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Regional dimension of firm level productivity determinants: the case of manufacturing and service firms in Ukraine

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Abstract: The main goal of this paper is to empirically investigate the regional dimension of productivity determinants for 24 regions of Ukraine using micro-level dataset for individual firms in 2013. The novelty of our analysis is the comparison of the determinants of productivity in the manufacturing and service sectors. We estimate both pooled regressions for all regions and separate regressions for particular regions. The estimation results obtained for the entire country demonstrate that the majority of our explanatory variables are statistically significant for the manufacturing sector and all are statistically significant for the service sector although at different levels of significance. At the same time, the estimation results obtained separately for each region show a large degree of heterogeneity across the regions and sectors and the lack of scale economies at the firm-level.

Keywords: Firms, total factor productivity, regions, Ukraine

JEL Codes: O52, P33, R12

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1 Introduction

For over two decades, Ukraine has been struggling with economic and political transition. The recent changes in the political leadership and declarations for deeper economic reforms as well as joining the WTO and the recent signing of the free trade agreement (FTA) with the European Union (EU) have created new opportunities and prospects for economic recovery and improved performance of Ukrainian firms located in various regions of the country. Traditionally, there have been significant differences in the level of economic development reflecting productivity difference between firms located in the industrialized East and the agricultural West. The latter asymmetric trade liberalization episode may not equally affect the firms located in various regions of Ukraine.

Up to now, there have been relatively limited empirical evidence on the performance of the Ukrainian enterprises in general, and in particular regions. Therefore, we aim to fill at least a part of the existing gap in the literature by analysing the determinants of firm-level productivity in the manufacturing and service sectors across various regions of the country. In this paper, we empirically study the relationship between total factor productivity, intangible assets, capital intensity, firm size, competition in the industry, ownership status, and firm internationalization (exports and imports) of Ukrainian firms located in various regions, having controlled for industry-specific effects. The main contribution of this paper lies in its focus on Ukraine, which is still a country in transition, where not much empirical firm-level based analysis in the regional context has been conducted so far. Moreover, the novelty of our analysis is the identification of the differences in the productivity determinants in the manufacturing and service sectors across different regions of Ukraine.

In addition, unlike many other studies that used simple labour productivity measures, such as output per worker, in this paper as a productivity measure, we employ total factor productivity calculated by the Levinsohn-Petrin (2003) method. In particular, we study the role of several firm characteristics such as internationalization measured by foreign ownership, exports and imported inputs, firm size, private ownership, and the level of market concentration. We are also able to control for industry-specific effects. This paper is organized as follows. In the next section, we describe the research methodology and statistical data. Then, we discuss our empirical results. The final section summarizes and concludes.

2 Literature review

The economic literature has shown that there exist significant differences in productivity levels across firms.[1] This finding has shaped research agendas in a number of fields, including industrial organization, labour economics, and international trade. In the industrial organization literature, productivity levels are linked to demand, market structure and a number of features of technology. The frequently cited examples include the effects of competition (Syverson, 2004a; and Schmitz, 2005), sunk costs (Collard-Wexler, 2013), as well as the interaction of product market rivalry and technology spillover (Bloom *et al.*, 2007). Another line of research has looked at the interaction between firm productivity levels and organizational structures (e.g., Maksimovic and Phillips, 2002; Schoar, 2002; Hortaçsu and Syverson, 2007).

Labour economics explores the impact of human capital of individuals on productivity differences (Abowd *et al.*, 2005; Fox and Smeets, 2011). In other studies, the authors explore the productivity effects of incentive pay (Lazear, 2000), various human resources practices (Ichniowski and Shaw, 2003), managerial talent and practices (Bloom and Van Reenen, 2007), organizational forms (Garicano and Heaton, 2010), and social connections among co-workers (Bandiera *et al.*, 2009). There are also studies on the role of productivity-driven reallocation on labour market dynamics (Haltiwanger *et al.*, 2008).

The importance of productivity has been also analysed in the international trade literature. Theoretical models using heterogeneous productivity firms proposed by Eaton and Kortum (2002) and Melitz (2003) and their multiple extensions now became the dominant frameworks of the new trade theory through which economists study the relationship between productivity and international trade flows. In these models, the effects of trade liberalization vary across producers and depend on their productivity levels in particular. Aggregate productivity gains come from improved selection and increased competition that trade brings.

1 See, for example, the studies by Jovanovic (1982), Hopenhayn (1992), Ericson and Pakes (1995), Melitz (2003), Asplund and Nocke (2006), and Foster *et al.* (2008).

A large number of empirical studies confirmed many of the predicted patterns predicted by the new trade theories that accounted for firm heterogeneity (e.g., Pavcnik, 2002; Bernard *et al.*, 2006; and Verhoogen 2008).

There have been a number of studies on the performance of enterprises in Ukraine. The majority of these studies focused on the whole country and only very few of them embraced a regional dimension. For example, in one of the early studies, Pivovarsky (2003) analysed the impact of ownership concentration on the firm performance. Subsequently, Brown *et al.* (2006) studied the effect of privatization on total factor productivity. Earle *et al.* (2014) showed that political favouritism combined with weak institutions had substantial redistributional impact on productivity, while Huynh *et al.* (2015) demonstrated that improvements in firm productivity in Ukraine's manufacturing sector varied substantially across industries.

Shepotylo and Vakhitov (2015) identified the effect of liberalization of services on total factor productivity (TFP) of manufacturing firms, while Cieślik *et al.* (2015) studied the relationship between productivity and exporting using the firm-level BEEPS survey data. This relationship has been recently re-examined by Cieślik *et al.* (2017a) using a broader firm-level Derzhkomstat (the State Committee of Statistics of Ukraine) dataset and a different measure of productivity. In both cases, the empirical results showed the positive link between the export status and productivity. In addition, it was found that firms located in western Ukraine were more export-oriented compared to their counterparts located in other regions of the country.

In another study based on the same dataset, Cieślik *et al.* (2017b) examined the determinants of total factor productivity of Ukrainian firms in manufacturing and services using the firm-level data for the years 2005 and 2013. Their empirical results showed a positive link between TFP, intangible assets, capital intensity, firm size, competition in the industry, ownership status and firm internationalization measured by exports and imports. However, so far, very few attempts were made to empirically study the relationship between productivity and firm characteristics of Ukrainian enterprises in the regional context.

The notable exception includes the recent study by Cieślik *et al.* (2017c) who studied the determinants of the firm-level productivity in the manufacturing sector only across the large Ukrainian macro-regions using micro-level dataset for 2013. They found that the link between the firms' productivity, firm size, imports and the level of competition seemed to be valid for all Ukrainian macro-regions. At the same time, the effects of private ownership status, capital intensity and exports seemed to be region specific. Finally, they found no relationship between firm productivity and foreign ownership in any of the macro-regions.

Similar to the study by Cieślik *et al.* (2017c), the current study is based on the extensive firm-level data for the Ukrainian firms in the year 2013. However, in contrast to the aforementioned study for five large macro-regions in this paper, we evaluate whether the determinants of productivity in both manufacturing and service sectors are significantly different across 24 smaller regions (*oblasts*) of Ukraine. Therefore, the current study can be viewed as an extension and reconsideration of the results presented in that paper.

3 Research Methodology and Statistical Data

In this section, we discuss our research methodology and statistical data. First, we briefly explain what productivity conceptually is and how we measured it in practice.[2] Then we discuss our estimating equation and the data sources.

In the simplest way, productivity is defined as efficiency in production, that is, how much output is obtained from a given set of inputs (Syverson, 2004). In the case of single-factor production functions, productivity measures the number of units of output produced per unit of a given input. The most commonly used measure of this type is labour productivity, that is, the number of units of output per unit of labour.[3] However, in reality, single factor productivity levels may be affected by the intensity of use of the other inputs that are also used in the production process. For example, two firms having the same production function can have different labour productivity levels resulting from different intensity of use of capital.

Therefore, a productivity concept that is invariant to the intensity of use of observable factor inputs is often employed in the productivity measurement. This measure is called total factor productivity (TFP). The difference in TFP reflects variation in output pro-

2 The extensive review of the theory of productivity indexes can be found in Caves *et al.* (1982) and the references therein.

3 Occasionally, capital based productivity measures are also used.

duced from a fixed set of inputs. Firm with higher-TFP produce greater amounts of output with the same set of observable inputs than firms with lower-TFP. TFP is most easily seen in the formulation of a production function where output is the product of a function of observable inputs and a factor-neutral shifter. This means that TFP is a residual. Over the years, the economic literature has made considerable progress in explaining the effects on output that do not come from changes in observable inputs like labour or capital.[4]

In this study, we use TFP calculated by the Levinsohn-Petrin method. This method enables the estimation of the production function on the basis of inputs of capital, labour and intermediate goods. The TFP-based measure of productivity is better as compared to the simple labour productivity measures used in the earlier studies, as it takes into account the productivity of other factors of production. Moreover, the TFP measure calculated by the Levinsohn-Petrin method is better as compared to the Olley-Pakes method, as it takes into account the role of intermediate inputs.

In explaining TFP differences between Ukrainian firms located in various regions in our estimating equation, we account for firm and industry characteristics that may affect firm productivity. Following the literature review presented in the previous section in our estimating equation, we refer to three previously discussed strands in the economic literature: industrial organization, international trade and labour economics. The firm characteristics include the firm's capital to labour ratio, its size, the ownership status, the level of firm internationalization (exports and imported inputs) as well as the measure of competition within the industry in particular regions. We also control for the level of market concentration in the industry and industry-specific effects.

To study empirically, the relationship between firm productivity, measured by its TFP, and its determinants, we estimate the following empirical model:

$$\begin{aligned}\ln TFP_{ijr} = {} & a_0 + a_1 \ln size_{ijr} + a_2 \ln KLratio_{ijr} + a_3 import_{ijr} \\ & + a_4 export_{ijr} + a_5 private_{ijr} + a_6 foreign_{ijr} \\ & + a_7 \ln HHI_j + v_j + v_r + \varepsilon_{ijr}\end{aligned} \quad (1)$$

where $\ln TFP_{ijr}$ denotes the natural logarithm of the level of productivity of firm i operating in industry j located in region r, $\ln size_{ijr}$ denotes the natural logarithm of the size of the firm measured in terms of its full-time employees, $\ln KLratio_{ijr}$ denotes the natural logarithm of the capital-labour ratio measured as the stock of firm's fixed assets per a full time employee, $imports_{ijr}$ is an indicator variable showing whether the firm is importing or not, $export_{ijr}$ is an indicator variable showing whether the firm is exporting or not, $private_{ijr}$ is an indicator variable showing whether the firm is privately owned or not, $foreign_{ijr}$ is an indicator variable showing whether the firm has foreign ownership or not, and $\ln HHI_j$ stands for the natural logarithm of the Herfindahl-Hirschman index calculated for the NACE 2-digit industry, v_j is a dummy variable representing the industry-specific fixed effect, u_r is a dummy variable measuring the region-specific fixed effect, and finally, ε_{ijr} is the error term that is assumed to satisfy the standard properties (iid). The αs are the parameters of the empirical model that need to be estimated by the ordinary least squares (OLS).

The data used in the empirical study comes from several statistical sources and covers only the year 2013. This data comes mainly from Derzhkomstat (2015) and includes the balance and income statement indicators. These are related to fixed assets, total revenues, total labour cost, cost of materials, and so on. Similarly, the information on domestic and foreign ownership comes from the State Committee of Statistics of Ukraine. The foreign trade data (export and imports) comes from External Economic Activity Database of the State Committee of Statistics of Ukraine. Finally, the employment data (total number of full-time workers) has been received from the Ukrainian employment authorities.

The statistical data has been classified according to the KVED-2010 statistics that became effective from 1 January 2012. KVED is the Ukrainian national classification developed by the State Committee for Technical Regulation and Consumer Policy of Ukraine to collect information on economic activity. KVED-2010 includes 3 agricultural industries, 5 mining industries, 25 manufacturing industries, 56 services industries. In this study, we limit our attention only to the manufacturing and services industries.

The definitions of variables used in our empirical study and their summary statistics for the firms operating in the manufacturing and service industries are reported in Tab. 1a and Tab. 1b, respectively.

4 The detailed discussion on the productivity measurement issues can be found in the vast literature on the subject. The frequently cited examples include Olley and Pakes (1996), Griliches and Mairesse (1998), Blundell and Bond (2000), Levinsohn and Petrin (2003), and Ackerberg *et al.* (2007).

Tab. 1a. Definitions of variables and summary statistics, manufacturing sector

Variable	Definition	Obs	Mean	Std. Dev.	Min	Max
TFP	Total factor productivity calculated based on Levinsohn-Petrin input shares	11556	188.81	839.98	0.17	52215.16
Size	Total number of full-time employees	11556	130.03	754.72	1	35625
KLratio	Capital to labour ratio calculated as the ratio of fixed assets in the end of period	11556	2475.68	40136.68	0.03	3762930
Import	Dummy variable indicating if an enterprise imports or not	11556	0.08	0.28	0	1
Export	Dummy variable indicating if an enterprise exports or not	11556	0.10	0.30	0	1
Private	Dummy variable indicating private ownership of an enterprise	11556	0.82	0.38	0	1
Foreign	Dummy variable indicating foreign ownership of an enterprise	11556	0.01	0.07	0	1
HHI	Herfindahl-Hirschman index for NACE 2-digit industry	11556	323.85	287.54	96.08	1929.94

Note: the values in the above tables are reported in absolute terms.

Tab. 1b. Definitions of variables and summary statistics, services sector

Variable	Definition	Obs	Mean	Std. Dev.	Min	Max
TFP	Total factor productivity calculated based on Levinsohn-Petrin input shares	84475	342.86	3015.44	0.01	594673
Size	Total number of full-time employees	84475	46.03	689.11	1	96477
KLratio	Capital to labour ratio calculated as the ratio of fixed assets in the end of period	84475	5538.65	78420.53	0.01	7842810
Import	Dummy variable indicating if an enterprise imports or not	84475	0.06	0.24	0	1
Export	Dummy variable indicating if an enterprise exports or not	84475	0.02	0.15	0	1
Private	Dummy variable indicating private ownership of an enterprise	84475	0.95	0.22	0	1
Foreign	Dummy variable indicating foreign ownership of an enterprise	84475	0.00	0.06	0	1
HHI	Herfindahl-Hirschman index for NACE 2-digit industry	84475	348.70	797.33	17.29	10000

Note: the values in the table are reported in absolute terms.

The level of firm productivity measured by TFP has been calculated using the Levinsohn-Petrin (2003) methodology. TFP can be estimated in Stata using command "levpet" that implements the estimators of input shares on the basis of log data for total revenues, capital stock, number of employees and cost of materials (raw materials, electricity, fuel).

The input shares were computed using the data of total revenues, fixed capital, number of employees and cost of materials of enterprises for each of KVED-2010 sectors on the basis of the unbalanced sample of enterprises for the time period of 2005–2013.[5]

The degree of competition between the firms within the industry has been measured by the Herfindahl-Hirschman Index (HHI). This is a frequently employed measure of market concentration in the industrial organization (IO) literature. It has been calculated for each of the available KVED-2010 industries so that

$$HHI_j = \sum_{i=1}^{N} \left(\frac{TR_i}{secTR} * 100 \right)_j^2$$

where N denotes the total number of firms operating in industry j, TR is the total revenue of the enterprise i,

5 Some industries were omitted from the analysis due to problems with calculating factor input shares. It was not possible to calculate the Levinsohn-Petrin input shares for the following manufacturing industries: production of ready-made garments, manufacture of leather, production of paper, manufacture of other mineral products, manufacture of transport equipment and tobacco industry, so they were not included in the sample.

Tab. 2a. Correlations between variables, manufacturing sectors

	TFP	Size	KLratio	Import	export	Private	foreign	HHI
TFP	1							
size	0.132	1						
KLratio	0.113	0.000	1					
import	0.094	0.133	-0.004	1				
export	0.021	0.120	-0.006	0.452	1			
private	0.039	0.007	0.006	0.049	0.055	1		
foreign	0.000	-0.001	0.003	0.054	0.040	0.035	1	
HHI	0.028	0.070	0.003	0.059	0.055	0.053	-0.0074	1

T**ab. 2b.** Correlations between variables, services sectors

	TFP	Size	KLratio	Import	export	Private	foreign	HHI
TFP	1							
Size	0.004	1						
KLratio	0.094	-0.002	1					
Import	0.056	0.030	-0.009	1				
Export	0.046	0.035	-0.001	0.216	1			
Private	0.003	-0.071	-0.013	0.051	0.027	1		
Foreign	0.005	0.007	0.011	0.050	0.028	0.008	1	
HHI	-0.031	0.021	-0.007	-0.064	-0.030	-0.121	0.015	1

secTR represents the sum of total revenues of all firms in industry j. The higher value of HHI is associated with the higher degree of concentration within the industry and consequently less competition.

The correlations between our explanatory variables for the manufacturing and service sectors are reported in Tab. 2a and 2b, respectively. The analysis of correlations between particular explanatory variables does not reveal strong correlations.

4 Estimation Results

In this section, we empirically investigate the firm-level determinants of productivity for particular regions of Ukraine and report two sets of estimation results for the manufacturing and service sectors, respectively. Our estimation results for manufacturing companies are reported in Tab. 3a, b, while for services firms in Tab. 4a, b.

First, as useful benchmarks, we describe our estimation results for the manufacturing and service sectors obtained for the entire country, which are reported in the first columns of Tab. 3a and Tab. 4a, respectively. These results were obtained having controlled for industry specific and region specific effects. It turns out that only some of our explanatory variables are statistically significant for manufacturing firms while all the explanatory variables turned out to be statistically significant for the services firms. In both cases, the estimated coefficient on the firm size variable is statistically significant at the 5% level. It displays a negative sign for both manufacturing and services firms, which is in line with the results reported in Cieślik *et al.* (2017c).

The estimated coefficient on the capital to labour ratio variable displays an expected positive sign and is statistically significant at 10% level for manufacturing firms and at 5% level for services firms. As a higher capital-labour ratio is associated with the higher level of productivity of Ukrainian firms and the cost of capital

Tab. 3a. Estimation results for the manufacturing sector across regions

	All regions	Kyiv	Cherkasy	Chernihiv	Chernivtsi	Dnipro	Donetsk	Ivano-Frankivsk	Kharkiv	Kherson	Khmelnitskyi	Kirovograd	Luhansk
lnSize	-0.064	0.004	-0.103	-0.028	-0.159	-0.063	-0.036	-0.179	-0.061	-0.046	-0.096	-0.126	-0.097
	(9.64)**	(0.22)	(2.52)*	(0.51)	(2.54)*	(2.71)**	(1.50)	(3.52)**	(2.68)**	(0.91)	(2.19)*	(2.32)*	(2.82)**
lnKLratio	0.010	0.020	0.038	0.128	0.005	-0.022	-0.003	0.040	0.011	-0.040	0.075	0.074	-0.021
	(2.14)*	(2.05)*	(1.23)	(3.27)**	(0.11)	(1.26)	(0.17)	(1.11)	(0.76)	(1.01)	(1.94)	(1.84)	(0.77)
Import	0.583	0.788	-0.087	-0.214	0.332	0.687	0.354	0.311	0.506	0.680	0.486	0.125	0.382
	(15.25)**	(10.26)**	(0.32)	(0.65)	(0.80)	(4.95)**	(2.26)*	(1.15)	(4.07)**	(1.66)	(1.86)	(0.30)	(1.76)
Export	0.111	-0.093	0.532	0.414	0.360	0.066	0.119	0.638	0.128	0.277	0.308	0.413	0.230
	(3.07)**	(1.07)	(2.43)*	(1.68)	(1.21)	(0.47)	(0.84)	(3.00)**	(1.03)	(0.90)	(1.31)	(1.35)	(1.26)
Private	-0.028	0.085	-0.157	-0.148	0.043	-0.027	0.036	-0.242	0.066	-0.247	-0.229	-0.088	0.199
	(1.08)	(1.18)	(1.08)	(0.79)	(0.19)	(0.28)	(0.34)	(1.15)	(0.77)	(1.41)	(1.49)	(0.50)	(1.52)
Foreign	-0.064	-0.145	-0.678	0.403		0.068	-0.917		0.540	-0.436		-0.498	-0.613
	(0.51)	(0.60)	(0.67)	(0.42)		(0.27)	(0.84)		(1.29)	(0.70)		(0.71)	(0.64)
lnHHI	0.656	0.334	-0.062	0.142	0.079	0.872	1.105	0.833	0.652	0.316	0.943	-0.345	0.475
	(12.62)**	(3.07)**	(0.18)	(0.30)	(0.18)	(5.04)**	(7.27)**	(3.44)**	(3.40)**	(0.73)	(2.10)*	(0.78)	(2.04)*
Constant	0.495	1.987	4.207	2.568	3.751	-0.191	-1.599	-0.116	0.609	2.661	-1.096	5.507	1.653
	(1.78)	(3.34)**	(2.25)*	(1.01)	(1.66)	(0.21)	(1.98)*	(0.09)	(0.60)	(1.13)	(0.47)	(2.38)*	(1.33)
Industry- specific effects	yes	yes	yes	yes	Yes	yes	yes	yes	yes	yes	yes	yes	yes
N	11557	2515	317	207	137	895	895	223	948	169	260	226	416
R2	0.51	0.53	0.48	0.58	0.51	0.50	0.46	0.51	0.57	0.66	0.56	0.49	0.55

(Absolute value of z-statistics in parentheses) Absolute value of t-statistics in parentheses * significant at 5%; ** significant at 1%.

Tab. 3b. Estimation results for the manufacturing sector across regions, continued

	All regions	Lutsk	Lviv	Mykolajiv	Odesa	Poltava	Rivne	Summy	Ternopol	Uzhgorod	Vinnytsia	Zaporizhzhe	Zhytomyr
lnSize	-0.064	0.030	-0.109	-0.152	-0.115	-0.036	-0.090	-0.126	0.010	-0.003	-0.055	-0.083	-0.065
	(9.64)**	(0.60)	(3.94)**	(2.86)**	(3.27)**	(1.07)	(1.86)	(2.93)**	(0.18)	(0.05)	(1.39)	(2.92)**	(1.65)
lnKLratio	0.010	-0.072	0.008	-0.034	-0.003	0.026	-0.137	0.021	0.025	-0.055	0.060	-0.013	0.004
	(2.14)*	(1.91)	(0.41)	(0.83)	(0.15)	(0.99)	(3.74)**	(0.54)	(0.57)	(1.36)	(2.05)*	(0.59)	(0.14)
Import	0.583	0.562	0.808	0.736	0.482	0.368	0.651	0.122	0.727	0.507	0.559	0.607	0.197
	(15.25)**	(1.98)*	(5.98)**	(2.17)*	(2.60)**	(1.39)	(2.80)**	(0.47)	(2.24)*	(2.07)*	(2.09)*	(2.75)**	(0.75)
Export	0.111	-0.143	-0.048	0.549	0.182	0.171	0.308	0.312	-0.130	0.175	-0.049	-0.000	0.511
	(3.07)**	(0.65)	(0.37)	(1.56)	(1.08)	(0.69)	(1.47)	(1.29)	(0.45)	(0.88)	(0.21)	(0.00)	(2.58)*
Private	-0.028	-0.004	-0.012	-0.132	-0.013	0.041	-0.193	0.004	-0.542	-0.171	-0.261	0.003	0.016
	(1.08)	(0.02)	(0.11)	(0.74)	(0.10)	(0.30)	(1.07)	(0.03)	(2.76)**	(0.78)	(1.88)	(0.03)	(0.12)
Foreign	-0.064	0.252	-0.498			0.513	-0.788			-0.665			
	(0.51)	(0.47)	(0.91)			(0.93)	(0.89)			(1.18)			
lnHHI	0.656	-1.139	0.942	-0.614	0.405	-1.031	-1.558	0.876	0.539	0.332	0.362	0.761	-0.023
	(12.62)**	(3.13)**	(5.42)**	(1.49)	(1.50)	(2.26)*	(4.77)**	(3.37)**	(1.47)	(1.13)	(1.65)	(3.20)**	(0.09)
Constant	0.495	9.705	-0.880	7.884	2.028	8.996	12.607	-0.583	0.594	2.411	1.561	0.304	3.828
	(1.78)	(4.98)**	(0.94)	(3.47)**	(1.43)	(3.84)**	(7.25)**	(0.39)	(0.31)	(1.43)	(1.25)	(0.24)	(2.91)**
Industry-specific effects	yes	Yes	yes	yes	Yes	yes	yes	Yes	yes	yes	yes	yes	yes
N	11557	183	725	241	499	347	201	193	191	199	338	529	311
R2	0.51	0.60	0.58	0.38	0.54	0.57	0.67	0.66	0.61	0.59	0.49	0.49	0.53

(Absolute value of z-statistics in parentheses) Absolute value of t-statistics in parentheses * significant at 5%; ** significant at 1%.

Tab. 4a. Estimation results for the services sector across regions

	All regions	Kyiv	Cherkasy	Chernigiv	Chernivtsi	Dnipro	Donetstk	Ivano-Frankivsk	Kharkiv	Kherson	Khmelnytskyi	Kirovograd	Luhansk
lnSize	-0.187	-0.155	-0.175	-0.235	-0.12	-0.194	-0.198	-0.14	-0.212	-0.229	-0.166	-0.228	-0.262
	(51.81)**	(24.32)**	(6.55)**	(6.39)**	(3.00)**	(15.93)**	(14.97)**	(5.08)**	(14.62)**	(7.57)**	(6.44)**	(6.33)**	(12.74)**
lnKLratio	0.041	0.048	0.039	0.049	0.025	0.020	0.049	0.010	0.047	0.016	0.036	0.022	0.043
	(22.05)**	(15.42)**	(2.63)**	(2.67)**	(1.10)	(3.10)**	(7.08)**	(0.69)	(6.34)**	(1.07)	(2.56)*	(1.22)	(3.78)**
Import	0.93	0.953	0.605	1.044	0.764	0.99	0.789	0.921	0.733	0.86	1.077	0.727	1.054
	(48.14)**	(33.51)**	(3.40)**	(4.19)**	(3.75)**	(14.01)**	(8.24)**	(5.77)**	(9.58)**	(3.85)**	(7.27)**	(2.54)*	(6.67)**
Export	0.409	0.573	0.381	0.206	-0.245	0.263	0.940	0.034	0.478	0.610	-0.279	0.723	0.549
	(13.43)**	(10.32)**	(2.03)*	(0.73)	(0.88)	(2.27)*	(6.45)**	(0.17)	(4.33)**	(2.48)*	(1.19)	(2.31)*	(3.12)**
Private	0.062	0.159	0.268	-0.689	-0.173	-0.043	0.001	0.569	0.252	0.483	0.137	-0.248	0.239
	(2.79)**	(3.13)**	(1.80)	(3.59)**	(0.93)	(0.51)	(0.01)	(3.57)**	(2.79)**	(3.34)**	(1.12)	(1.31)	(2.20)*
Foreign	0.277	0.222	0.209	0.272	1.768	0.091	-0.36	-0.467	0.450	0.649	0.735	0.270	0.341
	(3.59)**	(2.12)*	(0.24)	(0.19)	(1.96)	(0.45)	(0.58)	(0.57)	(1.18)	(0.76)	(1.50)	(0.41)	(0.39)
lnHHI	-0.127	-0.123	-0.058	0.004	-0.011	-0.112	-0.162	-0.044	-0.122	-0.039	-0.034	-0.118	-0.108
	(10.43)**	(5.93)**	(0.52)	(0.03)	(0.07)	(2.52)*	(3.34)**	(0.48)	(2.59)**	(0.41)	(0.38)	(0.95)	(1.36)
Industry-specific effects	yes	yes	yes	yes	yes	yes	Yes	yes	yes	yes	Yes	yes	yes
Constant	-3.218	-3.426	-3.884	-3.004	-3.922	-2.980	-2.712	-4.427	-3.218	-4.041	-4.034	-2.671	-3.168
	(34.50)**	(21.25)**	(4.95)**	(3.34)**	(3.63)**	(8.89)**	(7.52)**	(6.63)**	(9.03)**	(5.84)**	(6.18)**	(2.92)**	(5.35)**
Observations	84475	26838	1545	1150	645	6729	6882	1335	5465	1254	1387	1003	2399
R-squared	0.86	0.85	0.87	0.86	0.91	0.85	0.83	0.90	0.85	0.90	0.91	0.86	0.86

(Absolute value of z-statistics in parentheses) Absolute value of t-statistics in parentheses * significant at 5%; ** significant at 1%.

Tab. 4b. Estimation results for the services sector across regions

	All regions	Lutsk	Lviv	Mykolajiv	Odesa	Poltava	Rivne	Summy	Ternopil	Uzhgorod	Vinnytsia	Zaporizhzhe	Zhytomyr
lnSize	-0.187	-0.179	-0.197	-0.269	-0.201	-0.230	-0.196	-0.198	-0.171	-0.264	-0.240	-0.223	-0.181
	(51.81)**	(6.69)**	(13.09)**	(11.34)**	(11.63)**	(10.29)**	(7.43)**	(6.11)**	(4.82)**	(7.85)**	(9.15)**	(11.29)**	(5.83)**
lnKLratio	0.041	0.017	0.062	0.029	0.039	0.035	0.034	0.024	0.045	0.063	0.047	0.023	0.003
	(22.05)**	(1.25)	(7.71)**	(2.31)*	(4.55)**	(2.94)**	(2.43)*	(1.33)	(2.54)*	(3.55)**	(3.47)**	(2.16)*	(0.20)
Import	0.930	1.225	0.859	0.841	1.142	0.883	0.908	0.660	0.595	0.726	0.955	0.849	0.933
	(48.14)**	(9.15)**	(12.66)**	(3.71)**	(11.46)**	(5.49)**	(5.85)**	(2.92)**	(2.97)**	(4.89)**	(6.32)**	(6.87)**	(4.71)**
Export	0.409	-0.214	0.188	0.780	0.508	0.608	0.270	0.385	0.212	-0.336	0.701	0.377	0.169
	(13.43)**	(1.24)	(1.68)	(3.07)**	(3.68)**	(3.21)**	(1.54)	(1.36)	(0.68)	(1.89)	(3.92)**	(2.13)*	(0.99)
Private	0.062	-0.124	0.007	0.219	-0.272	-0.011	-0.135	-0.056	0.267	-0.469	0.403	0.116	-0.107
	(2.79)**	(0.70)	(0.09)	(1.63)	(2.45)*	(0.08)	(1.08)	(0.38)	(1.60)	(2.74)**	(3.23)**	(0.96)	(0.79)
Foreign	0.277	1.796	0.040	0.721	0.285	0.453	-0.265		0.784	0.129	-0.009	0.197	-0.080
	(3.59)**	(2.21)*	(0.08)	(1.09)	(0.85)	(0.54)	(0.43)		(0.62)	(0.17)	(0.01)	(0.16)	(0.11)
lnHHI	-0.127	-0.014	-0.049	-0.021	-0.258	-0.054	-0.101	-0.176	-0.079	-0.128	0.017	-0.127	-0.099
	(10.43)**	(0.14)	(1.06)	(0.25)	(4.65)**	(0.74)	(1.16)	(1.48)	(0.67)	(1.15)	(0.18)	(1.89)	(0.98)
Constant	-3.218	-3.833	-3.817	-4.018	-1.594	-3.533	-3.232	-2.465	-3.651	-2.581	-4.396	-2.950	-2.853
	(34.50)**	(5.33)**	(11.38)**	(6.23)**	(3.74)**	(6.43)**	(4.98)**	(2.86)**	(4.18)**	(3.16)**	(6.66)**	(5.80)**	(3.93)**
Industry-specific effects	yes	yes	yes	Yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	84475	1292	4444	1568	4435	2078	1277	1173	859	1157	1680	2905	1398
R-squared	0.86	0.90	0.90	0.88	0.84	0.88	0.91	0.87	0.89	0.88	0.88	0.86	0.87

(Absolute value of z-statistics in parentheses) Absolute value of t-statistics in parentheses * significant at 5%; ** significant at 1%.

remains quite high while the cost of labour remains quite low in Ukraine, there is a substantial potential to boost firm productivity by increasing their capital stocks.

The estimated coefficients on all the variables measuring internationalization of firms, including exports and imports, display expected positive signs and are statistically significant at 5% levels for both manufacturing and services firms. This confirms the positive relationship between firm productivity and international openness in Ukraine documented in Cieślik *et al.* (2017c). The estimated coefficient on the variable describing the foreign ownership is not statistically significant at all in the manufacturing sector; while in the service sector, it is significant at 5% level. Similarly, we find that the estimated coefficient on the private ownership variable is not statistically significant at all in the manufacturing sector; while in the service sector, it is significant at 5% level.

Finally, we find that the market structure also matters for firm productivity in both manufacturing and service sectors. In particular, we find that in both cases, the estimated parameters on this variable are statistically significant at 5% levels. However, in the case of manufacturing sector, the estimated parameter on this variable is positive, while in the case of the service sector it is negative. This means that firm productivity in the manufacturing sector increases with the higher concentration within the industry, while the opposite holds for the service sector.

In the remaining columns of Tab. 3a, b and Tab. 4a, b, we show the estimation results for each of the 24 regions in Ukraine. We find that in the majority of regions, the results remain generally consistent with the benchmark results, although not all explanatory variables are statistically significant in all regions. In particular, the capital to labour ratio is statistically significant for the manufacturing firms only in four regions: Kyiv, Chernihiv, Rivne and Vinnytsia, while for the services firms, it is significant in a majority of regions except Chernivtsi, Ivano-Frankivsk, Kherson, Krivograd, Lutsk, Summy and Zhytomyr.

The firm size contributes negatively to firm productivity; this result holds for most regions for the manufacturing firms except Kyiv, Chernihiv, Donetsk, Kherson, Lutsk, Poltava, Rivne, Ternopil, Uzhgorod, Vinnytsia and Zhytomyr, and for all 24 regions for the services firms.

The importance of internationalization for productivity of Ukrainian firms is quite limited in the manufacturing sector. Imports matter for firm productivity in Kyiv, Dnipro, Donetsk, Kharkiv, Lutsk, Lviv, Mykolajiv, Odesa, Rivne, Ternopil, Uzhgorod, Vinnytsia, and Zaporizhzhe. However, the export status is important for productivity of manufacturing firms only in a few regions: Cherkasy, Ivano-Frankivsk and Zhytomyr. At the same time, imports are important for productivity in the service sector in all regions and exports in the majority of regions including: Kyiv, Donetsk, Dnipro, Kharkiv, Cherkasy, Kherson, Kirovograd, Luhansk, Mykolajiv, Odesa, Poltava, Vinnytsia and Zaporizhzhe.

Foreign ownership is not significant in any of the regions in the case of the manufacturing sector, while in the case of the service sector, it is statistically significant in two regions: Kyiv and Lutsk. Private ownership is statistically significant only in a very limited number of regions. In the case of manufacturing sector, it is significant only in one region: Ternopol, while in the case of the service sector in nine regions: Kyiv, Chernigiv, Ivano-Franskivsk, Kharkiv, Kherson, Luhansk, Odesa, Uzhgorod and Vinnytsia.

Finally, the HHI for the manufacturing sector is statistically significant in several regions and displays a positive sign in ten regions: Kyiv, Dnipro, Donetsk, Ivano-Frankivsk, Kharkiv, Khmelnytskyi, Luhansk, Lviv, Summy, and Zaporizhzhe and the negative sign in three regions: Lutsk, Poltava, and Rivne. In the case of service sector, the estimated parameter on the HHI is always negative and statistically significant in five regions: Kyiv, Dnipro, Donetsk, Kharkiv, and Odesa.

5 Conclusions

The paper presented the study of micro-level determinants of total factor productivity of manufacturing and services firms in 24 Ukrainian regions in 2013. First, we discussed separately the benchmark results for manufacturing and services sectors obtained for the entire country and then separate results for each region. The estimation results obtained for the whole country demonstrated that the majority of firm productivity determinants were statistically significant for the manufacturing sector except foreign and state ownership variables and all of them for the service sector although at different levels of significance.

Then, we discussed the results obtained separately for each region. These results revealed a large degree of heterogeneity across regions with respect to the role of particular determinants of firm-level productivity for

the manufacturing and the service sectors. In particular, the negative link between firm productivity and firm size turned out to be valid for a majority of regions in the case of manufacturing firms and for all regions in the case of services firms. The lack of evidence for economies of scale at firm-level, which is in contrast to the studies for other countries, requires further investigation. Moreover, the positive link between productivity and firm capital to labour ratio turned out to be valid for only a few regions in the case of manufacturing firms and for a majority regions in the case of services firms.

Similarly, the positive link between productivity and exports and imports turned out to be valid for only a few regions in the case of manufacturing firms, while in the case of services firms, it was significant for a majority regions for exports and all of them for imports. The indicator variable describing the private ownership was not statistically significant in all but one region in the case of manufacturing sector, while in the case of service sector, private ownership was significant only in a minority of regions. At the same time, the variable describing foreign ownership was not statistically significant in any region in the case of manufacturing sector, while in the case of service sector, foreign ownership was not significant in a majority of regions, in contrast to the studies for other countries. These unexpected results may reflect a still relatively low level of inward foreign direct investment in Ukraine. Therefore, this issue requires more attention in future studies.

Finally, the role of market concentration turned out to be different for manufacturing and services firms. In particular, the estimated coefficient on the HHI variable in the case of manufacturing sector turned out to be statistically significant for a majority of regions and mostly positive, while in the case of service sector, it was statistically significant only in a minority of regions and negative.

The comparison of estimated parameters across regions can be a starting point for future research on identification of groups of similar regions, decomposition of TFP variance into firm-level and regional-level determinants, or a closer evaluation of cross-regional heterogeneity. Moreover, the use of spatial statistics and spatial econometrics in future studies could broaden the scope of regional analysis by identifying possible spillover mechanisms. This could lead to specific regional policy guidelines.

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Annex: The regions (oblasts) of Ukraine

Source: http://2001.ukrcensus.gov.ua/eng/regions/