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**Working Paper**

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GUT FME Working Paper Series A, No. 3/2019 (55)

**Provided in Cooperation with:**

Gdańsk University of Technology, Faculty of Management and Economics

*Suggested Citation:* Kordalska, Aleksandra; Olczyk, Magdalena (2019) : What fosters firm-level labour productivity in Eastern European and Central Asian countries?, GUT FME Working Paper Series A, No. 3/2019 (55), Gdańsk University of Technology, Faculty of Management and Economics, Gdańsk

This Version is available at:

<https://hdl.handle.net/10419/202503>

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GDAŃSK UNIVERSITY OF TECHNOLOGY  
FACULTY OF MANAGEMENT AND ECONOMICS

# WHAT FOSTERS FIRM-LEVEL LABOUR PRODUCTIVITY IN EASTERN EUROPEAN AND CENTRAL ASIAN COUNTRIES?

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**GUT Faculty of Management and Economics**

**Working Paper Series A (Economics, Management, Statistics)**

**No 3/2019 (55)**

**July 2019**

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# What fosters firm-level labour productivity in Eastern European and Central Asian countries?

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*This version 30/05/2019*

**Abstract:** This study examines labour productivity performance and its determinants in Eastern European and Central Asian (EECA) firms using micro-level data. We find significant differences in labour productivity among members of the European Union in Eastern Europe and other Eastern European and Central Asian countries. We also confirm the important impact of foreign ownership, exporter status, and highly skilled workers on productivity levels. However, we reveal a non-linear relationship between firm age and their labour productivity. Additionally, significant differences in labour productivity determinants between the services and manufacturing are found. The productivity of service firms, unlike manufacturing firms, is much more sensitive to changes in productivity factors.

**Keywords:** Eastern Europe and Central Asia, firm-level analysis, labour productivity

**JEL:** C21, J24 O52, O53

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## Introduction

Two decades after the collapse of communist regimes, Eastern European and Central Asian (EECA)<sup>3</sup> countries are remarkably different. The differences are particularly large among the countries of Central and Eastern Europe. Advanced democratic welfare states in East-Central Europe have converged economically with the continental member states of the European Union (EU) (Lauzadyte-Tutlien *et al.* 2018). The former Soviet republics (except the Baltic countries) tend to have authoritarian or hybrid regimes, higher levels of poverty and inequality, and much less generous welfare policies (Ekiert 2015). Countries in Southeast Europe are somewhere between this two groups, with some progress on many dimensions and significant stagnation in reforms (OECD 2016). In turn, the new Southeast European members of the EU, Bulgaria and Romania, tend to lag behind all the other EU countries in all important respects.

Despite many differences, EECA countries have one common feature according to the Transition Report prepared by the European Bank for Reconstruction and Development (EBRD 2017). They may be stuck in a “middle-income trap” and experience a slowdown in productivity growth at income levels between one-third and two-thirds that of the United States. Furthermore, in many economies in the EECA region, growth lags behind that of comparable middle-income countries elsewhere in the world. The most recent analysis, by Levenko *et al.* (2019), confirms that in CEE countries, after the global financial crisis, capital deepening and increased capital utilisation have contributed to economic growth in equal proportions, while growth in total factor productivity (TFP) has been virtually absent in most Central and Eastern European countries in this period. The lack of TFP growth is delaying the catch-up process and casts doubt on the ability of these countries to sustain growth without the increased use of resources (Vuegelers 2011). Having exhausted the advantages that underpinned their strong growth performance in the past—almost without exception, low-cost labour—the countries in the EECA region now require a new growth model to create sustained economic growth, focused on improving the productivity of individual firms, expanding infrastructure, and green growth. That is why research on the determinants of productivity in Eastern European and Central Asia have become more important.

Also, some empirical analyses show a large dispersion in firm productivity, which suggests that analysing total economic or industry average productivity will not give a full picture (Bartelsman and Doms, 2000; Bartelsman *et al.* 2013; Dosi *et al.* 2010). Syverson (2004) finds that, in the US manufacturing sector, firm productivity was on average 1.92 times higher in the 90th

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<sup>3</sup> List of analysed Eastern European and Central Asian countries – see Appendix 1.

percentile than the 10th percentile, implying that with the same inputs, firms in the 90th percentile have nearly twice as much output as those in the 10th percentile. Using a harmonised cross-country firm-level database in EU countries, the CompNet Task Force (2014) also documents a large degree of heterogeneity in terms of firm productivity and size, both within and across countries. This is because countries, or industries within countries, might display the same productivity on average but have a very different underlying distribution (Papa *et al.* 2018). So, micro-data-based research on productivity is essential.

Consequently, the purpose of this study is to provide deeper insights into labour productivity among selected EECA economies and to understand its firm-level drivers. We add something new to the empirical literature on productivity in EECA countries by exploiting information from a unique firm-level survey carried out by the EBRD and the World Bank (WB), called the Business Environment and Enterprise Performance Survey (BEEPS V).

Studies on the determinants of labour productivity in EECA economies are relatively scarce mostly due to data limitations, i.e. the lack of available data. Only a few studies on this topic use a disaggregated firm-level approach, e.g. Botrić *et al.* (2017) on post-transition economies.

Additionally, the majority of these studies concentrate on analysing manufacturing productivity. This is connected with belief that productivity is a vague, useless concept in the services industry, because service companies do not usually measure their success in terms of productivity (Dobmeier 2016). However, reduction of the differences between the two sectors is strongly observed. First, the environment in which service companies operate is becoming more like the industrial business environment: markets are becoming more competitive, the turnover rate is increasing, and the life cycle of services is becoming shorter (Balci *et al.* 2011). Additionally, innovation in the services is becoming more like that in manufacturing, i.e. the distinction between ‘hard’ innovation in the industrial sector and ‘soft’, non-technological innovation in the service sector is very blurred. The aim of the research is to emphasise differences between these two sectors in EECA economies.

The rest of the paper is organised as follows. Section 2 provides a brief review of the literature on the main determinants of labour productivity. In section 3 a research strategy is presented. Section 4 gives an overview of our data and methodology. Section 5 looks at the survey results on labour productivity, focusing on the empirical models and a discussion of the results. Section 6 concludes and offers some policy recommendations.

## Theoretical Background and Related Empirical Studies

In a survey of the literature, Syverson (2011) divided inter-firm differences in productivity into two broad categories. The first group consists of factors within the firm, such as managerial talent, the quality of labour and capital inputs, product innovation, and the organisational structure of the firm's production units. The second group is made up of environmental determinants, such productivity spillovers from knowledge transfers, the degree of competition in labour and product markets, and the impact of regulation. Some studies document complementarities between the two groups. For instance, strong competition and flexible labour markets allow firms to adopt better human resource management practices (Bloom *et al.*, 2012). In our paper, we propose to divide them into two subgroups: factors connected with enterprise characteristics (e.g. age or size) and those related to firm economic activity (e.g. their innovation level or technological capability).

The growing literature on firm heterogeneity shows a massive dispersion in firm outcomes, such as revenue, employment, and TFP (Bernard *et al.* 2019; Syverson 2011). It draws attention to the role of the individual firm characteristics in explaining some economic phenomena. All begins with Melitz's model (2003), which underlines the role in productivity growth of 'being an exporter', but other papers indicate the importance of other firm-specific features, such as productivity determinants (Aiello and Ricotta 2016; Sangho 2018).

The first is firm size. The literature has established that small firms are less productive than large firms, especially because of scale economics (larger firms may have lower average and marginal costs). A positive relationship between firm size and labour/TFP is found in several studies, i.e. Leug et al (2008) on Canadian firms, Du and Temouri (2015) on UK enterprises, and Cieřlik *et al.* (2017) on Ukrainian companies. However, in Moral-Benito (2016), Spanish firm size shocks are not followed by productivity gains at the firm level. Accordingly, our paper tests the following hypothesis:

H1: *Firm size is expected to have a positive effect on labour productivity.*

Second, among various firm-specific factors influencing productivity, firm age is important. Coad *et al.* (2013) have three theoretical predictions on how firm age affects firm productivity positively or negatively: selection effects, learning by-doing effects, and inertia effects. Selection pressures result in an increase in the average productivity level of surviving firms, even if the productivity levels of individual firms do not change with age (Jovanovic 1982). Learning-by-doing effects occur when firms increase their productivity as they learn about more productive production techniques and incorporate these improvements into their production

routines (Arrow 1962; Vassilakis 2008). Inertia effects indicate that as firms get older, they might become less productive if they become increasingly inert and inflexible. When firms grow older, they become very bureaucratic, with less organisational flexibility and ability to change rapidly (Barron *et al.* 1994; Hannan and Freeman 1984). So in the first period of the company's maturity, its age can positively influence the productivity achieved (via selection and learning effects), but after the enterprise reaches maturity, its age may weaken its performance in terms of productivity (via inertia and learning effects).

Previous studies on the relationship between firm age and enterprise productivity may indicate the nonlinear character of this relationship. Generally, firm age is positively related to productive growth, as shown in recent analyses of Czech (IMF 2018) or Ethiopian (2018) firms, but 'the size premia' for productivity are significantly weaker in the service sector than in manufacturing (Berlingieri *et al.* 2018). Simultaneously, we find strong evidence at Australian (Palangkaraya 2009), Spanish (Coad *et al.* 2013), and Croatian (Pervan *et al.* 2017) enterprises of a high degree of inertia in terms of productivity: older firms on average are less productive, as the benefits of their cumulative knowledge on all crucial aspects of the business are overcome with their inertia, inflexibility, and ossification due to the accumulated rules, routines, and organisational structure. In view of these different relationships between age and productivity, we propose the following hypothesis:

H2: *Firm age needs to be controlled for when looking at relationships between factors that affect labour productivity, as a nonlinear relationship may exist between firm age and labour productivity.*

Another characteristic of many companies and being part of large firm may also affect productivity. In the literature it is often related to the ownership advantages of transnational corporations, which provide local affiliates with two benefits (Nguyen & Nishijima 2009; Srinivasan & Archana 2011). First, access to their better marketing connections and know-how of parent companies enable the use of scale economies. Second, access to parent companies' cumulative learning experience as well as access to sophisticated technologies and management experience improve technical efficiency. All this could have a positive influence on the labour productivity of enterprises, so we propose the following hypothesis:

H3: *Being a part of larger firm is positively related to labour productivity growth.*

Some studies on firm-specific determinants of firm performance indicate that foreign ownership participation increases firm performance (Greenaway *et al.* 2014; Javorcik 2004). In the literature, we found strong evidence that foreign-owned firms are more productive than domestic firms in analyses by Guadalupe *et al.* (2012) and Blonigen *et al.* (2012) on Spain, Weche Gelübcke (2013) on Germany, Waldkirch (2014 on 118 developing countries), Koch, Smolka (2017) on

Austria. This is because foreign-owned firms invest more in R&D, are more likely to innovate (introduce new products and/or processes) than their domestic counterparts, and may be better managed (Haldane 2017). Driffield *et al.* (2018), analysing a large firm-level dataset on Germany, Poland, Italy, and the UK and using an endogenous threshold approach shows significant differences and some non-linearities in the relationship between foreign ownership and productivity. These considerations lead us to propose the following hypothesis:

*H4: Foreign-owned firms are more productive than domestic firms.*

The last firm-specific feature as productivity determinant is a firm's status as an exporter. This is connected with the learning-by-exporting (LBE) hypothesis stipulated by Alvarez and Lopez (2005) that firms increase their productivity as a consequence of exporting. According to this hypothesis, the productivity-increasing effect of a firm's international activity is a consequence of, for example, increased competition from the larger international market and knowledge and expertise related to the foreign market, which non-exporters do not possess (Silva *et al.* 2012). In terms of LBE, some studies find a positive link between exporting and subsequent productivity growth (on Estonia, De Loecker 2013; on Japan, Hosono *et al.* 2015; on Spain, Manjon *et al.* 2013; on Germany, Schwarzer 2017). However, others find no evidence of such effects (on Latvia and Estonia, Benkovskis *et al.* 2017; on Germany, the UK, and France, Temouri *et al.* 2013). The evidence for this effect so far is rather sparse, but the main factors that make it difficult to observe LBE are: quick diffusion of all innovative solutions, which prevents enterprises from investing, and a relatively small share of exporters with little experience, among whom the effect is the strongest. Furthermore, supporting evidence suggests that LBE is far from guaranteed but, instead, is conditional on several factors. For example, it tends to occur more when firms export to developed economies (De Loecker 2007), or when they export many products to many destinations (Masso and Vahter 2015). According to Benkovskis *et al.* (2017), the occurrence of LBE can be conditional on the type of activities in which exporters. These arguments lead us to propose the following hypothesis:

*H5: A firm's international activity may foster labour productivity.*

Innovations are part of the second group of determinants, which may foster labour productivity of firms but are not related to firm characteristics. Measuring firm innovations is challenging. Many existing approaches focus on measuring inputs to innovation (e.g. R&D expenditures) or proxies for the output of innovation (e.g. patents), but such measures may capture only a fraction of firm innovative activity (Foster *et al.* 2018). Despite this, many studies show that R&D per employee or relative R&D intensity contribute to firm-level labour productivity growth across countries and sectors (on German enterprises, Baumann and Kritikos



2016; on the US and the EU, Castellani 2016; on China and India, Hecht 2018). Moreover, substantial empirical literature shows positive impacts of the output of innovations (product and process innovations) on labour productivity, but that the impact of process innovation is more ambiguous (Hall 2011; Peters 2005). As mentioned earlier, the correlation between product innovation and productivity is often higher at larger firms, and as expected, in most countries the productivity effect of product innovation is larger in the manufacturing sector than in the services sector (OECD 2009). In view of the foregoing, we propose the following hypothesis:

H6: *The level of innovativeness, measured by R&D expenditures or in terms of product/production/management/process/innovations, is positively correlated with labour productivity.*

We also test how a human capital determines labour productivity, based on the theoretical achievements of the ‘new growth theories’ (Lucas 1988; Romer 1986). In the literature, the four main effects of human capital impact on labour productivity are the *worker effect* (education increases the effective labour input from the hours worked), the *allocative effect* (better-educated workers are more effective at allocating available input factors to the production process), the *diffusion effect* (better-educated workers are more able to adapt to technological change and introduce new production techniques more quickly), and the *research effect* (higher education as an important input factor in R&D activities) (Cörvers 1994). Many empirical studies confirm the positive impact of highly skilled labour on the sector/firm labour productivity level, such as Rukumnuaykit and Pholphirul (2016) on Thailand, Bank of Malta (2018) on Malta, Sasso and Ritzen (2019) on 12 OECD economies and 17 industries, and Okumu and Maweje (2019) on African firms. In addition to employee skills, the CEO’s college degree, vocational training, and work experience are important in the increase in labour productivity growth. The results of the very large international survey of 10,000 organisations across 20 countries provide convincing evidence that the wide range in the quality of management practices explains differences in productivity among firms and countries, implying that better management leads to higher rates of growth and productivity (Bloom *et al.* 2012). Accordingly, we propose the following hypothesis:

H7: *Higher levels of human capital, in terms of secondary-level educated workers or well-educated and experienced CEOs, are positively correlated with labour productivity growth.*

The last group of labour productivity determinants is related to firms’ technological capabilities. They are not only built by years of production experience but also require technologically advanced investment (Wignaraja 2012). Many technological activities are involved, but our research focuses on importing technology through foreign licences as an important factor in technology transfer and building internal capability (Wignaraja 2015). Many previous analyses show that technology imports have a significantly positive impact on labour productivity, in

researches by OECD (2018) on Thailand, Fotros and Ahmadvan (2017) on Iran, and Youssef and Wei (2011) on China. Additionally, we want to check not only how a technology imports but also how technology use influences labour productivity at firms. ICT (information, communication, and technology) use affects labour productivity through different channels. It improves access to information, helping firms to optimise management practices and reorganise their business model, to use their existing capacity more efficiently, and to reduce risks and costs (Bartel *et al.* 2007). The literature highlights the role of necessary skills and modern organisational practices to obtain the productivity gains that ICT can provide (Bloom 2012). Previous studies suggest that ICT has a very strong positive impact on labour productivity, sometimes more than the other determinants (Ayodele *et al.* 2017; Cardona *et al.* 2013; Nurmilaakso 2009; Oulton 2012), but this impact is greater in transition economies than in developed economies (Relich 2017). As a result of this discussion, we propose the following hypothesis:

*H8: Enterprises that use ICT and foreign technology have higher labour productivity than other firms.*

## Research Strategy

In this study, we examine the relationship between firm-level labour productivity ( $Y$ ) and a set of selected determinants collected on individual enterprises. To evaluate this relationship empirically, we use a regression with two sets of explanatory variables which reflect firm characteristics ( $X$ ) and firm activities ( $Z$ ) respectively. Additionally, we explore whether the factors determining labour productivity vary across two groups of countries: Eastern EU countries and the other European and Central Asian countries and two groups of industries: manufacturing and services. We first examine this using binary variables ( $EU$ ,  $sector$ ) with the full sample. Our model takes the following form:

$$\ln Y_i = \beta_0 + \beta_1 X_i + \beta_2 Z_i + \beta_3 EU + \beta_4 sector + \varepsilon_i \quad (1)$$

In the next step, we focus on a regression estimated for sub-samples covering firms in Eastern EU countries and in the other EECA separately and then consider the manufacturing and service sectors separately.

The first estimator used in the regression is ordinary least squares (OLS). To evaluate the sensitivity of our results to changes in determinants that influence productivity, we estimate several specifications with alternative factors taking from separate, specific group of variables  $Z$  as a robustness check.

In this study, we also consider the problem of potential endogeneity, which can appear especially when we test the LBE hypothesis and exports are used as an explanatory variable for

labour productivity. This problem is widely discussed in the literature, mainly because of a simultaneous relationship between productivity and exports (e.g. Feenstra and Kee 2008). Because of the sample limitations, in terms of both the cross-sectional dimension of our data instead of panel data and the lack of a reliable and highly correlated ‘proxy’ for exports at the level of disaggregation we use, we are forced to reject the usual approaches.

To address the problem of potential endogeneity of regressors, we use an instrumental variables (IV) estimation with heteroskedasticity-based instruments proposed by Lewbel (2012). Lewbel’s estimator utilises the heteroskedasticity of error terms to identify the structural parameters in a model with endogenous regressors if traditional identifying information, such as external instruments or repeated measurements, are absent. In our model, we use modified two-stage least squares (2SLS) estimation based on this method.<sup>4</sup> The robustness check for 2SLS estimates is similar to that for OLS estimates.

## Data Description and Empirical Model

The main database used in our empirical study is derived from the BEEPS V conducted by the EBRD and the WB. The survey provides a wide range of information at the firm level from 32 EECA countries. The database takes a form of cross-sectional data for 16 556 enterprises, between 2011 and 2016, with 62% of them evaluated in 2013. Detailed information about the database structure by country and by industry is presented in Appendix 1.

In our paper, firm-level labour productivity ( $\ln/prod$ ) is measured by the logarithm of the share of annual sales and the number of permanent full-time employees. To obtain the measure of firm-level productivity, first, we express firm sales in a common currency, US dollars. To do that, we convert firm sales with aid of the WB market annual average exchange rates for particular years, and then we express all the values in 2013 constant prices.

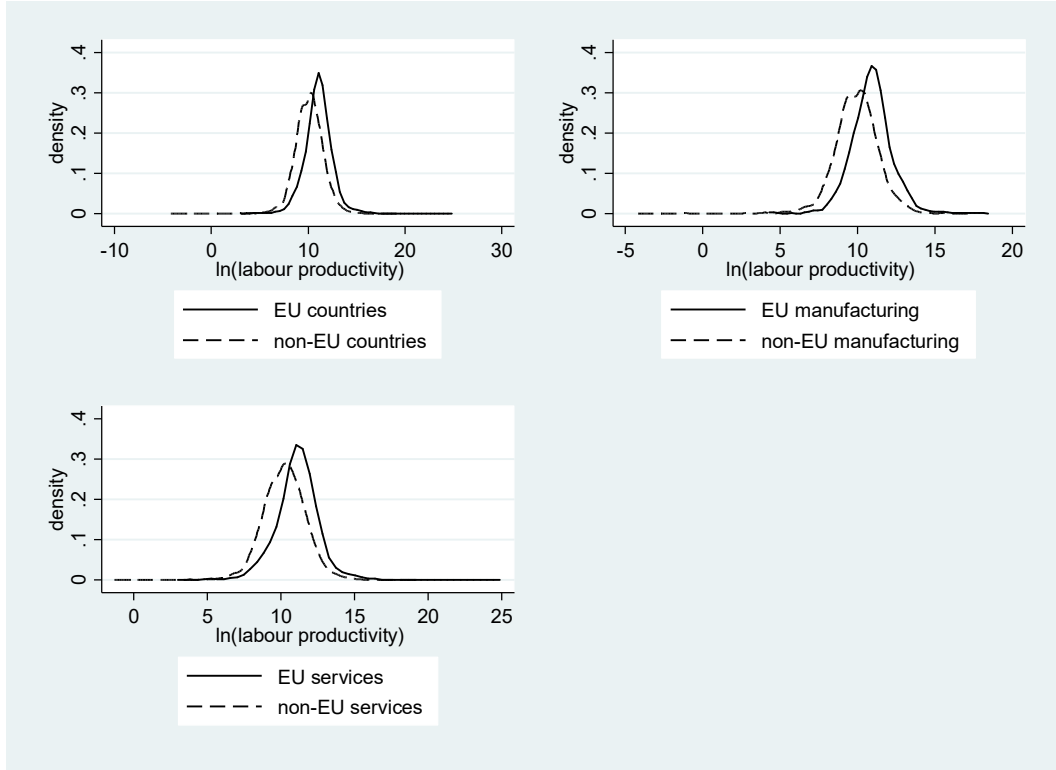
Figure 1 illustrates the differences in labour productivity for EU and non-EU economies as well as for manufacturing and service sectors in both groups of countries. In all the graphs, the pattern of labour productivity distribution is similar, and the distributions for EU countries shift slightly to the right. On average, labour productivity in EU countries is always higher than in the rest of the sample, whether we analyse the full sample or particular sectoral groups. Additionally, two sample t-tests on the equality of means and on the equality of distribution are conducted. Both indicate significant differences across EU and non-EU economies as well as in the manufacturing and service industries in terms of labour productivity. All the results suggest that,

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<sup>4</sup> We employ the Stata routine `ivreg2h`.

in addition to relationships in the full sample, it is worth taking a closer look at the sub-samples to assess the discrepancies in productivity factors.

Figure 1. Productivity differences: Kernel distribution of log labour productivity for EU and non-EU countries and for manufacturing and service sectors



The equation for estimating labour productivity takes the following form:

$$\ln lprod_{ijc} = \beta_0 + \beta_1 X_{ijc} + \beta_2 Z_{ijc} + \beta_3 EU + \beta_4 sector + D_j + D_c + \varepsilon_{ijc} \quad (2)$$

The explanatory variables are divided into two main groups. A set of variables described by  $X$  consists of firm-level characteristics. The age of establishment ( $\ln age$ ) is measured by the difference between the year the survey was conducted and the year that the firm began operations, and it is taken in logarithm. Firm size ( $size$ ) is a discrete variable that reflects whether the firm is micro, small, medium, or large, depending on the level of employment.<sup>5</sup> We also consider firm ownership, especially whether it has a foreign owner ( $foreigner$ ) as well as whether it is a part of larger organisation ( $partOfLarge$ ). The last factor in this group is linked to the firm's

<sup>5</sup> According to the BEEPS V database, micro firms employ fewer than 5 workers, small firms between 5 and 19, medium-size firms between 20 and 99, and large firms over 100 workers.

export performance. *Export* is a binary variable which takes a value of 1 if the share of exported products, both directly and indirectly<sup>6</sup>, in total sales is greater than 0.

The second main group of variables  $Z$  reflects significant firm activities that may affect labour productivity. Those factors are divided into three sub-groups. In each sub-group we propose two measures which are used alternatively in different model specifications. The first sub-group illustrates the involvement of the firms analysed in different kinds of innovation—product, production, process, or management (*inno*)—as well as their R&D expenditure (*rd*). The second consists of binary variables that represent the firm’s technology involvement. *Ftech* takes a value of 1 if the firm uses a technology licensed from a foreign-owned company, and *ICT* variable takes a value of 1 when the firm uses ICT tools. The third sub-group is variables which describe firm workers and their skills—i.e. in our model we use the number of workers with a university degree (*workerskills*) and the years of experience of top managers (*managerskills*).

Additionally, our model includes binary variables *EU* and *sector*, which allow us to observe the differences in labour productivity between Eastern EU countries and the ECA countries and between manufacturing and service sectors respectively as seen in Figure 1. Finally, the model contains dummy variables to control for industry (*D<sub>i</sub>*) and country (*D<sub>c</sub>*) heterogeneity.

## Empirical Results and Discussion

In this section, we present the results of estimating model (2). First, we analyse the model for the full sample, comprising more than 12,000 individual firms in 32 countries and 36 NACE 1.1 sectors (Table 1). Column (1) lists the OLS results for the base model with firm-level characteristics only and individual effects for industries and countries. In columns (2), (4), (6), and (8), we present the OLS results for an extended model that takes into account alternative measures of firm-level activities, as described earlier. Columns (3), (5), (7), and (9) report the same specifications, but the models are estimated with the IV method and heteroskedasticity-based instruments to control for potential endogeneity.

Regardless of the model specification and estimation method, we find evidence that firm ageing significantly influences labour productivity, but that relationship is parabolic rather than linear. In the first period of firm activity in a market, its productivity is supported by increasing experience and the ‘learning-by-doing’ effect, but as firms age, their productivity drops because of increasing inertia and flexibility, as explained in the theoretical section of this paper.

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<sup>6</sup> In the BEEPS V questionnaire, indirect exports are understood as products that are sold domestically to third parties that then export them.

Among other firm characteristics that foster increases in labour productivity is firm size. The larger the enterprise is, the higher the labour productivity is. That conclusion is in line with our expectations and confirms that the firms analysed achieve economies of scale. The positive and statistically significant link to productivity is also given by firm ownership expressed by foreign owner participation. Higher R&D expenditure, more innovation, or better management practices combined with foreign ownership positively affect firm productivity.

Considering firms' export status, we find a positive and significant impact on the phenomenon analysed, and at the same time it confirms the LBE hypothesis. The variable *export* is the sum of direct and indirect exports, so it suggests that linkages between domestic firms, so-called domestic value chains, support an increase in labour productivity.

In this group of factors, the variable for which no significant influence is observed is *partOFlarge*, however the coefficients remain positive.

In our approach, to assess the sensitivity of the results to changes in data, we estimate different model specifications with the use of alternative variables within sub-groups of determinants. As mentioned earlier, we employ alternative measures of innovation, technology engagement, and human capital. Taking into account these measures of firm activity, we find strong and positive evidence for a relationship between firm-level labour productivity and different forms of innovation in which firms are involved, technology engagement linked to the use of ICT tools, and the use of technology delivered by foreign owners, as well as between productivity and the share of employees with a university degree (*workerskill*). Regardless of the model specification, the contribution of top managers' experience remains negligible. The impact of R&D activity is indeed positive, but it does not explain productivity in a significant way.

Our results indicate that firms in the Eastern EU and in manufacturing on average have higher labour productivity than those in the other of EECA countries and in the services. It clearly suggests that individual regressions should be estimated for separate sub-samples.

Table 1. Determinants of labour productivity in Eastern European and Central Asian countries

	OLS (1)	OLS (2)	2SLS (3)	OLS (4)	2SLS (5)	OLS (6)	2SLS (7)	OLS (8)	2SLS (9)
<i>ln_age</i>	0.324*** [0.108]	0.360*** [0.108]	0.362*** [0.105]	0.376*** [0.106]	0.378*** [0.103]	0.344*** [0.105]	0.344*** [0.103]	0.318*** [0.102]	0.319*** [0.099]
<i>ln_age2</i>	-0.08*** [0.020]	-0.08*** [0.020]	-0.08*** [0.019]	-0.08*** [0.020]	-0.08*** [0.019]	-0.08*** [0.020]	-0.08*** [0.019]	-0.08*** [0.018]	-0.08*** [0.017]
<i>size</i>	0.147** [0.070]	0.140* [0.070]	0.136* [0.071]	0.148** [0.070]	0.144** [0.071]	0.131* [0.070]	0.131* [0.071]	0.132* [0.070]	0.130* [0.071]
<i>partOFlarge</i>	0.140 [0.088]	0.112 [0.088]	0.109 [0.091]	0.108 [0.088]	0.104 [0.091]	0.109 [0.091]	0.108 [0.093]	0.118 [0.086]	0.115 [0.088]
<i>fowner</i>	0.359*** [0.061]	0.317*** [0.064]	0.311*** [0.071]	0.303*** [0.064]	0.296*** [0.071]	0.327*** [0.062]	0.324*** [0.069]	0.329*** [0.067]	0.324*** [0.074]
<i>export</i>	0.159*** [0.043]	0.112*** [0.040]	0.156** [0.070]	0.128*** [0.035]	0.180** [0.072]	0.110** [0.042]	0.119* [0.062]	0.136*** [0.037]	0.172** [0.077]
<i>inno</i>		0.047*** [0.009]	0.046*** [0.010]			0.045*** [0.010]	0.045*** [0.011]	0.056*** [0.009]	0.054*** [0.009]
<i>rd</i>				0.090 [0.059]	0.084 [0.065]				
<i>Ftech</i>		0.133*** [0.031]	0.129*** [0.030]	0.150*** [0.031]	0.146*** [0.031]			0.153*** [0.030]	0.150*** [0.030]
<i>ICT</i>						0.223*** [0.068]	0.222*** [0.068]		
<i>workerskill</i>		0.005*** [0.001]	0.005*** [0.000]	0.005*** [0.001]	0.005*** [0.000]	0.005*** [0.001]	0.005*** [0.001]		
<i>managerskill</i>								0.000 [0.001]	0.000 [0.001]
<i>EU</i>		1.436*** [0.024]	2.122*** [0.030]	1.439*** [0.024]	2.127*** [0.029]	1.204*** [0.032]	2.108*** [0.023]	1.423*** [0.020]	2.043*** [0.033]
<i>sector</i>		0.425*** [0.085]	0.451*** [0.094]	0.452*** [0.107]	0.459*** [0.095]	0.471*** [0.085]	0.480*** [0.094]	0.434*** [0.081]	0.206** [0.098]
<i>_cons</i>	9.074*** [0.118]	8.487*** [0.175]	10.33*** [0.016]	8.437*** [0.192]	10.32*** [0.017]	8.325*** [0.189]	10.34*** [0.014]	8.619*** [0.155]	10.32*** [0.018]
<i>R2/R2c</i>	0.267	0.279	0.279	0.281	0.281	0.281	0.281	0.273	0.273
<i>N</i>	12 362	11 716	11 716	11 774	11 774	11 778	11 778	11 905	11 905
<i>idp</i>			0.000		0.000		0.000		0.000

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ , clustered robust errors by country in square brackets. All specifications include individual effects for both industries and countries. The figures reported for the *idp* are the p-values and refer to the Kleibergen-Paap rk LM test statistic.

Based on significant differences in labour productivity distribution (Figure 1) confirmed by the results of the equality of distribution and of means tests, as well as bearing in mind the positive and significant *EU* coefficient in Table 1, we estimate equation (2) for Eastern EU countries and countries in Eastern Europe and Central Asia. The estimation results are presented

in Tables 2 and 3. Columns (1)–(9) in both tables reflect analogous model specifications as described for Table 1, omitting only *EU* variable.

A comparison of the estimation results for the two separate groups of countries reveals important differences in the significance of particular factors and the level of their influence on labour productivity. Considering firm age, we confirm the non-linear pattern in the relationship as seen in a joint model. In the first period of activity in a market, the EU firms generate higher levels of productivity than non-EU firms, and they do it more rapidly. At the same time, the decline in productivity connected with their age takes place later at EU firms than at those in non-EU economies. Such significant differences can be explained as a result of non-EU countries having a less competitive market.

Discrepancies in coefficients are also visible when foreign ownership is taken into consideration. Enterprises in EU countries and those with foreign ownership on average have higher productivity than those with only domestic ownership (42-48%), whereas the average difference in labour productivity between foreign and domestically owned companies in non-EU countries is about 20-22%. We also note differences between Tables 2 and 3 in the significance of particular factors that influence productivity. Their impact still creates growth in the phenomenon, but firm size, widely understood innovations, and the use of foreign technology are not significant at Eastern EU firms, whereas *partOFlarge* and *rd* are insignificant in other EECA firms.

Regardless of the group of countries, model specification, or estimation method, human capital measured by employee skills positively contribute to this phenomenon, but its impact is not very big. On average, productivity is about 0.5% higher at firms that employ highly skilled workers than at those that do not. Human capital expressed by firm managers' experience is still insignificant in both groups of countries as observed in the joint model.



Table 2. Determinants of labour productivity for Eastern EU countries

	OLS (1)	OLS (2)	2SLS (3)	OLS (4)	2SLS (5)	OLS (6)	2SLS (7)	OLS (8)	2SLS (9)
<i>ln_age</i>	0.555** [0.212]	0.543** [0.206]	0.545*** [0.195]	0.551** [0.211]	0.553*** [0.199]	0.514** [0.218]	0.516** [0.206]	0.520** [0.189]	0.520*** [0.180]
<i>ln_age2</i>	-0.103** [0.040]	-0.101** [0.039]	-0.10*** [0.037]	-0.102** [0.040]	-0.10*** [0.037]	-0.094** [0.041]	-0.094** [0.038]	-0.097** [0.035]	-0.10*** [0.034]
<i>size</i>	0.052 [0.064]	0.068 [0.059]	0.065 [0.052]	0.068 [0.059]	0.06 [0.052]	0.055 [0.059]	0.052 [0.052]	0.049 [0.055]	0.049 [0.049]
<i>partOfLarge</i>	0.236* [0.119]	0.203 [0.119]	0.200* [0.114]	0.178 [0.122]	0.172 [0.117]	0.222* [0.118]	0.219* [0.114]	0.258* [0.121]	0.258** [0.115]
<i>fowner</i>	0.487*** [0.087]	0.445*** [0.082]	0.439*** [0.083]	0.428*** [0.084]	0.416*** [0.083]	0.447*** [0.083]	0.442*** [0.084]	0.467*** [0.084]	0.466*** [0.084]
<i>export</i>	0.184*** [0.049]	0.131*** [0.035]	0.170* [0.083]	0.141*** [0.045]	0.234*** [0.068]	0.125*** [0.033]	0.159* [0.091]	0.168*** [0.042]	0.174* [0.105]
<i>inno</i>		0.011 [0.014]	0.009 [0.015]			0.008 [0.013]	0.006 [0.014]	0.023 [0.015]	0.023 [0.017]
<i>rd</i>				0.103 [0.090]	0.089 [0.084]				0.097 [0.064]
<i>Ftech</i>		0.046 [0.069]	0.043 [0.064]	0.049 [0.065]	0.043 [0.061]			0.097 [0.068]	
<i>ICT</i>						0.327*** [0.084]	0.326*** [0.080]		
<i>workerskill</i>		0.006*** [0.001]	0.006*** [0.001]	0.006*** [0.001]	0.006*** [0.001]	0.006*** [0.001]	0.006*** [0.001]		
<i>managerskill</i>								0.002 [0.002]	0.002 [0.002]
<i>sector</i>	.	0.159 [0.122]	0.578*** [0.157]	0.155 [0.122]	0.609*** [0.152]	0.455*** [0.083]	0.588*** [0.176]	0.15 [0.126]	0.338** [0.136]
<i>_cons</i>	10.26*** [0.323]	10.05*** [0.288]	11.70*** [0.048]	10.06*** [0.295]	11.66*** [0.050]	9.563*** [0.379]	11.67*** [0.083]	10.10*** [0.253]	11.56*** [0.049]
<i>R2/R2c</i>	0.213	0.228	0.228	0.227	0.227	0.232	0.232	0.219	0.219
<i>N</i>	3353	3161	3161	3184	3184	3176	3176	3222	3222
<i>idp</i>			0.000		0.000		0.000		0.000

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ , clustered robust errors by country in square brackets. All specifications include individual effects for both industries and countries. The figures reported for the *idp* are the p-values and refer to the Kleibergen-Paap rk LM test statistic.

Table 3. Determinants of labour productivity for Eastern non-EU countries and Central Asian countries

	OLS (1)	OLS (2)	2SLS (3)	OLS (4)	2SLS (5)	OLS (6)	2SLS (7)	OLS (8)	2SLS (9)
<i>ln_age</i>	0.251* [0.128]	0.306** [0.131]	0.308** [0.124]	0.325** [0.126]	0.327*** [0.120]	0.290** [0.127]	0.291** [0.102]	0.267** [0.124]	0.269** [0.118]
<i>ln_age2</i>	-0.067** [0.024]	-0.07*** [0.025]	-0.07*** [0.024]	-0.08*** [0.024]	-0.08*** [0.023]	-0.07*** [0.024]	-0.07*** [0.023]	-0.07*** [0.023]	-0.07*** [0.021]
<i>size</i>	0.182* [0.090]	0.166* [0.092]	0.161* [0.095]	0.179* [0.091]	0.174* [0.092]	0.160* [0.091]	0.157* [0.093]	0.164* [0.091]	0.160* [0.094]
<i>partOfLarge</i>	0.11 [0.109]	0.082 [0.108]	0.077 [0.111]	0.087 [0.109]	0.083 [0.111]	0.072 [0.108]	0.07 [0.108]	0.073 [0.102]	0.07 [0.105]
<i>fonner</i>	0.257** [0.105]	0.215* [0.108]	0.207* [0.118]	0.205* [0.107]	0.198* [0.116]	0.224** [0.105]	0.219* [0.114]	0.220* [0.111]	0.213* [0.121]
<i>export</i>	0.143** [0.058]	0.097* [0.055]	0.164* [0.091]	0.114** [0.047]	0.171* [0.098]	0.097 [0.060]	0.134* [0.075]	0.118** [0.049]	0.178* [0.107]
<i>inno</i>		0.062*** [0.008]	0.060*** [0.009]			0.060*** [0.008]	0.059*** [0.009]	0.069*** [0.008]	0.068*** [0.009]
<i>rd</i>				0.083 [0.075]	0.076 [0.083]				
<i>Ftech</i>		0.171*** [0.028]	0.165*** [0.027]	0.195*** [0.027]	0.189*** [0.028]			0.181*** [0.029]	0.175*** [0.032]
<i>ICT</i>						0.201** [0.078]	0.201*** [0.077]		
<i>workerskill</i>		0.005*** [0.001]	0.005*** [0.001]	0.005*** [0.001]	0.005*** [0.001]	0.005*** [0.001]	0.005*** [0.001]		
<i>managerskill</i>								-0.001 [0.001]	-0.001 [0.001]
<i>sector</i>		0.409*** [0.112]	0.407*** [0.108]	0.403*** [0.113]	0.402*** [0.109]	0.229 [0.155]	0.435*** [0.109]	0.166 [0.123]	0.165 [0.119]
<i>_cons</i>	9.143*** [0.142]	8.557*** [0.178]	10.01*** [0.020]	8.532*** [0.170]	10.00*** [0.021]	8.645*** [0.232]	10.02*** [0.018]	8.928*** [0.178]	10.00*** [0.022]
<i>R2/R2c</i>	0.217	0.231	0.231	0.233	0.233	0.232	0.232	0.225	0.225
<i>N</i>	9009	8555	8555	8590	8590	8602	8602	8683	8683
<i>idp</i>			0.000		0.000		0.000		0.000

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ , clustered robust errors by country in square brackets. All specifications include individual effects for both industries and countries. The figures reported for the *idp* are the p-values and refer to the Kleibergen-Paap rk LM test statistic.

In addition to discrepancies in labour productivity distribution in the EU and non-EU groups of countries, we also observe significant differences in labour productivity when manufacturing and services are considered. Again, columns (1)–(9) in Tables 4 and 5, for manufacturing and services respectively, are analogous to those in Table 1, omitting *sector*.

Table 4. Determinants of labour productivity in manufacturing in EECA countries

	OLS (1)	OLS (2)	2SLS (3)	OLS (4)	2SLS (5)	OLS (6)	2SLS (7)	OLS (8)	2SLS (9)
<i>ln_age</i>	0.187 [0.165]	0.232 [0.168]	0.232 [0.162]	0.228 [0.169]	0.23 [0.162]	0.214 [0.165]	0.212 [0.160]	0.213 [0.154]	0.211 [0.149]
<i>ln_age2</i>	-0.049 [0.029]	-0.056* [0.030]	-0.056* [0.029]	-0.055* [0.031]	-0.055* [0.029]	-0.052* [0.030]	-0.052* [0.029]	-0.053* [0.027]	-0.053** [0.026]
<i>size</i>	0.101** [0.047]	0.079* [0.046]	0.080 [0.059]	0.088* [0.046]	0.081* [0.049]	0.079* [0.042]	0.084 [0.056]	0.072 [0.045]	0.078 [0.056]
<i>partOFlarge</i>	0.049 [0.154]	0.013 [0.141]	0.014 [0.146]	0.014 [0.139]	0.01 [0.143]	0.018 [0.136]	0.021 [0.142]	0.023 [0.136]	0.026 [0.142]
<i>fowner</i>	0.328*** [0.085]	0.265*** [0.089]	0.266*** [0.101]	0.259*** [0.089]	0.252*** [0.096]	0.293*** [0.088]	0.299*** [0.102]	0.291*** [0.092]	0.297*** [0.105]
<i>export</i>	0.195*** [0.038]	0.166*** [0.033]	0.160 [0.115]	0.182*** [0.032]	0.228* [0.135]	0.161*** [0.037]	0.126 [0.149]	0.170*** [0.034]	0.126 [0.178]
<i>inno</i>		0.057*** [0.015]	0.057*** [0.016]			0.056*** [0.016]	0.057*** [0.019]	0.067*** [0.013]	0.069*** [0.015]
<i>rd</i>				0.029 [0.099]	0.024 [0.104]				
<i>Ftech</i>		0.228*** [0.055]	0.228*** [0.056]	0.248*** [0.055]	0.244*** [0.053]			0.222*** [0.050]	0.225*** [0.054]
<i>ICT</i>						0.189** [0.072]	0.191** [0.076]		
<i>workerskill</i>		0.004*** [0.001]	0.004*** [0.001]	0.004*** [0.001]	0.004*** [0.001]	0.004*** [0.001]	0.004*** [0.001]		
<i>managerskill</i>								-0.002 [0.001]	-0.002 [0.002]
<i>EU</i>		1.567*** [0.039]	1.812*** [0.072]	1.425*** [0.021]	1.819*** [0.056]	1.438*** [0.017]	1.764*** [0.061]	1.564*** [0.041]	1.833*** [0.093]
<i>_cons</i>	9.386*** [0.201]	9.258*** [0.205]	10.18*** [0.053]	9.262*** [0.203]	10.18*** [0.048]	9.199*** [0.225]	10.20*** [0.055]	9.326*** [0.193]	10.15*** [0.068]
<i>R2/R2c</i>	0.257	0.273	0.273	0.272	0.272	0.272	0.272	0.269	0.269
<i>N</i>	5127	4826	4826	4858	4858	4856	4856	4921	4921
<i>idp</i>			0.000		0.000		0.000		0.000

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ ; clustered robust errors by country in square brackets. All specifications include both individual effects for industries and for countries. The figures reported for the *idp* are the p-values and refer to the Kleibergen-Paap rk LM test statistic.

Table 5. Determinants of labour productivity for service industries in EECA countries

	OLS (1)	OLS (2)	2SLS (3)	OLS (4)	2SLS (5)	OLS (6)	2SLS (7)	OLS (8)	2SLS (9)
<i>ln_age</i>	0.427*** [0.116]	0.446*** [0.109]	0.446*** [0.107]	0.469*** [0.108]	0.469*** [0.105]	0.424*** [0.107]	0.425*** [0.105]	0.403*** [0.111]	0.402*** [0.109]
<i>ln_age2</i>	-0.10*** [0.025]	-0.09*** [0.023]	-0.09*** [0.022]	-0.10*** [0.022]	-0.10*** [0.022]	-0.10*** [0.023]	-0.10*** [0.022]	-0.09*** [0.023]	-0.09*** [0.023]
<i>size</i>	0.185** [0.090]	0.187** [0.090]	0.186** [0.089]	0.197** [0.090]	0.197** [0.088]	0.174* [0.092]	0.174* [0.091]	0.181* [0.091]	0.180** [0.090]
<i>partOfLarge</i>	0.209** [0.086]	0.182* [0.091]	0.180** [0.087]	0.177* [0.088]	0.176** [0.085]	0.176* [0.098]	0.177* [0.094]	0.188** [0.091]	0.186** [0.088]
<i>fowner</i>	0.396*** [0.089]	0.368*** [0.092]	0.364*** [0.092]	0.348*** [0.092]	0.345*** [0.092]	0.364*** [0.093]	0.367*** [0.091]	0.374*** [0.088]	0.371*** [0.087]
<i>export</i>	0.154* [0.079]	0.093 [0.081]	0.125* [0.076]	0.114 [0.071]	0.140** [0.071]	0.096 [0.079]	0.075 [0.087]	0.137* [0.077]	0.160** [0.074]
<i>inno</i>		0.042*** [0.012]	0.041*** [0.012]			0.037*** [0.012]	0.038*** [0.012]	0.048*** [0.011]	0.047*** [0.012]
<i>rd</i>				0.175** [0.068]	0.172*** [0.065]				
<i>Ftech</i>		0.033 [0.051]	0.031 [0.049]	0.05 [0.047]	0.048 [0.047]			0.081 [0.053]	0.079 [0.052]
<i>ICT</i>						0.241*** [0.075]	0.241*** [0.074]		
<i>workerskill</i>		0.006*** [0.001]	0.006*** [0.001]	0.006*** [0.001]	0.006*** [0.001]	0.006*** [0.001]	0.006*** [0.001]		
<i>managerskill</i>								0.002 [0.002]	0.002 [0.002]
<i>EU</i>		1.482*** [0.041]	2.281*** [0.038]	1.487*** [0.039]	2.274*** [0.044]	1.510*** [0.033]	2.282*** [0.046]	1.399*** [0.037]	2.142*** [0.038]
<i>_cons</i>	8.527*** [0.168]	8.641*** [0.131]	10.17*** [0.030]	8.221*** [0.183]	10.17*** [0.031]	8.453*** [0.136]	10.17*** [0.029]	8.859*** [0.127]	10.25*** [0.037]
<i>R2/R2c</i>	0.265	0.277	0.277	0.28	0.28	0.28	0.28	0.268	0.268
<i>N</i>	7235	6890	6890	6916	6916	6922	6922	6984	6984
<i>idp</i>			0.000		0.000		0.000		0.000

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ ; clustered robust errors by country in square brackets. All specifications include both individual effects for industries and for countries. The figures reported for the *idp* are the p-values and refer to the Kleibergen-Paap rk LM test statistic.

Taking into account firm age, the difference in coefficients and their significance is noticeable, however, the parabolic pattern remains. The model for productivity in manufacturing, unlike in the services, is the first model in which firm age and its significance are not that clear. When we take a closer look at the coefficients, they suggest that service firms achieve higher levels of productivity than manufacturing firms, and that growth is more rapid, a pattern that is similar to the one seen in EU countries. The decline in this phenomenon based on non-linear character of the relationship is also not deep in the services. Comparing productivity factors more

globally, we see that their importance in supporting productivity is much more visible when service firms are analysed as a group. Firm size, being a part of a larger company, exporting status, both forms of innovation, the use of ICT, and worker skills boost productivity in services. Manufacturing firms show the strong impact on productivity when they engage in exporting, have a foreign owner or highly skilled workers, and when they engage in at least one of the four forms of innovation. Productivity is also supported by the use of foreign technology.

## **Conclusions**

This paper investigates the determinants of labour productivity at Eastern European and Central Asian firms, paying special attention to the role of particular factors in manufacturing and the services. Our analysis of a comprehensive sample of firms in the EBRD-WB BEEPS provides also additional insights on labour productivity differences between Eastern EU countries and the EECA countries.

The micro-econometric analysis underscores firm heterogeneity in labour productivity growth. Firm characteristics play a large role. Young, large exporters with foreign ownership generate higher productivity. Also, Eastern European and Central Asian firms that employ highly skilled workers supported by ICT use and intensive innovation activity foster labour productivity growth. Specific determinants play different roles depending on the sector in a firm is operating and where it is located. Enterprises in countries that are EU members and are foreign owned on average have higher productivity than firms in countries that are not EU members. In addition, productivity is much more sensitive at service firms than at manufacturing firms to changes in productivity factors, such as firm size, being part of a larger company, export status, innovation activity, and the use of ICT, which boost productivity in services much more than in manufacturing.

Our findings lead to some important implications for policies on labour productivity growth in Eastern European and Central Asian firms. Of course, there is no ‘one-size-fits-all’ policy that can be implemented in EECA countries, but we can offer some general recommendations.

We show that the more productive a company is, the more important are innovative sources of productivity. We recommend that government support programmes be put in place at highly productive companies, which often require a higher level of ICT complementarity to boost productivity.

Our findings also suggest that favourable business conditions need to be created for the most productive firms, facilitating technology diffusion. Incentives should focus on ICT activity, which will create strong potential for spillovers, including linkages between foreign and local firms, education, training, and R&D.

In the paper, we underline the importance of investment in human capital (higher skills), providing recommendations for the government to design financial incentives and favourable tax policies that encourage individuals and employers to invest in tertiary education and on-the-job training for all workers.

Our study has some limitations. First, causality issues may result from any unobservable not identified variables in the matching model and may also arise from the cross-sectional nature of the data. Second, the limited availability of data forced us to use total sales per employee as our main dependent variable.

Further research utilising the BEEPS data should try to incorporate evolution in the firms and their adaptation to changing economic conditions (use of lagged variables). However, this requires a panel dataset. It would also be fruitful to match micro-survey information in the BEEPS with other databases, such as firms' balance sheets. In this regard, an interesting avenue for future research is focusing on a better understanding of the relationship between productivity, investment, and financing conditions.

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Appendix 1. Structure of database by country and by industry

Eastern EU countries			Eastern non-EU and Asian countries			Manufacturing sector			Service sector		
country	N	%	country	N	%	NACE 1.1	N	%	NACE 1.1	N	%
Bulgaria	293	1.77	Albania	360	2.17	15	1169	7.11	45	1343	8.17
Croatia	360	2.17	Armenia	360	2.17	16	29	0.18	50	442	2.69
Cyprus	360	2.17	Azerbaijan	390	2.36	17	330	2.01	51	2532	15.41
Czech Rep.	254	1.53	Belarus	360	2.17	18	581	3.53	52	3784	23.02
Estonia	273	1.65	Bosnia-Herzegovina	360	2.17	19	91	0.55	55	653	3.97
Greece	315	1.9	Macedonia	360	2.17	20	340	2.07	60	332	2.02
Hungary	310	1.87	Georgia	360	2.17	21	70	0.43	61	1	0.01
Latvia	336	2.03	Kazakhstan	600	3.62	22	379	2.31	62	1	0.01
Lithuania	270	1.63	Kosovo	200	1.21	23	14	0.09	63	290	1.76
Poland	542	3.27	Kyrgyzstan	270	1.63	24	404	2.46	64	164	1.00
Romania	540	3.26	Moldova	360	2.17	25	302	1.84	65	1	0.01
Slovakia	268	1.62	Mongolia	360	2.17	26	700	4.26	70	3	0.02
Slovenia	270	1.63	Montenegro	150	0.91	27	87	0.53	72	230	1.40
			Russia	4220	25.49	28	659	4.01			
			Serbia	360	2.17	29	548	3.33			
			Tajikistan	359	2.17	30	22	0.13			
			Turkey	1344	8.12	31	237	1.44			
			Ukraine	1002	6.05	32	30	0.18			
			Uzbekistan	390	2.36	33	183	1.11			
						34	44	0.27			
						35	58	0.35			
						36	346	2.11			
						37	37	0.23			

Source: Author calculations based on BEEPS V.

**Original citation:**

Kordalska A., Olczyk, M. (2019). What fosters firm-level labour productivity in Eastern European and Central Asian countries? GUT FME Working Paper Series A, No 3/2019 (55). Gdansk (Poland): Gdansk University of Technology, Faculty of Management and Economics.

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