is significant. However, it should be noted that the coefficient for the foreign sub-sample is still positive and large in size. The loss in significance might be driven by a considerably smaller sample size of the foreign-owned firms.

Firm size

Finally, we split the sample into small and large firms, defining a small firm as the firm that employs less than 50 workers. We expect the small firms gaining more from the services liberalization because larger firms can produce some services internally (i.e. having a transportation or auditing departments), while small firms rely on external services providers more heavily. The results, presented in columns (5) and (6) of the table, indicate that the effect of the services liberalization on the small firms is about fifty percent larger. The result has an important policy implication that improved services encourage development of small and medium enterprises. A caveat to this conclusion is that small manufacturing firms are under-represented in our sample, because a considerable number of small manufacturing firms do not report their use of services and are excluded from the sample.

4.5 Robustness checks

One-stage method with exit depending on TFP

The literature, while giving advantage to the two-stage procedure of estimating the impact of policy change on TFP (Pavcnik, 2002; Amiti and Konings, 2007; Arnold et al., 2011), also utilizes a one-step approach (Fernandes and Paunov, 2008; Javorcik, 2004). As pointed out by De Loecker (2007b), the standard two-stage procedure of estimating the impact of liberalization on productivity implicitly assumes that services liberalization does not impact prices and variable inputs in production, is not related to returns to scale. Even more importantly, this approach does not allow liberalization to dynamically impact the evolution of productivity, which is crucial for exit decision by the firm. However, the findings presented in the previous subsections directly contradict these assumptions. In particular, increase in contemporaneous TFP due to services liberalization induces higher capital accumulation due to expectation of even higher TFP in the future. It also has an effect on exit decision.

To investigate how our results change if we allow services liberalization interact with variable inputs, investment, and exit, we implement a one stage procedure that simultaneously estimate parameters of the production function and the effect of services liberalization on productivity. We introduce two possible channels of influence of liberalization on TFP and exit. One of the channels comes from overall trade liberalization either due to selection process (Melitz, 2003) or due to learning by exporting (De Loecker, 2007a; Amiti and Konings, 2007). We control for this effect by including the export status as one of the variables that influences TFP either directly in the production function or indirectly through the selection process. The second channel, the one we are focused on, is from services liberalization to productivity.

We modify the model by changing the productivity process to depend on export status and services liberalization $\omega_{it} = h_t(k_{it}, i_{it}, export_{it}, servlib_{it})$. This create two effects: a contemporaneous effect on current level of productivity and the dynamic effect on future

productivity due to current investment decisions. While we capture the first effect in the two-stage procedure, the dynamic effect is ignored. The results of the one-stage estimation by manufacturing industries is presented in the panel B of Table 6 and compared with the results of the two-stage procedure by industries, presented in the panel A of the table. In general, the one-stage procedure estimations of the effect of services liberalization are higher relative to the two-stage, which is an indication of the dynamic interaction of services and export liberalization with productivity and choice of variable inputs. At the same time, the one stage procedure suffers from the fact that the services liberalization indicator is an endogenous variable because it depends on the choice of services inputs. Therefore, these results should be taken with care.

Industry level results and firm dynamics with exit depending on productivity

We expect that the effect of services liberalization on industry level productivity should be greater than the *within* effect on firm level productivity. Additional channels of increase in industry productivity works through exit of low productive firms and reallocation of capital, labor, and materials towards more productive firms, which expand their output and boost industry level productivity.

The services sector liberalization, which according to our results increases productivity of firms that use services more intensively, shifts the TFP distribution within an industry to the right. The size of the shift varies across firms – heavy services users gain more – and is exogenous to the firm. Analyzing the effect of the shift of productivity on exit and entry of firms and distribution of firms within the industry in the framework of the Melitz (2003) model brings the following conclusions: high productive firms that use services more intensively expand their output, revenues, and profits, while low productive firms exit the market. Therefore, *ceteris paribus*, services liberalization should lead to a higher aggregate productivity within the industry, which exceeds the effect for a particular firm in the industry,

A. Two-stage Olley-Pakes results by manufacturing industries

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Serv. Lib.	0.279*** (0.043)	0.085 (0.052)	0.239* (0.103)	0.235*** (0.025)	0.195* (0.083)	0.069 (0.054)	0.223*** (0.051)	0.231*** (0.049)	0.099 (0.066)	0.309*** (0.079)	0.366*** (0.066)
Exporter	0.156*** (0.018)	0.288*** (0.038)	0.167*** (0.048)	0.213* (0.086)	0.077 (0.068)	0.06 (0.035)	0.121* (0.057)	0.108*** (0.031)	0.249*** (0.049)	0.465*** (0.072)	0.200** (0.064)
Servlib × Exporter	0.118 (0.071)	0.104 (0.056)	0.034 (0.130)	-0.111 (0.077)	0.397 (0.206)	0.182* (0.087)	0.235 (0.195)	-0.005 (0.073)	0.146 (0.085)	-0.11 (0.105)	0.155 (0.159)
Firms	3011	1074	600	960	874	918	866	1258	816	343	662
N	11616	3728	1759	2826	3087	3516	3066	4592	2854	1323	2073

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

B. One-stage Olley-Pakes results by manufacturing industries

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Serv. Lib.	0.355*** (0.049)	0.160** (0.055)	0.324*** (0.086)	0.287*** (0.035)	0.256** (0.087)	0.138** (0.043)	0.205*** (0.055)	0.308*** (0.049)	0.173** (0.053)	0.329*** (0.050)	0.456*** (0.086)
Exporter	0.081*** (0.017)	0.262*** (0.039)	0.081 (0.043)	0.106 (0.084)	0.101* (0.042)	0.043 (0.032)	0.093* (0.046)	0.069* (0.032)	0.124** (0.039)	0.098 (0.063)	0.193** (0.065)
Servlib × Exporter	0.088 (0.077)	0.077 (0.054)	-0.090 (0.095)	-0.124* (0.061)	0.229 (0.175)	0.100 (0.056)	0.263 (0.175)	-0.103 (0.067)	0.107 (0.063)	-0.088 (0.075)	-0.051 (0.113)
$\ln(K)$	0.046 (0.024)	0.109** (0.039)	0.023 (0.035)	0.068 (0.047)	0.127* (0.064)	0.046 (0.032)	0.061* (0.026)	0.062*** (0.018)	0.028 (0.039)	-0.000 (0.043)	0.111* (0.046)
$\ln(L)$	0.185*** (0.015)	0.326*** (0.027)	0.117*** (0.025)	0.346*** (0.041)	0.082** (0.025)	0.157*** (0.028)	0.124*** (0.032)	0.329*** (0.027)	0.197*** (0.028)	0.280*** (0.054)	0.304*** (0.060)
$\ln(M)$	0.772*** (0.013)	0.532*** (0.024)	0.794*** (0.026)	0.547*** (0.034)	0.764*** (0.025)	0.823*** (0.019)	0.678*** (0.040)	0.639*** (0.021)	0.666*** (0.024)	0.638*** (0.047)	0.558*** (0.056)
$\ln(Y)$	0.019 (0.028)	-0.012 (0.048)	0.238** (0.086)	-0.056 (0.072)	0.056 (0.033)	0.044 (0.052)	0.091* (0.038)	-0.023 (0.033)	-0.012 (0.070)	0.079 (0.058)	-0.092 (0.088)
Log like.	6443***	1481***	768***	1017***	1792***	1793***	1563***	2255***	1461***	790***	916***
Firms	2567	816	513	848	798	758	747	1033	705	305	555
N	11253	3104	2025	3363	3662	3269	2999	4291	3111	1355	2159

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

Notes: Panel A reports point estimates of regression of $\ln(TFP)$, estimated by Olley-Pakes procedure, on services liberalization and export status. Robust standard errors are reported in parenthesis. Each estimation is performed with year dummies and industry fixed effects, which are not reported for brevity. Panel B reports point estimates of regression of $\ln(Sales)$ on services liberalization and export status, as well as revenue function parameters for Ukrainian manufacturing firms for 2001-2007. Each column in the table represents Olley-Pakes estimation of production function for eleven manufacturing industries, defined according to NACE Revision 1 classification. Each estimation is performed with year and industry dummies, which are not reported for brevity.

Table 6: One- and two-stage results by manufacturing industries

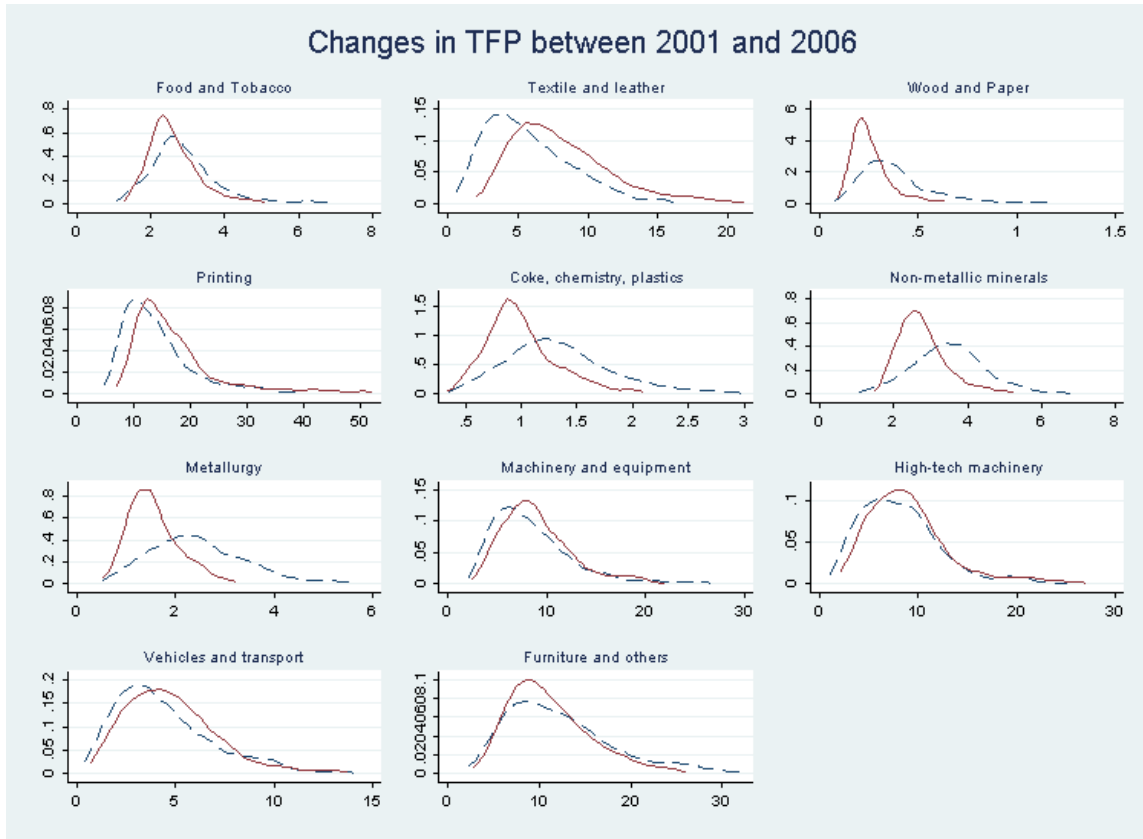


Figure 4: TFP in 2001 and 2006

Notes: Figure presents kernel density of TFP in 2001 (dashed line) and in 2006 (solid line) by each industry

and to higher dispersion of output, revenues, and profits.⁹

The industry productivity is defined as output-weighted average TFP of firms operating in the industry. The measure of TFP is taken from the baseline estimation of production function presented in Table 3. Figure 4 shows kernel densities of TFP for each manufacturing industry in 2001 and 2006¹⁰. The distribution has shifted to the right for Textile and Leather, Printing, High-tech machinery, Vehicles and transport. At the same time, productivity has shifted to the left in Food and tobacco, Wood and Paper, Coke, chemistry and plastics, Non-metallic minerals, and Metallurgy.

Industry level regressions, presented in Table 7 confirm our conjecture of large and positive

⁹The analysis is almost identical to the analysis of trade liberalization presented by Melitz. The important difference is that Melitz assumes that the distribution of productivity is constant over time, while we consider the case when the distribution shifts exogenously.

¹⁰We have chosen TFP in 2006 rather than in 2007, because the sample of firms in 2007 is much smaller and comparison of distributions in 2001 and 2007 might be misleading.

	(1)	(2)	(3)
Serv. Lib.	1.348*	0.446***	0.133*
	(0.483)	(0.086)	(0.061)
Exporter	3.114***	0.294	0.094
	(0.330)	(0.223)	(0.080)
Serv. Lib. \times Exporter	-1.241	-0.007	0.078
	(0.558)	(0.126)	(0.078)
Industries	11	102	238
N	77	498	1574

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

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

Table 7: Industry level results

impact of services liberalization on *within* industry productivity. Results are presented for industry-level aggregation in column (1), NACE 2 digit aggregation in column (2), and NACE 3 digit aggregation in column (3).

Finally, we estimate the effect of productivity, capital, and liberalization on probability of exit. We expect that services liberalization should encourage exit of low productive firms. We split the sample of firms according to their productivity into quartiles and report estimates of probit for firms in the first productivity quartile (low productive firms) and the fourth productivity quartile (high productive firms) in Table 8. Indeed, low productive firms are more likely to exit, when the services sector liberalizes. All other variables influence the probability of exit in the expected direction. More productive firms and firms with more capital are less likely to exit. Exporters are less likely to exit.

Alternative methods

There is inherent difficulty of and methodological debates on estimating production function (Akerberg et al., 2005; Van Biesebroeck, 2007), which is the crucial element of our empirical procedure. We try several alternative methods of estimation of the production function to reassure the robustness of our results, presented in Table 9. The estimation results of the two-stage Olley-Pakes procedure estimated on the pooled manufacturing sample (columns (1) and

	High productive firms	Low productive firms
$\ln(TFP_{i,t-1})$	-0.149* (0.069)	-0.103* (0.042)
$\ln(K_{i,t-1})$	-0.067*** (0.016)	-0.084*** (0.014)
$Serv.Lib_{i,t-1}$	0.082 (0.054)	0.215*** (0.052)
$Exporter_{i,t-1}$	-0.194* (0.087)	-0.271** (0.084)
$Serv.Lib_{i,t-1} \times Exporter_{i,t-1}$	-0.020 (0.090)	0.063 (0.134)
N	6300	8103
Log Likelihood	-773	-1608

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

Table 8: Exit

(2) of the table) is compared with the estimation results by several other methods. The one-stage Olley-Pakes procedure, analogous to the method presented in panel B of Table 6, but estimated on the pooled manufacturing sample is presented in column (3). Similarly to the results by manufacturing industries, the one-stage method estimate of services liberalization is considerably larger relative to the two-stage method. A one standard deviation in services liberalization is associated with 16 percent increase in productivity. The one-stage Levinsohn-Petrin (Levinsohn and Petrin, 2003) procedure, which treats the selection of materials to infer unobserved productivity, is presented in column (4). It also estimates the effect of services liberalization to be higher relative to the two-stage method. As results of OLS with firm fixed effects in column (5) and estimate in first differences in column (6) demonstrate, the much higher estimate of the effect by the one-stage OP and LP methods are not due to the inherent differences between the one- and two-stage methods, but due to the dynamic effects of services liberalization on exit and entrance of firms through the effect on future productivity. Finally, column (7) presents the Blundell-Bond estimate of the services liberalization effect (Blundell and Bond, 2000), which is smaller but still positive and significant.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	OP 2 stage		OP	LP	FE	Dif	BB
	1st stage	2nd stage					
Serv. Lib.		0.130*** (0.020)	0.314*** (0.018)	0.284*** (0.017)	0.100*** (0.016)	0.075*** (0.014)	0.049*** (0.008)
Exporter		0.075*** (0.012)	0.117*** (0.013)	0.097*** (0.011)	0.097*** (0.011)	0.095*** (0.010)	0.085*** (0.010)
Serv. Lib × Exporter		0.011 (0.025)	0.032 (0.031)	0.148*** (0.029)	0.040 (0.024)	0.029 (0.020)	0.034** (0.012)
Revenue function parameters							
ln(K)	0.054*** (0.008)		0.050*** (0.014)	0.134*** (0.020)	0.027*** (0.007)	0.035*** (0.008)	0.029*** (0.005)
ln(L)	0.272*** (0.009)		0.229*** (0.010)	0.242*** (0.011)	0.398*** (0.017)	0.414*** (0.017)	0.378*** (0.010)
ln(M)	0.635*** (0.009)		0.688*** (0.009)	0.569*** (0.047)	0.560*** (0.013)	0.505*** (0.011)	0.502*** (0.004)
ln(Y)	0.024* (0.011)		0.022 (0.015)	0.023 (0.013)	0.048*** (0.012)	0.033*** (0.009)	0.065*** (0.012)
ln($r_{i,t-1}$)							0.064*** (0.014)
Time	Yes	Yes	Yes	Yes	Yes	Yes	
Industry	Yes		Yes	Yes	Yes	Yes	
Time × Industry		Yes					
Firm		Yes			Yes		
Firms	9411	11057	9411		11057		
Obs.	41127	40440	41127	40440	40440	29041	32306

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Table reports point estimates of regression of $\ln(TFP)$ (column (2)) or $\ln(Sales)$ (columns (3)-(7)) on services liberalization and export status, as well as revenue function parameters for Ukrainian manufacturing firms for 2001-2007. Production function in all models is estimated for all manufacturing industries pooled in one regression. Columns (1) and (2) are estimated by Olley-Pakes two-stage procedure. Column (3) is estimated by Olley-Pakes one-stage procedure. Column (4) is estimated by Levinsohn-Petrin procedure. Column (5) is estimated by OLS with firm fixed effects. Column (6) is estimated by OLS in first differences. Column (7) is estimated by Blundell-Bond. Standard errors, reported in parentheses, are either bootstrapped for OP and LP methods, or robust for all other methods.

Table 9: Alternative methods

5 Conclusions

This paper finds that liberalization of services has a positive effect on productivity of manufacturing firms. We consider an episode of a limited liberalization in Ukraine, which primarily targeted services sector as a prerequisite to the WTO accession. These particular features of the episode allow to separate the effect of services liberalization from the effects of other re-

forms and to reduce concerns on the endogeneity of the reform. We pay particular attention to unbiased estimation of TFP by employing Olley-Pakes methodology of estimation of the production function with important innovations laid out in De Loecker (2007b). In addition, we compare one- and two-stage methods of estimation of the effect of liberalization and find that the two-stage procedure biases the effect of policy downwards by failing to account for the effect of the policy on exit and on the variable inputs mix.

According to more conservative results from the two-stage estimation procedure, a standard deviation increase in the services liberalization boosts the productivity by 9 percent. An alternative measure of the services liberalization, based on FDI penetration in services sector, indicates that a standard deviation increase in the FDI based index is associated with 5.5 percent increase in productivity. The size of the effect is higher than in other studies (Arnold et al., 2011; Fernandes and Paunov, 2011), probably reflecting the fact that the initial conditions in the services sector in Ukraine were much worse than in the Czech Republic or Chile. The effect is stronger for domestic firms and for small firms, which gives the policymakers a nice tool to support and develop small and medium size domestic enterprises.

Another important finding is much stronger estimates of the effect by the one-stage method. It shows that the services liberalization has an important effect on exit decision and on dynamics of TFP through its impact on the investment decisions. This conclusion is supported by the fact that the effect of services liberalization is stronger at industry level and the exit decision of low productive firms strongly depends on our measure of services liberalization. However, the one-stage method introduces endogeneity problem which is not resolved in this paper. We leave this task for future research.

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6 Appendix

6.1 Olley-Pakes procedure

Unobserved productivity follows an exogenous first order Markov process $p(\omega_{it}|I_{it}) = p(\omega_{it}|\omega_{it-1})$, where I_{it} is the firms information set at time t . Capital accumulated by firms is determined as $k_{it} = k_{it-1}(1 - \delta) + i_{it-1}$, where i is log of investment. Solving a dynamic problem of profit maximization yields the following investment function

$$i_{it} = i_t(k_t, \omega_{it}). \tag{13}$$

Assuming (13) is strictly increasing in ω_{it} , we invert it to generate

$$\omega_{it} = h_t(k_{it}, i_{it}). \quad (14)$$

Substituting (14) into (8) yields

$$r_{it} = \beta_l l_{it} + \beta_m m_{it} + g(k_{it}, i_{it}) + \beta y_{gt} + \delta_t D_t + \delta_g D_g + \tilde{u}_{it}, \quad (15)$$

where

$$g(k_{it}, i_{it}) = \beta_k k_{it} + h_t(k_{it}, i_{it}).$$

Clearly, β_k can not be identified from (15), but β_l and β_m are identified, using a third-order polynomial approximation of $g(k_{it}, i_{it})$. The capital coefficient is further identified from

$$E[r_{it}|I_t, \chi_{it} = 1] = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta y_{gt} + \delta_t D_t + \delta_g D_g + \psi(\Pi_{it}, \omega_{it-1})$$

or

$$r_{it} = E[r_{it}|I_t, \chi_{it} = 1] + e_{it}. \quad (16)$$

where we preliminary estimate the survival probability, $\chi_{it} = 1$, given by

$$Pr\{\chi_{it} = 1|\omega_{it}(k_{it}), I_{it-1}\} = \varphi(k_{it-1}, i_{it-1}) = \Pi_{it}$$

and approximate $\psi(\Pi_{it}, \omega_{it-1})$, using predicted probability of survival $\widehat{\Pi}_{it}$ and a third degree linear approximation of $\omega_{it-1} = h_{t-1}(k_{it-1}, i_{it-1})$.

	(1)	(2)
	$index_{jt}$	$FDIshare_{jt}$
$\ln(FDI_{jt})$	0.156*** (0.041)	0.013** (0.005)
Constant	0.466 (0.534)	-0.133* (0.063)
N	32	32
R^2	.32	.23

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

Table 10: IV. First stage

6.2 IV first stage

We regress our services sub-sector specific indicators of liberalization $index_{jt}$ and $FDIshare_{jt}$ on the log of services sub-sector specific outward FDI from the EU towards the rest of the world, $\ln(FDI_{jt})$. The results are presented in Table 10.

We further construct $\overline{serv\ lib}_{it} = \sum_j a_{ijt} \cdot \overline{index_{jt}}$ and $\overline{serv\ lib(FDI)}_{it} = \sum_j a_{ijt} \cdot \overline{FDIshare_{jt}}$, where $\overline{index_{jt}}$ and $\overline{FDIshare_{jt}}$ are linear predictions taken from the first stage regressions.

6.3 Mapping EBRD indices to services sub-sectors

We have constructed two indices of services liberalization: one that includes utilities and retail trade and another that does not. All results in the paper are reported for the index that includes transportation, telecom, financial services, and business services. The results for the index that includes utilities are very similar.

Index with utilities and retail trade

For eight services sub-sectors – Electricity, Gas, Water and water waste, Retail trade and repair, Transport, Telecom, Finance, and Other business-related services (hotels and restaurants, real estate, rent, informatization, R&D, agencies) – we map the sub-sector with EBRD indices of reforms as follows:

E: Electricity - (electric)

E1: Gas (IER index: 2 all the time)

E2: Water and water waste (water)

G: Retail trade and repair

I: Transportation 1/2(rail + roads)

I1: Telecom (telecom)

J: Finance 1/2(banking + financial)

H+K: Other business-related services (hotels and restaurants, real estate, rent, informatization, R&D, agencies) 1/5(ssp + price_lib + trade_lib+ competition+ financial)

Index without utilities and retail trade

For four services sub-sectors – Transport, Telecom, Finance, and Other business-related services (hotels and restaurants, real estate, rent, informatization, R&D, agencies) – we map the sub-sector with EBRD indices of reforms as follows:

I: Transportation 1/2(rail + roads)

I1: Telecom (telecom)

J: Finance 1/2(banking + financial)

H+K: Other business-related services (hotels and restaurants, real estate, rent, informatization, R&D, agencies) 1/5(ssp + price_lib + trade_lib+ competition+ financial)