REGIONAL FDI SPILLOVERS AND PRODUCTIVITY OF LOCAL FIRMS

IN NEW EU MEMBER STATES

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Abstract. *This research investigates how FDI affects the TFP of local firms in 59 NUTS3 regions of five new EU member states in 2004-2009 period. Although a lot of empirical work has been undertaken on the impact of FDI on indigenous firms' performance the regional channels through which MNCs affect TFP of local firms have been investigated to a much lesser extent. The results from spatial Durbin model and several other analytical methods reveal existence of inter-regional TFP spillovers as well as intra-regional and horizontal inter-regional FDI spillovers. The inter-regional impact of independent variables on the TFP of local firms amounts to about half of the impact on the region itself.*

Keywords: FDI, TFP, regions, spatial analysis, new EU member states

JEL: F23, R12

1. Introduction

The achievement of harmonious and balanced development of economic activities and convergence of economic performance are among founding principles of European Union. Yet, recent Report on economic and social cohesion in European Union (European Commission, 2013) reveals widening of development gap between EU regions. This is particularly true for regions in new EU member states whose GDP per capita falls below EU27 average with ten least advanced EU regions coming from these countries. Many theoretical models and empirical studies nowadays suggest that the persistence and widening of regional development disparities can be attributed to differences in productivity caused by variations in factor rewards, knowledge and technology intensity as well as spatial clustering of industries (Esteban, 2000; Boldrin and Canova, 2001; Benito and Ezcurra, 2005). Same line of reasoning indicates that one of the most important mechanisms behind regional economic convergence is the diffusion of technology and knowledge.

A lot of attention in recent years has been devoted to the impact of foreign direct investment (FDI) spillovers on the reduction of inter-regional income differences as well as the convergence in the inter-sectoral and inter-regional reallocation of productive factors (De la Fuente, 2002). The benefits of multinational corporations (MNCs) for local firms encompass increased local demand for upstream industries and local supply within same industries as well as forward linkages such as increased variety and quantity served at lower price (Markusen and Venables, 1999; Lin and Saggi, 2007). Transition literature has so far associated the entry of MNCs with enterprise restructuring (Djankov and Murrell, 2002), export competitiveness (Rugraff, 2006) and productivity growth (Schadler et al., 2006). Moreover, FDI spillovers influence regional output levels through technological spillovers and vertical linkages (Altomonte and Guagliano, 2004). Yet, there is no evident role in reducing the disparities across regions.

The high per capita FDI inflow in these countries makes it of crucial importance to analyse whether incentives given to MNCs so far are warranted and should countries continue to pursue policies aimed at attracting MNCs. To this end, the research posits two questions. First, whether and up to what extent the regional disparities in these countries are emphasized and second, whether MNCs contributed to regional convergence or divergence? In order to answer these questions the influence of FDI spillovers on the regional productivity of domestic firms in five new EU member states (Czech Republic, Estonia, Hungary, Slovak Republic and Slovenia) in 2004-2009 period is examined.

The empirical analysis of paper consists of two building blocks. The decomposition of regional income dynamics following Altomonte and Colantone (2008) is undertaken in order to assess the role of productivity dynamics in reduction of regional economic imbalances. Furthermore, a spatial Durbin model is applied to the data taken from Amadeus database in order to investigate the role of FDI spillovers and number of other regional characteristics for total factor productivity of domestic firms within regions defined at NUTS3 level. The novelty of our approach lies in distinction between the impact of inter-regional productivity spillovers among domestic firms, intra-regional and inter-regional FDI spillovers using spatial econometric techniques. To the best of our knowledge, there has been no attempt to analyse the role of FDI spillovers in regional productivity dynamics in such framework.

The rest of paper is structured as follows. Section two discusses different theoretical perspectives on sources and the nature of regional variations in productivity. The patterns of FDI spillovers are analysed in section three while section four assesses existing literature on FDI and productivity. Regional differences in productivity are examined in section five. The model of investigation relating productivity and FDI spillovers is discussed in section six. The dataset is presented in section seven while results of econometric analysis of the relationship between FDI spillovers and productivity of domestic firms are presented in section eight. Finally, section nine concludes.

2. Theoretical foundations of regional productivity differences

Regional variations in productivity have been investigated within variety of economic schools such as new classical, endogenous growth and more recently new economic geography (NEG). The search for causes of regional economic disparities has pointed to number of factors that could be behind divergent economic performance of regions ranging from institutional factors, regional and industry characteristics to the behaviour of firms. While diverging on opinions about origins and persistence of regional economic imbalances all theories agree that important role in the process of convergence belongs to the diffusion of technology and knowledge through spillover mechanisms.

New classical models consider regional variations in productivity as a temporary consequence of differences in capital-labour ratios and technological progress (Barro and Sala-I-Martin, 1991; Gardiner et al., 2004; Altomonte and Colantone, 2008). In the world of perfect competition, constant returns to scale, complete information and full divisibility of factors, the diffusion of technology across market takes place freely and instantaneously irrespective of regional or national administrative borders and paves the way for regional productivity convergence. Findings from empirical studies, however, point to the persistence national and regional income and productivity disparities more in line with predictions of endogenous growth literature or new economic geography (Quah, 1996; De la Fuente, 2002; Altomonte and Colantone, 2008).

Endogenous growth models suggest that the diffusion of technology across market does not take place instantaneously and inter-regional productivity differences may persist and even widen over time. This literature associates regional variations in productivity with components of regional innovation potential such as knowledge base, technological intensity of industries and proportion of workforce in knowledge intensive activities (Romer, 1986; 1990; Aghion and Howitt, 1998). The leadership of some regions in innovativeness provides their firms and industries with competitive advantage on goods and services market (Gardiner et al., 2004) and attracts inflow of knowledge and highly skilled workers from other regions (Aumayr, 2007). This is the reason why the knowledge and technology diffusion potential decreases with distance and above-average returns and knowledge externalities tend to be geographically concentrated.

New economic geography models (NEG) associate localised increasing returns with spatial concentration of economic activity and related externalities such as accumulation of skilled labour, local knowledge spillovers, specialised suppliers and services, cooperation between firms and scientific institutions as well as professional agencies (Krugman, 1991; Fujita et al., 1999; Fujita and Thisse, 2003; Baldwin et al., 2005; Hafner, 2013; Stojcic, et al., 2013). The emergence of agglomerations on particular locations is viewed as an outcome of socio-cultural, political and institutional structures. These factors explain why regions with initially similar underlying structures endogenously differentiate into rich "core" regions and less wealthy "peripheral" regions (Ottaviano and Puga, 1998; Altomonte and Colantone, 2008). Same factors can be accountable for the persistent inter-regional productivity differences.

3. FDI spillovers and productivity dynamics

Positive externalities of FDI in host country range from job creation, provision of necessary capital, tax revenues to the productivity growth. The productivity spillovers are often labelled as the most important benefits of FDI. According to Narula and Marin (2005), entry and presence of MNCs generate efficiency gains for host country's local firms and opens up the possibility for them to access foreign markets via the marketing and business networks of foreign companies with which they interact. This process, however, is not automatic but it depends on the ability of local environment to absorb the benefits of MNCs presence. Common classification of spillovers in the literature is the one on horizontal or intra-industry spillovers and vertical or inter-industry spillovers which can be further divided on backward and forward linkages indicating knowledge spillovers in supply chain.

Several theoretical models have been put forward explaining the mechanism of horizontal spillovers. In one set of models the emphasis is on acquisition of information about the costs and benefits of new methods, management practices and marketing strategies through demonstration or imitation of MNCs activities (Wang and Blomstrom, 1992). Models of competition spillovers generally assume that entry of MNCs motivates local firms to enforce stricter or more cost conscious management and stimulate faster adoption of new technologies and management practices (Blomstrom and Kokko, 1998). While on overall increased competition provides incentives for domestic firms to improve their performance, in the short run it may reduce market share of less productive firms and lead to their exit (Aitken and Harrison, 1999). Finally, models of worker mobility postulate that MNCs provide host country workforce with a higher degree of training, education and valuable working experience which gets diffused to local firms through movement of trained workers (Smeets, 2008; Markusen and Trofimenko, 2009).

MNCs also have the incentive to improve the productivity of their suppliers (backward linkages) through provision of training, organization and management, setting up a production facility, technical support for the improvement of the quality of goods and inventory management (Lall, 1980; Javorcik, 2004). Furthermore, forward linkages promote the forward transfer of knowledge from MNCs in upstream sectors to downstream indigenous firms. By purchasing high-quality intermediate products from MNCs domestic firms can improve their efficiency and as in case with backward linkages domestic firm has to improve its product, train its employees to use these more advanced technologies.

In one set of vertical spillovers models the entry of MNC increases demand for intermediate inputs which establishes the backward linkage (Rodriguez-Clare, 1996). According to Markusen and Venables (1999) entry of MNC produces competitive effect in the final goods sector, leading to exit of domestic firms. At the same time, establishment of backward linkages leads to lower average costs and increase in profits resulting in increased entry in upstream sector. This entry causes third effect as the reduction in prices of inputs benefits firms in downstream sector because of improved and cheaper intermediate products supplied by domestic firms. Finally, Pack and Saggi (2001) show how technology transfer to firms in upstream sector induces entry of other suppliers thus reducing concentration and lowering prices.

The necessary condition for transformation of knowledge spillovers potential into actual knowledge spillovers is the existence of absorptive capacity. On the one hand, it is suggested that the potential for technological imitation and adoption is larger when the technology gap between countries is wider (Findlay, 1978). However, Glass and Saggi (1998) suggest that it is less likely for domestic firms to have the human capital, organisational capabilities and sources of finance, physical infrastructure and distribution networks to benefit from spillovers when the technological gap is large. Cohen and Levinthal (1990) relate firm’s absorptive capacity with its existing level of technological competence at the time of foreign entry as well as the learning and investment efforts it makes afterwards in order to benefit from foreign knowledge.

The possibilities for indigenous firms to benefit from knowledge spillovers of MNCs located nearby are also affected by geographical distance. As knowledge is mainly tacit, geographical distance inhibits its transmission and absorption. Therefore, spatial proximity facilitates the process of knowledge diffusion influencing the existence and magnitude of spillovers for both domestic firms and MNCs with asset seeking motives. According to Girma (2005) demonstration effects will be local as the benefits are likely to be spread to neighbouring firms while the low mobility of labour can be a strong obstacle for technology spillovers. Finally, MNCs may prefer local linkage industries in order to minimize transaction costs and facilitate communication with the domestic supplier or distributor.

4. Review of literature

Early research on FDI spillovers has related measures of labour productivity with the share of foreign presence using aggregated data limited to a very short time span (Caves, 1974; Globerman, 1979; Blomstrom and Persson, 1983; Blomstrom, 1986). Second generation of empirical studies used firm level panel data and included many factors not considered earlier such as industry and regional characteristics and firm-level specificities. It also addressed methodological problems of the previous literature such as bias of total factor productivity arising from the fact that a firm may observe part of its productivity before the choice of inputs is made (Olley and Pakes, 1996; Levinsohn and Petrin, 2003). Existing studies have generally reported ambiguous results on the impact of FDI horizontal spillovers while theoretical predictions about positive impact of vertical spillovers have largely been confirmed (Javorcik, 2004; Tytell and Yudayeva, 2005; Gorodnichenko et al., 2007; Blalock and Gertler, 2008; Lefilleur and Maurel, 2010; Havranek and Irsova, 2011).

Over recent years sizeable body of empirical literature has addressed the spatial dimension of FDI knowledge spillovers. Liu and Wei (2006) found evidence of strong regional intra industry and inter industry spillovers from FDI and R&D on productivity in China while inter-regional spillovers are mostly negative due to barriers to the movement of factors of production and output across regions. Lin and Kwan (2013) show that FDI generates negative intra-regional spillovers to domestic firms. However, local firms are found to benefit from inter-regional FDI spillovers. Same study reports that in the long run the positive inter-regional spillovers outweigh the negative intra-regional spillovers thus creating overall positive effect.

Findings from European countries are somewhat opposite. Using UK data, Driffield (2004) showed that there are positive productivity spillovers from FDI in the same region while FDI outside the region has a negative impact on productivity. Girma and Wakelin (2007) assess whether the benefits from FDI are particularly high or low in relatively underdeveloped regions. Their results indicate that the productivity within and across sectors is positively affected by FDI within but not outside the region. Furthermore, they report evidence that domestic plants located in regions where MNCs receive government assistance gain less from FDI. Smaller plants are found to benefit more from FDI, especially those with a relatively high proportion of skilled employees accentuating the role of absorptive capacity.

Regional aspect of FDI might be particularly important in new EU member states. In these countries FDI was mainly attracted to capital cities and western regions (Torlak, 2004), thus the absence or negative effects of FDI spillovers on national level in transition economies may be offset by positive effects on regional level which so far have received less attention. Empirical analysis of regional patterns of spillovers in transition economies has been conducted by several authors. Nicolini et al. (2007) used spatial error model taking into account both spatial dependence and spatial heterogeneity on the sample of manufacturing firms operating in Bulgaria, Poland and Romania between 1998 and 2003. Their findings reveal positive and significant intra and inter industry spillovers at regional level. Negative spillovers are found outside the region though limited to specific groups of regions, such as the capital regions and regions bordering with former EU-15 countries. Large firms in regions with high absorptive capacity enjoy higher total factor productivity growth rates.

Evidence from Altomonte and Colantone (2008) for Romania suggests that in case of regional disparities MNEs act as magnifiers of these disparities instead of being factor of convergence.

The entry of MNEs in selected regions leads to compositional effect associated with the better performance of these firms with respect to domestic ones and tends to magnify disparities. Moreover, the restructuring efforts of MNEs demonstrate great deal of heterogeneity leading to variations in output dynamics across regions and further divergence. Positive spillover effects of MNEs on domestic firms are found in best performing areas while in laggard regions MNEs crowd out domestic firms.

There are also studies that failed to confirm the importance of regional spillovers. Halpern and Murakozy (2007) examined productivity spillovers in Hungary for the period 1996-2003 and weighed measures of horizontal and vertical spillovers by distance expecting that the farther the foreign firm, the smaller the spillover. They found that both types of spillovers within or across regions were not different from each other. Using an unbalanced panel of firms in five transition countries (Hungary, Poland, Romania, Bulgaria and Czech Republic) Torlak (2004) found evidence for productivity spillovers for the Czech Republic and Poland. Yet, when controlling for location-specific variations in productivity due to agglomeration economies or other region-specific effects positive result only remains in the case of Czech Republic whilst a negative effect is detected in the Bulgarian case.

5. Micro-foundations of regional productivity dynamics

Several authors over recent years have suggested that the sources of variations in aggregate productivity should be looked for within plant changes in productivity related to technology diffusion as well as in between plant changes in the allocation of inputs and in the effect of entry and exit of firms. (Bartelsmann et al., 2004; Altomonte and Colantone, 2008; Resmini and Nicolini, 2011). The starting point in such analysis is the firm-level estimation of TFP within a Cobb-Douglas aggregate production technology where for firm i from industry j in period t the total factor productivity can be measured as the residual obtained by subtracting the predicted log output $\hat{y}_{ijt}$ from the actual log output y_{ijt} of a given firm in form:

$$\omega_{ijt} = y_{ijt} - \hat{y}_{ijt} = y_{ijt} - \beta' x_{ijt} \quad (1)$$

where $\beta' x_{ijt}$ stands for the contribution of inputs in the production function.

The equation (1) is estimated with Wooldridge (2009) one-step estimator. The advantage of this estimator over traditional two-step semi parametric estimation techniques (Olley and Pakes, 1996; Levinsohn and Petrin, 2003) is the ability to provide efficient standard errors robust to both heteroscedasticity and autocorrelation. It also allows the inclusion of cross equation restrictions and testing of the validity of the specifications using the Sargan-Hansen test of overidentifying restrictions and it is robust to Ackerberg, Caves and Frazer (2006) critique that labour may be unidentified in the first stage of Levinsohn-Petrin estimator. The estimation is undertaken on unbalanced panel of data which implicitly takes into account firms entry and exit in order to tackle selectivity bias. The estimation of firm-level TFP from Cobb-Douglas production function with capital and labour is being undertaken separately for each industry in order to capture the heterogeneity arising from different production technologies, quality and intensity of inputs used in the production.[1]

Ever since the work of Levinsohn and Petrin (2003) several authors have formulated aggregated firm-specific TFP measures starting from equation:

$$Y_{jt} = \sum_{i=1}^{N} z_{ijt} TFP_{ijt} \quad (2)$$

where Y_{jt} is the aggregate output (in levels) of industry *j*, $TFP_{ijt} = e^{\omega_{ijt}}$ is the exponentiated measure of TFP and $z_{ijt} = e^{\beta' x_{ijt}}$ defined as an input index (Levinsohn and Petrin, 2003; Altomonte and Colantone, 2008). Further development of expression in equation (2) enables the decomposition of changes in the output of the industry *j* while taking into account the entry and exit of firms. Decomposing $\Delta Y_{jt} = \sum_{i=1}^{N} z_{ijt} TFP_{ijt} - \sum_{i=1}^{N} z_{ijt-1} TFP_{ijt-1}$ Altomonte and Colantone (2008) obtain following equation:

[1] Although TFP has also a regional dimension, due to insufficient number of observation for each industry/region pair, the beta coefficients are industry specific.

$$\Delta Y_{jt} = \sum_{i\epsilon C}\left[z_{ijt-1}\Delta TFP_{ijt} + \Delta z_{ijt}TFP_{ijt-1} + \Delta z_{ijt}\Delta TFP_{ijt}\right] + \sum_{i\epsilon E} z_{ijt}TFP_{ijt} - \sum_{i\epsilon X} z_{ijt-1}TFP_{ijt-1} \quad (3)$$

In equation (3) the total number of firms N has been decomposed in three sets as continuing (C), entering (E) and exiting (X) firms. The first term in square brackets measures the changes to aggregate output induced by changes in productivity holding the inputs constant, the second term captures the extent of restructuring, i.e. the variation in the use of inputs, keeping productivity constant while the third term is the covariance between productivity growth and input changes. Last two parts of equation (3) measure the effect of net entry on aggregate output growth. Finally, the changes in regional aggregate output ΔY_t^r for region r consisting of M industries can be calculated as:

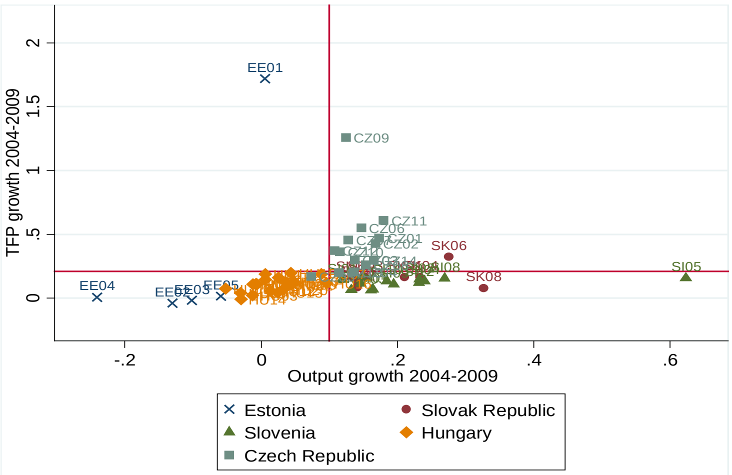
$$\Delta Y_t^r = \sum_{j=1}^{M} \Delta Y_{jt}^r \quad (4)$$

The expressions in equations (2)-(4) establish link between firm-level TFP dynamics and changes in regional output. Moreover, they provide deeper insight into sources of variations in regional output including changes in productivity, changes from restructuring in the use of inputs as well as the effects of entry and exit.

In order to assess drivers of regional disparities a previously described decomposition has been applied to the data from large pan-European firm level database Amadeus provided by Bureau van Dyke on five new EU member states (Czech Republic, Estonia, Hungary, Slovak Republic and Slovenia) in period 2004-2009, years immediately following their accession to the European Union. Regions and industries are observed at NUTS3 level and NACE2 2-digit industry level respectively. The definitions of firm level output, inputs and proxy variables follow the standard practice in the literature. All financial variables used in the estimation of production function are deflated using industry price deflators obtained from EU Klems, Eurostat and OECD Stan database. Output is measured as value added and constructed as difference between real gross output and real intermediate inputs. The latter are measured as costs of materials. Capital is measured as total fixed tangible assets by book value, recorded annually while labour is measured as a number of employees.

The analysis covers all major sectors of economic activity where firms are considered as active if at least one observation of revenues is available over observed time period. Following Altomonte and Colantone (2008) firm's entry is defined as a year in which the first observation of revenues is recorded while exit is assumed to take place in the year after which no new information is available in the dataset. Previous studies on sources of regional disparities have assessed among sources of output variations differences in productivity between domestic firms and affiliates of MNCs. However, weakness of our dataset is insufficiently high number of observations on MNCs' affiliates in number of industries for estimation of TFP to be possible. Hence, the analysis in this part of paper is limited to domestic firms only.

Figure 1: Regional output and productivity growth 2004-2009



Source: Authors calculations

As a first step of exploratory analysis Figure 1 reveals heterogeneity in country specific patterns of evolution of regional output and TFP of domestic firms. Horizontal axis measures average output growth of firms across 59 regions of five analysed countries over 2004-2009 period while vertical axis measures growth of total factor productivity (TFP) of local firms in the same period. Reference lines reveal average rates of growth in the sample. In majority of

Estonian and Hungarian regions both growth of productivity of local firms as well as of output was below sample average. In Slovenian regions the growth of output was above sample average but the growth of GDP was below average. Finally, in majority of Slovak and Czech regions both growth of output and of productivity were above sample average. In order to shed further light on these findings, a previously defined method for decomposition of output of domestic firms is applied (Table 1).

Table 1: The decomposition of changes in regional output in percentage terms (2004-2009)

	ΔY_t	Productivity	Restructuring	Covariance	Net Entry
Czech Republic	**1.08e+08**	**6.60**	**21.28**	**-26.46**	**-0.42**
Estonia	**5.42e+07**	**-0.12**	**0.15**	**-0.17**	**1.14**
Hungary	**1.65e+08**	**1.24**	**-0.58**	**-0.72**	**1.06**
Slovak Republic	**1.04e+07**	**1.11**	**1.22**	**-1.25**	**-0.08**
Slovenia	**9882708**	**0.96**	**0.01**	**-0.33**	**0.36**

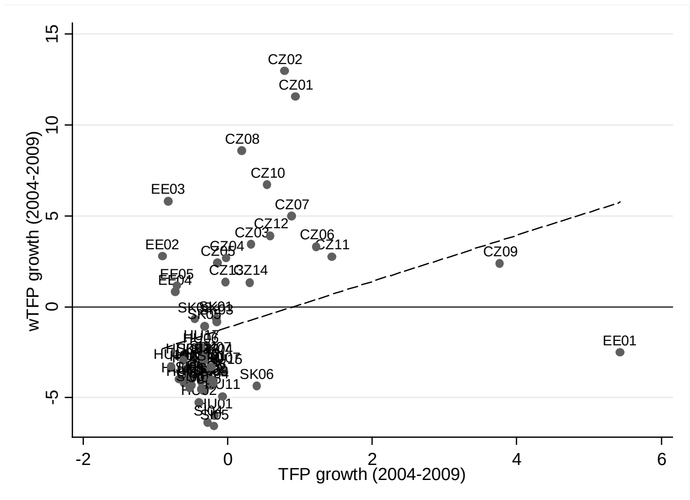
Source: Author's calculations

Information in Table 1 refers to average output changes while table with detailed annual decomposition can be found in Appendix. It enables the assessment of various channels through which domestic firms contribute to the evolution of regional output. It appears that in all countries except Estonia productivity changes positively contribute to the output. Another channel of positive influence on regional output changes is restructuring suggesting that increase in aggregate output is the result of reallocation of inputs to most productive firms which is in line with Olley and Pakes (1996) and Foster et al (2001). The exception from this finding is Hungary where reallocation of inputs contributes negatively to output change suggesting that firms experiencing an increase in productivity are also loosing market shares due to ongoing restructuring process.

Across all five countries a negative impact of covariance element can be observed. Altomonte and Colantone (2008) interpret negative sign on this component as evidence of the ongoing restructuring process where negative changes in variations of inputs have positive impact on productivity. From there, the finding in our paper can be interpreted as further evidence of rationalizing in use of inputs where firm experiencing an increase in productivity were losing market shares due to restructuring and downsizing, rather than expansion (Bartelsman et al, 2004). The positive reallocation effects and negative covariance term may indicate divergence in TFP, i.e. high productivity incumbent firms further increased their productivity and allocative efficiency, while low productivity incumbents witnessed slow growth in TFP and lost their market shares.

In the case of Slovenia, Hungary and Estonia a positive contribution of the net entry to the dynamics of output is recorded. Such finding is in line with several earlier studies for new EU member states that reported a positive contribution in terms of job creation and growth from the net entry of new firms (De Loecker and Konings, 2005; Altomonte and Colantone, 2008). This suggests the importance of creative destruction process where more productive firms replace less productive ones. Hence, promoting policies which encourage competitive behaviour should be important for productivity growth and regional output.

Figure 2: Moran I scatterplot of TFP growth rates over the 2004-2009 period

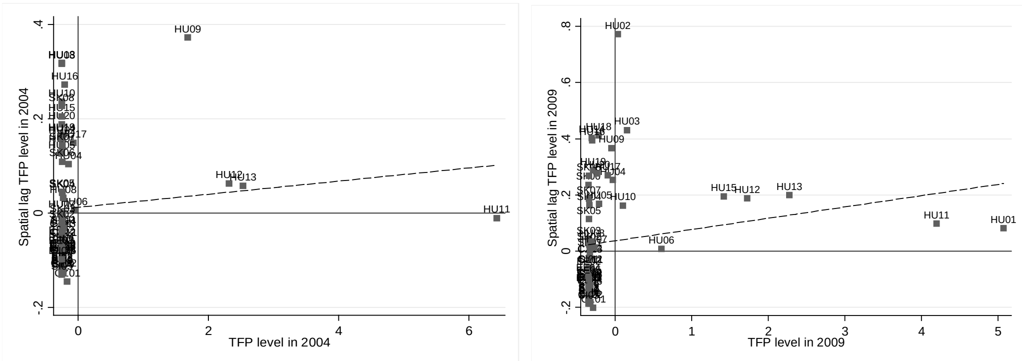


Source: Authors' calculation

A question that arises in light of these findings is whether changes in productivity are spatially correlated. As noted earlier, important channel for productivity improvements are spatial technology and knowledge spillovers. The spatial autocorrelation can be defined as the occurrence of value similarities in locational similarity (Anselin, 2001; Resmini and Nicolini, 2011). Spatial clustering of high or low values of variable in space is interpreted as positive spatial autocorrelation while the opposite holds when high values of variable are surrounded with low values (and vice versa).

In order to examine the existence of spatial autocorrelation a Moran scatterplot is used (Anselin, 1996) where the spatial lag *Wx* of the variable *x* is plotted against variable itself. For the purpose of this analysis, both levels and growth rates of TFP are plotted against their spatial lags. Figure 2 plots TFP growth rates against their spatial lags indicating that growth rates in our sample are spatially correlated.

Figure 3: Moran I scatterplot of TFP levels (2004 and 2009)



Source: Authors' calculations

Further evidence in favour of the thesis that our data follow systematic spatial pattern can be found in Figure 3 which plots TFP levels in 2004 and 2009 against their spatial lags. In both cases, similar to findings on growth rates (Figure 2), a positive pattern of spatial correlation can be observed. For this reason, Moran's test on spatial autocorrelation for both TFP growth and levels is undertaken (Table 2). Under null hypothesis of this test there is zero spatial autocorrelation. The results in Table 2 reveal existence of positive spatial autocorrelation and consistent with findings from earlier literature on new EU member states suggest that the spatial correlation is stronger in levels than in growth form (Resmini and Nicolini, 2011).

Table 2: Moran's two-tail test for spatial autocorrelation of TFP levels and growth

Variable	**I**	**E(I)**	**sd(I)**	**Z**	**p-value**
TFP growth	0.016	-0.017	0.022	1.514	0.065
2004 level	0.014	-0.017	0.018	1.696	0.045
2009 level	0.040	-0.017	0.022	2.576	0.010

Source: Authors' calculations

Several stylised facts emerge from analysis in this section. On one hand, in regions of nearly all analysed countries the positive contribution of productivity changes to changes in regional output has been observed. However, while both productivity improvements and restructuring individually contribute to increase in regional output, the joint impact of the two is negative suggesting that factors other than changes in the use of inputs may be associated with improvements in productivity and consequent output increases. However, important drawback of this part of analysis is inability to address role of foreign firms in regional output changes. For this reason, remaining part of the paper addresses the role of FDI spillovers in regional productivity of local firms.

6. Model specification

Building on theoretical predictions and empirical findings from earlier sections the regional analysis of the impact of FDI spillovers on productivity of domestic firms is based on model which can be expressed as follows:

$$TFP_{rt} = f(Spillovers_{rt}, RC_{rt}, IC_{rt}, FC_{rt}) \qquad (5)$$

where TFP stands for total factor productivity of domestic firms in region *r* in period *t*, Spillovers refer to FDI spillovers while RC, IC and FT refer to regional, industrial and firm specific characteristics.

The dependent variable, TFP_{rt} is defined as the regional average level of TFP of domestic firms. Starting from previously defined firm-level estimates the productivity of local firms is first calculated for each industry *j* in region *r* following Tanaka and Hashiguchi (2012):

$$TFP_{jrt} = n_{ijrt}^{-1} \sum_{i \epsilon \Omega jrt} \frac{q_{ijrt}}{\sum_{i \epsilon \Omega jrt} q_{ijrt}} TFP_{ijrt} \qquad (6)$$

where n is the number of domestic firms *i* in industry *j* of region *r* in period *t*, Ω_{jrt} is the set of domestic firms that belong to industry j, q_{ijrt} is firm's output and TFP_{jrt} is an industrial average of firm productivity in a given industry and region. From there, the regional average of firm productivity can be calculated as:

$$TFP_{rt} = m_{rt}^{-1} \sum_{j\epsilon rt} TFP_{jrt} \quad (7)$$

where m is the number of industries in given region. Hence, in construction of regional average of firm productivity TFP of each firm is weighted by its output share in industry. Several authors have warned that input shares of each firm might be better weights as output is dependent on productivity (Foster et al., 2001; Altomonte and Colantone, 2008). In order to check for robustness of results alternative measure of TFP is also constructed using input shares as weights.

The modelling of spillovers begins with standard approach in the literature (Javorcik, 2004), and makes distinction between horizontal, vertical backward and vertical forward spillovers. The regional average of intra-industry or horizontal spillovers is calculated as follows:

$$Horizontal_{rt} = m_{rt}^{-1} \sum_{j\epsilon\Omega rt} \frac{q_{jrt}}{\sum_{j\epsilon\Omega rt} q_{jrt}} * \frac{\sum_{i\epsilon\Omega jrt} Foreign_{ijrt} * q_{ijrt}}{\sum_{i\epsilon\Omega jrt} q_{ijrt}} \quad (8)$$

where q_{ijrt} is the output produced by firm *i* in industry *j* and region *r* in year *t* , m is number of industries in region r and $Foreign_{it}$ is a dummy variable indicating foreign participation in firm *i* in year *t*[2] while q_{jrt} is the output of industry *j* in region *r* and year *t*. Hence, in order to capture regional differences in industry composition, spillovers for each industry are weighted with share of given industry in regional output prior to calculation of regional average.

The computation of technical coefficients for vertical linkages departs from standard approach in the literature and includes inputs supplied within the same industry. The reason for this lies in the fact that it is unrealistic to assume no intra-industry linkages in highly aggregated

[2] Firm is considered foreign if the sum of shares of foreign investors exceeds 10% of its equity. Ownership information is available for each year and for each firm. In the calculation of horizontal measure the total number of firms available in the database was used regardless whether these firms had data on all production variables for TFP estimation.

industries. Therefore, exclusion of inputs supplied within the same industry might affect empirical results (Leanerts and Merlevede, 2013). The backward vertical linkages can be calculated as follows:

$$Backward_{rt} = m_{rt}^{-1} \sum_{j\epsilon\Omega rt} \frac{q_{jrt}}{\sum_{j\epsilon\Omega rt} q_{jrt}} * \sum_{j=1}^{k} \alpha_{jkrt} Horizontal_{krt} \quad (9)$$

where industrial horizontal spillovers are multiplied with the technical coefficient from input-output tables and previously defined industry weights. In this case, technical coefficient α_{jkrt} is the proportion of industry j's output supplied to industry k in period t. Hence, the backward linkage captures spillovers between MNCs and local suppliers. The technical coefficients $\alpha_{jkrt}$are calculated for domestic intermediate consumption excluding final uses, export and imports. This way, the common assumption that MNCs employ domestic inputs in the same proportion as imported inputs is relaxed. While both types of inputs can increase TFP of domestic firms, MNCs may source different inputs in host country (Barrios et al., 2011). Analogously, forward linkages can be calculated as:

$$Forward_{rt} = m_{rt}^{-1} \sum_{j\epsilon\Omega rt} \frac{q_{jrt}}{\sum_{j\epsilon\Omega rt} q_{jrt}} * \sum_{j=1}^{k} \gamma_{kjrt} Horizontal_{krt} \quad (10)$$

In this case technical coefficient γ_{kjt} the proportion of industry *j*'s inputs purchased from industries *k* at time *t*. The forward linkage is a proxy for spillovers between MNCs and their local clients. The larger the presence of MNCs in upstream sectors *k* and the larger the output sold to local firms the higher is the value of the variable.

Model of investigation also includes several control variables. Regional characteristics include measures of net migration share, human capital and agglomeration economies. The net migration share in total population is defined as the absolute share of the difference between count of new residents in the region and the residents leaving region divided by total regional population. Migration is associated with the brain circulation" paradigm according to which immigrants create benefits for destination countries and regions in terms of creativity and innovations (Saxenian, 1999; Florida, 2002). Hence, it is expected that higher migration has beneficial effect on TFP of local firms. Regional human capital is proxied with the share of workers employed in high technology intensive industries and it is expected to have positive sign. Finally, two variables are included reflecting agglomeration economies, defined as urbanisation and localisation economies. As noted in section 2 of paper, NEG literature points to the beneficial impact of geographical proximity of firms with their counterparts, professional and scientific institutions (Krugman, 1991; Venables, 1996; Hafner, 2013).

The urbanisation economies aim to capture between-industry spillovers from inter-sectoral diversity such as sharing of basic assets, information, resources and institutions while localisation economies control for within industry factors such as learning, contact with early adapters or information about market conditions (Stojcic et al., 2013). The urbanisation economies is measured as the ratio between the number of all firms in region and the total number of firms in country while regional average of localisation economies is measured as the regional average of a ratio between the number of firms belonging to same industry and all firms within a given region. A positive sign could be expected for these variables.

Among industry specific characteristics the regional average of industrial concentration is included. The measure of horizontal spillovers may also capture competition effects for which reason it is necessary to isolate these two effects. Foreign entry may increase the intensity of competition thus forcing local firms to become more efficient and productive. The failure to control for the intensity of competition could attribute increases in TFP of local firms to spillovers. For this reason, Herfindahl-Hirschman concentration index is employed as a measure of competition intensity. The sign of this variable is expected to be negative.

We also include average firm size in region. On the one hand, firm size, measured as number of employees, is expected to control for absorption of spillovers and productivity enhancing processes. As noted by Farole and Winkler (2012) larger firms usually have large number of trained and skilled people, more competent management, pay higher wages and are also more visible, thus are more likely to be selected as suppliers and become clients of MNCs. Yet, smaller firms may be more responsive to changing business environment. Therefore for this variable there are no expectations regarding its sign. Finally, several variables are included measuring the quality of institutional environment on national level. These include business freedom, intellectual property rights quality and investment freedom. The latter factors are important for both domestic and foreign firms as reliable institutional environment reduces the risk and uncertainties related to imperfect information (North, 1990), creates incentives and business practices that facilitate knowledge acquisition process (Meyer and Sinani, 2009) and act as a determinant of both quantity and quality of FDI which may influence the potential and magnitude of spillovers.

7. Data and methodology

As noted previously, primary source of data in this analysis is the firm-level database Amadeus produced by Bureau van Dyke. The data from this database have been used to construct variables of regional TFP of local firms, FDI spillovers, concentration index, urbanisation and localisation economies, average regional firm size and the proportion of workers in high-tech industries. In order to estimate previously defined model this database has been combined with several other sources.

The calculation of vertical FDI spillovers would not have been possible without the use of input-output tables. These were taken from World Input Output Database used previously by Timmer (2012). Being published only recently, this database provides yearly input output tables aggregated over 35 sectors at 2-digit level. The advantage of annual data is possibility of estimation of time varying input output coefficients which is a significant improvement over previous studies which used IO tables from early/mid 2000s, thus reflecting the changing economic structure of countries over years. The data on migration are taken from OECD regional statistics database. Finally, in order to measure the quality of institutional environment the data on business freedom, investment freedom and IPR are taken from Heritage Foundation. As previously, data in this part of analysis cover period between 2004 and 2009 in 59 NUTS3 regions of five new EU member states.

Findings from section 5 and longitudinal nature of our dataset suggest that suitable estimator should be looked for within family of spatial panel estimators. Broadly speaking, spatial dependence among observations can be investigated with four main types of estimators known as spatial autoregression model (SAR), spatial error model (SEM), Durbin spatial autoregression model (DSAR) and general spatial error model (GSAR). In simplest form SAR model can be defined as:

$$y_{it} = \rho \sum_{j=1}^{n} w_{ij} y_{jt} + \beta X_{it} + \varepsilon_{it} \quad (11)$$

Equation (11) establishes a direct relationship between the dependent variable y_{it} for cross sectional unit *i* in period *t* and the dependent variables y_{jt} of other cross-sectional units. The expression $\sum_{j=1}^{n} w_{ij} y_{jt}$ is the interaction effect of the dependent variable y_{it} with the dependent variables of other units (y_{jt}) while w_{ij} is the i,j-th element of a prespecified nonnegative NxN spatial weights matrix W and (ρ) is spatial dependence parameter. Finally, X and β stand for the regional independent variables and their respective coefficients while ε is idiosyncratic error term. This specification reveals whether the TFP of local firms in given region and time period is affected with TFP of local firms in other regions.

The spatial error model (SEM) imposes specific structure to the unobserved factors influencing dependent variable which would otherwise be captured by the error term (Blonigen et al., 2007; Kayam et al., 2013). The model is specified as follows:

$$y_{it} = \beta X_{it} + \varepsilon_{it}, \varepsilon_{it} = \rho \sum_{j=1}^{n} w_{ij} \varepsilon_{jt} + u_{it} \quad (12)$$

where ρ is the spatial autocorrelation coefficient. The use of SEM model allows to investigate the impact of shocks in dependent variable of other cross-sectional units (regions) to the dependent variable of region *i*.

DSAR and GSEM models can be considered as extensions of the two previously discussed (Le Sage and Pace, 2009; Elhorst, 2013). Durbin spatial autoregression model (DSAR) can be defined as:

$$y_{it} = \rho \sum_{j=1}^{n} w_{ij} y_{jt} + \beta X_{it} + \theta \sum_{j=1}^{n} w_{ij} x_{jt} + \varepsilon_{it} \quad (13)$$

In equation (13) the dependent variable of particular unit depends on independent explanatory variables of the dependent variables of other units. One can observe how FDI spillovers to other regions influence the TFP of local firms in a given region. Finally, the general spatial error model (GSEM) adds the spatially weighted dependent variables matrix to the right hand side of the error term (Baltagi et al., 2007). It takes form of:

$$y_{it} = \beta_1 X_{it} + \beta_2 w_{ij} X_{jt} + \varepsilon_{it}, \varepsilon_{it} = \rho \sum_{j=1}^{n} w_{ij} \varepsilon_{jt} + u_{it} \quad (14)$$

The selection of appropriate spatial estimator involves choice between conventional and spatial econometric techniques on the basis of Lagrange Multiplier (LM) tests for a spatially lagged dependent variable and for spatial error autocorrelation as well as the testing for the existence of one type of spatial dependence conditional on the other using robust LM, Likelihood Ratio (LR) or Wald tests (Elhorst, 2013). Burridge (1981) notes that spatial Durbin model should be given preference when hypotheses of H_0: θ=0 and H_0: $\theta + \rho\beta$=0 are both rejected. Conversely if one of these hypotheses cannot be rejected spatial lag or spatial error models should be used.

Findings from spatial dependence analyses are sensitive on the specification of the weighting matrix (W), a symmetric NxN matrix, where N is the number of units that defines position of cross-sectional units in space with respect to each other (Anselin, 1999; Le Sage, 1998; 1999).

In order to examine robustness of our results, two alternative specifications of W are employed, “neighbourhood” matrix where w_{ij} takes value of 1 if regions i and j are neighbours and 0 otherwise and another one where the w_{ij} is defined as inverse distance between regional centres (Baltagi et al., 2007). Furthermore, following standard procedure each weight matrix is row standardized with elements w_{ij} of each row having sum of 1 (Olejnik, 2008).

Findings from spatial regressions are usually interpreted on the basis of point estimates. Le Sage and Pace (2009) suggest that a partial derivative interpretation of the impact from changes to the variables of different model specifications is a far better approach. Following this approach a distinction can be made between the effect of a change of a particular explanatory variable in a particular spatial unit on the dependent variable of all other units in the short run and in the long run. Furthermore, it has been suggested by several authors that spatial non-stationarity may lead to spurious regression (Fingleton, 1999; Olejnik, 2008; Elhorst, 2013). As noted by Le Sage and Pace (2009) for this reason the condition $\rho \in (1/r_{min}, 1)$ is imposed where r_{min} equals the most negative purely real characteristic root of W after this matrix has been row-normalized. In that case, the dependent variable can be said to follow spatially integrated process of SI(0).

Two prevalent methods of estimation have been applied to the above models, maximum likelihood method (ML) and generalised method of moments (GMM). Some authors note that GMM estimator can be severely biased due to endogeneity in spatially lagged dependent variable WY_t (Elhorst, 2010; Lee and Yu, 2014). Bearing everything above said in mind the model is estimated using maximum likelihood estimator and standard procedure for selection of appropriate model is applied. Furthermore, in addition to point estimates the analysis also makes distinction between indirect and direct effect of spillovers. Finally, robust standard errors are employed in order to control for potential heteroscedasticity.

8. Discussion of findings

Building on theoretical arguments and research methodology discussed above the model in following form is being estimated:

$$lnTFP_{it} = c_0 + \rho \sum_{j=1}^{n} w_{ij} lnTFP_{jt} + \beta_1 horizontal_{it} + \beta_2 forward_{it} + \beta_3 backward_{it} + \theta_1 \sum_{j=1}^{n} w_{ij} horizontal_{jt} + \theta_2 \sum_{j=1}^{n} w_{ij} forward_{jt} + \theta_3 \sum_{j=1}^{n} w_{ij} backward_{jt} + \beta_4 lnmigration_{\ it} + \beta_5 lnconcentration_{it} + \beta_6 lnurbanisation_{it} + \beta_7 lnlocalisation_{it} + \beta_8 hcapital_{it} + \beta_9 lnemployees_{it} + \beta_{10} lnbuss_{ct} + \beta_{11} lninv_{ct} + \beta_{12} lnipr_{ct} + \lambda \sum_{j=1}^{n} \varepsilon_{jt} + u_{it}$$

(15)

Equation 15 is known as the spatial Durbin model discussed in previous section. The model is specified in semi-logarithmic form with all variables taking positive values entering model in logarithm form while variables containing zeros and negative values enter model in levels form. It is estimated with maximum likelihood method robust to presence of non-normality and heteroscedasticity. As our main interest lies in the relationship between productivity of local firms and FDI spillovers the analysis of spatial effects is limited to these variables. However, prior to discussion of results the procedure for model selection and relevant model diagnostics are addressed.

8.1. Model diagnostics

Relevant model diagnostics are presented in Table 3. In models (1) and (2) inverse distance spatial weight matrix is used while neighbourhood matrix is used in models (3) and (4). Furthermore, the dependent variable of models (1) and (3) has input shares as weights while output shares are used in models (2) and (4). In all four models the null hypothesis of Wald test that variables jointly have no explanatory power is rejected with very high probability. The value of coefficient ρ falls within its acceptable range which suggests that the dependent variable follows spatially integrated process SI(0) (Le Sage and Pace, 2009). Finally, LR tests in Table 3 demonstrate that null hypotheses of spatially lagged dependent variable and spatial lags of regressors being equal to zero are rejected with very high probability in all four models. This suggests that spatial estimation techniques should be preferred over conventional econometric analysis (Elhorts, 2013; Shehata and Mickaiel, 2014).

Table 3: Model diagnostics

Model	(1)	(2)	(3)	(4)
Number of observations	354	354	354	354
Number of units (regions)	59	59	59	59
Log likelihood function	-770.57	-773.62	-772.19	-776.08
Wald test	259.6***	269.8***	331.30***	354.46***
LR TEST SDM vs. OLS H_0: $(\rho = 0)$	31.26***	36.41***	9.38***	10.89***
LR TEST H_0: $(wX's = 0)$	11.83***	11.62***	19.72***	19.22***
ρ	0.61	0.63	0.21	0.22
Acceptable range for ρ	-2.8< ρ<1	-2.8< ρ<1	-1.6< ρ<1	-1.6< ρ<1
Spatial Error Autocorrelation Tests				
H_0: (no spatial error autocorrelation)				
Global Moran MI	0.19***	0.22***	0.11***	0.13***
Global Geary GC	0.82***	0.80***	0.88***	0.86***
Global Getis-Ords GO	-0.19***	-0.22****	-0.11***	0.13***
Moran MI Error Test	17.19***	19.06***	3.44***	3.84***
LM Error (Burridge)	115.26***	143.50***	5.27**	6.79**
LM Error (Robust)	106.77**	136.31***	0.02	0.01
Spatial Lagged Dependent Variable Tests				
H_0: (no spatial autocorrelation)				
LM Lag (Anselin)	46.69***	56.34***	6.67**	8.55**
Lm Lag (Robust)	38.20***	49.15***	1.41	1.77
General Spatial Autocorrelation Tests				
H_0: (no general spatial autocorrelation)				
LM SAC (LMErr+LMLag_R)	153.47***	192.65***	6.69**	8.56**
LM SAC (LMLag+LMErr_R)	153.47***	192.65***	6.69**	8.56**

*Note: ***,** and * denote statistical significance at 1%, 5% and 10% level of significance respectively*

Further testing procedure involves conventional and robust LM tests in order to determine the proper spatial estimator (Burridge, 1980; Anselin, 1988). Common procedure suggests that spatial lag model should be given preference if its LM test is more significant than LM test for spatial error and robust LM test for spatial error is not significant while in opposite case spatial error model should be preffered (Shehata and Mickaiel, 2014). Also, when LM tests for both spatial lag and spatial error are significant or the conventional LR tests and robust LM tests point to different models preference should be given to spatial Durbin model (Elhorst, 2011). Following above described procedure it is evident that in all four specifications model diagnostics suggest that spatial Durbin model should be preferred over other spatial estimators. Overall, these diagnostics indicate robustness of selected models and allow us to proceed with interpretation of results.

8.2. Interpretation of results

Results of estimation are presented in Table 3 where as previously models (1) and (2) are estimated using inverse distance spatial weight matrix while neighbourhood matrix is used in models (3) and (4). The dependent variable of models (1) and (3) has input shares as weights while output shares are used in models (2) and (4). First striking finding is robustness of results with respect to sign and significance across all four specifications. Moreover, with exception of spatially lagged dependent variable all coefficients are of similar magnitude providing further support to the robustness of our model. Across all four models, a positive spatial spillovers of TFP among local firms can be observed. The magnitude of coefficient ranges from 0.22 in models with neighbourhood matrix to the 0.63 in models with inverse distance matrix. These findings are in line with evidence from earlier literature suggesting increase of coefficient on spatially lagged dependent variable when full inverse distance matrix is used (e.g. Seldadyo et al., 2010).

Table 4: Results of estimation

Model **Variable**	**(1)**	**(2)**	**(3)**	**(4)**
Spatial lag of dependent variable ln (*wTFP*)	0.61***	0.63***	0.21***	0.22***
FDI SPILLOVERS				
Backward FDI spillovers (*backward*)	-0.003*	-0.003*	-0.003*	-0.003*
Forward FDI spillovers (*forward*)	0.01**	0.01*	0.01**	0.01**
Horizontal FDI spillovers (*horizontal*)	-0.17***	-0.17***	-0.18***	-0.18***
Backward FDI spillovers – spatial lag (*wbackward*)	0.003	0.003	-0.003	-0.002
Forward FDI spillovers – spatial lag (*wforward*)	0.02	0.02	0.01	0.01
Horizontal FDI spillovers – spatial lag (*whorizontal*)	-0.76***	-0.76***	-0.40***	-0.40***
REGIONAL CHARACTERISTICS				
Net migration share in population ln(*migration*)	0.15	0.130	0.21*	0.19*
Average industry concentration ln (*hhi*)	-1.18***	-1.27***	-1.08***	-1.17***
Urbanisation externalities ln (*urbanisation*)	0.79 ***	0.82***	0.87***	0.90***
Localisation externalities ln (*localisation*)	-0.37	-0.34	-0.60	-0.57
Human capital (*hcapital*)	0.34	0.28	0.57	0.51
Average firm size ln (*emp*)	0.95***	0.96***	0.91***	0.92***
INSTITUTIONAL ENVIRONMENT				
Business freedom ln (*buss*)	2.34	2.48	2.27	2.40
Investment freedom ln (*inv*)	-0.19	-0.17	0.46	0.56
Protection of intellectual property rights ln (*ipr*)	2.43***	2.43***	2.92***	2.94***
Constant term (*cons*)	-17.65	-18.61*	-18.30	-19.41

Source: Authors' calculations

*Note: p-values in brackets where ***,** and * denote statistical significance at 1%, 5% and 10% level of significance respectively*

Turning to the most important issue the relationship between FDI spillovers and TFP of domestic firms, all three variables measuring intra-regional FDI spillovers are statistically significant while among inter-regional spillovers only horizontal ones have impact on TFP of local firms. Within intra-regional spillovers positive impact is found on forward FDI linkages suggesting beneficial supplier role of MNCs on local firms in downstream sectors. The negative impact of backward linkages seems to contradict much of existing studies (Javorcik, 2004; Blalock and Gertler, 2008; Javorcik and Spatareanu, 2008; Lesher and Miroudot, 2008) but it can be associated with Global Supply Chains (GSC) concept (Baldwin, 2011; 2012).

According to GSC, growth of exports in “factory” economies such as new EU member states is mainly driven with vertical specialisation in which foreign firms play important role (Damijan et al., 2013). However, these firms also increase the imports of intermediate goods thus creating negative linkages. The negative backward linkages may be caused with inability of domestic firms to sell their inputs to MNCs due to high quality requirements. Furthermore, the lengthy nature of the establishment of linkages with MNCs due to specific nature of technology transfer may lead to occurrence of backward linkages with time lag.

The negative sign on the horizontal FDI spillovers is consistent with earlier findings from literature suggesting that FDI penetration leads to crowding out of domestic firms due to low levels of absorptive capacity. Reduction in market share can lead to production at less efficient scale, increased costs and declining profits which together leave less funds available for investment in training and technology. In similar manner, higher wages offered by foreign firms may trigger negative worker mobility thus leading to negative competition effects (Heyman et al., 2007; Earle and Telegdy, 2007). Finally, among spatial lags of FDI spillovers only variable measuring horizontal spillovers is statistically significant and with negative sign providing further support to above mentioned arguments. Together, these findings are consistent with evidence reviewed in section 4 on the existence of intra-regional FDI spillovers and no or negative inter-regional impact on TFP of local firms.

The negative sign on industrial concentration suggests that the concentration of market share among smaller number of firms likely comes at the expense of domestic firms which leaves them with less funds for investment in improvements in efficiency. Positive impact of urbanisation economies further supports such reasoning. Moreover, large firms seem to be more productive which as noted earlier can be associated with higher pool of trained and skilled employees, better management and visibility to MNCs (Farole and Winkler, 2012). The positive impact of net migration is also observed in models (3) and (4) suggesting that transfer of ideas and creativity contribute positively to TFP of local firms. Finally, among institutional variables protection of intellectual property rights is significant with positive sign. This finding may signal that the ability of firms to protect their intellectual property acts as incentive to innovate which in turn has beneficial effect on their total factor productivity.

8.3. Direct and indirect spillover effects

It has been noted in section 7 that interpretation of point estimates in spatial regressions may lead to erroneous conclusions for which reason a partial derivative interpretation may be better approach. Common interpretation of direct and indirect spatial effects states that the change in independent variable in given region can be decomposed on direct effect on the dependent variable of that region as well as indirect effect on the dependent variables of other regions (Seldadyo et al., 2010). Hence, the indirect effect can be understood as the impact on TFP of local firms in particular region from the change in exogenous variables of other regions or the impact of change in independent variable of particular region on dependent variables of all other regions. As noted by Le Sage and Pace (2009) the magnitude of above two calculations is same and both approaches can be used to derive indirect effects. The total, direct and indirect effect of independent variables in our model is presented in Table 5.

Table 5:Direct and indirect marginal effects

Model	**(1)**		**(2)**		**(3)**		**4**	
Variable	**Direct effect**	**Indirect effect**	**Direct effect**	**Indirect effect**	**Direct effect**	**Indirect effect**	**Direct effect**	**Indirect effect**
FDI SPILLOVERS								
Backward	-0.001	-0.002	-0.001	-0.002	-0.003	-0.001	-0.002	-0.001
Forward	0.003	0.004	0.002	0.004	0.006	0.002	0.005	0.002
Horizontal	-0.065	-0.098	-0.062	-0.103	-0.139	-0.035	-0.139	-0.037
Wbackward	0.001	0.002	0.001	0.002	-0.002	-0.001	-0.002	-0.0004
Wforward	0.008	0.012	0.008	0.013	0.007	0.002	0.006	0.002
Whorizontal	-0.296	-0.449	-0.279	-0.459	-0.319	-0.080	-0.311	-0.084
REGIONAL CHARACTERISTICS								
ln(*migration*)	0.057	0.086	0.048	0.079	0.165	0.041	0.149	0.040
ln (*hhi*)	-0.458	-0.696	-0.468	-0.770	-0.858	-0.214	-0.909	-0.245
ln (*urbanisation*)	0.306	0.465	0.300	0.494	0.686	0.171	0.697	0.188
ln (*localisation*)	-0.144	-0.218	-0.124	-0.204	-0.473	-0.118	-0.447	-0.120
(*hcapital*)	0.133	0.203	0.104	0.171	0.448	0.112	0.396	0.107
ln (*emp*)	0.368	0.558	0.354	0.583	0.722	0.180	0.718	0.194
INSTITUTIONAL ENVIRONMENT								
ln (*buss*)	0.905	1.374	0.911	1.501	1.799	0.449	1.865	0.503
ln (*inv*)	-0.075	-0.114	-0.061	-0.101	0.367	0.092	0.432	0.117
ln (*ipr*)	0.941	1.429	0.894	1.472	2.310	0.576	2.286	0.616

Source: Author's calculations

Findings from Table 5 reveal two interesting features. First, it is evident that the direct effects are different from the estimates of parameters which can be explained with feedback effect. Seldadyo et al. (2010) note that the impact of particular explanatory variables is partly realised through neighbouring regions and back to original region. Second, while there appears to be no sensitivity on the construction of dependent variable, results are sensitive on the specification of spatial weight matrix. The direct effects are almost twice as large when first-neighbour matrix is used than with full inverse distance matrix while opposite holds for indirect effects.

Bearing in mind findings from previous section about the sensitivity of spatially lagged dependent variable coefficient magnitude on the choice of matrix W together with findings of this section, a logical question arises which of above specifications best describes analysed data. Some of earlier studies advocate comparison of log-likelihood function values where the model with highest values should be preferred (Seldadyo et al., 2010). Model diagnostics in Table 3 suggest that specification (4) using nearest neighbour matrix and output shares as TFP weights has highest log-likelihood value. In view of these findings one can conclude that the

TFP of local firms in one region is related to TFP of local firms in surrounding regions with the magnitude of impact of about 0.22%. Furthermore, there is evidence of intra-regional and horizontal inter-regional FDI spillover impact on TFP of local firms. Finally, the impact of change in independent variable of individual regions on the TFP of local firms in other regions amounts to about 50% of the impact on the region itself.

9. Conclusion

Over past decades significant efforts have been invested by policy makers in new EU member states to attract FDI. The underlying reasoning behind these activities has been theoretical prediction and empirical evidence about the beneficial impact of FDI on host economy, particularly on the ability of its firms to compete on both domestic and international markets through horizontal, backward and forward spillovers. Nevertheless recent figures point that majority of regions in CEECs are still lagging behind EU27 average in terms of GDP per capita. Bearing in mind high inflow of FDI in these countries over past decades the objective of this research was to investigate whether incentives given to MNCs so far should be warranted. As main driving force of regional output is productivity, the emphasis of analysis was on the evolution of the latter.

Results of investigation reveal that in regions of several countries productivity and restructuring exert positive impact on output but it seems that the restructuring efforts do not translate to higher productivity as joint impact of the two is negative. In other countries the net entry turnover of firms is important driver of changes in regional output. Our analysis also reveals existence of spatial productivity effects among local firms. In both growth and level forms the evidence have been found of positive spatial effects suggesting that high productivity of firms in particular region has beneficial effect on local firms in neighbouring regions as well.

The above findings have been further confirmed with spatial econometric analysis. The evidence from this part of investigation reveals of positive spatial productivity effects among local firms. However, the findings with respect to FDI spillovers do not offer clear picture. The only positive effect has been found in case of intra-regional forward FDI spillovers. The impact of intra-regional horizontal and backward spillovers as well as that of inter-regional horizontal spillovers is negative. These latter findings suggest that local firms lack absorptive capacity or do not meet standards required by MNCs to act as their suppliers which ultimately leads to crowding out of domestic firms from market. It appears that far more important channel for improvements in local firms' productivity are urbanisation externalities and in case of large firms own resources. Finally, there is some evidence of the beneficial impact of institutional quality and migration on the productivity of firms.

Further conclusions about behaviour of domestic firms can be reached from the analysis of direct and indirect effects of explanatory variables. From there it is evident that indirect effects of improvements in explanatory variables are several times lower than direct ones. Together with earlier findings this suggests that impact of FDI on local firms is primarily intra-regional while inter-regional diffusion of technology and knowledge takes place through interactions between local firms. These findings question the validity of schemes offered to attract MNCs in new EU member states. It is evident on the one hand that downstream firms benefit from FDI presence while the opposite holds for firms in upstream sectors and those competing with MNCs. Hence, in addition to measures for attraction of FDI, actions should be undertaken in order to increase absorptive capacity of domestic firms and their ability to benefit from FDI spillovers.

While our research offered many interesting insights there are several limitations that could not be addressed. On the one hand, lack of data prevented us from estimation of TFP for foreign firms and thus from analysis of their contribution to changes in regional output.

Another fact is lack of additional data at regional level. Moreover, small number of regions analysed prevented use of more complex estimation methods that could include also dynamics of TFP and distinguish between short and long run impact of FDI. These limitations can be understood as directions for further research.

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Appendix

Table A1: Decomposition of regional output (annual results 2004-2009)

Czech Republic					
	ΔY_t	**Productivity**	**Restructuring**	**Covariance**	**Net Entry**
2004/05	4.82e+08	2.33	2.49	-4.39	0.57
2005/06	2.77e+08	6.60	-0.84	-5.00	0.24
2006/07	2.20e+08	3.18	-0.48	-1.14	-0.56
2007/08	-3.89e+08	0.15	0.14	-0.16	-1.13
2008/09	-4.93e+07	-2.88	214.30	-212.44	0.02
Entire period	**1.08e+08**	**6.60**	**21.28**	**-26.46**	**-0.42**
Estonia					
	ΔY_t	**Productivity**	**Restructuring**	**Covariance**	**Net Entry**
2004/05	1.12e+07	0.28	0.05	-0.15	0.82
2005/06	1.16e+07	0.30	0.26	-0.14	0.58
2006/07	3.33e+07	0.09	0.09	-0.05	0.87
2007/08	-7804839	-0.09	0.10	-0.41	-0.60
2008/09	2.23e+08	-0.19	0.15	-0.17	1.21
Entire period	**5.42e+07**	**-0.12**	**0.15**	**-0.17**	**1.14**
Hungary					
	ΔY_t	**Productivity**	**Restructuring**	**Covariance**	**Net Entry**
2004/05	3.48e+07	0.07	-0.07	-0.04	1.04
2005/06	6.75e+07	0.05	0.02	-0.01	0.94
2006/07	5.43e+08	0.32	-0.09	-0.32	1.09
2007/08	3.18e+08	2.56	-0.87	-1.26	0.57
2008/09	-1.37e+08	0.22	-1.11	-0.15	0.04
Entire period	**1.65e+08**	**1.24**	**-0.58**	**-0.72**	**1.06**
Slovak Republic					
	ΔY_t	**Productivity**	**Restructuring**	**Covariance**	**Net Entry**
2004/05	8.54e+07	0.13	-0.01	-0.11	0.99
2005/06	3.61e+07	0.85	0.53	-0.13	-0.25
2006/07	-3.05e+07	0.70	0.18	-0.40	-1.48
2007/08	-3.03e+07	-0.03	0.43	-0.29	-1.11
2008/09	-8909005	-0.58	2.98	-3.40	0.002
Entire period	**1.04e+07**	**1.11**	**1.22**	**-1.25**	**-0.08**
Slovenia					
	ΔY_t	**Productivity**	**Restructuring**	**Covariance**	**Net Entry**
2004/05	1.21e+07	0.38	0.11	-0.38	0.89
2005/06	2.82e+07	0.27	0.24	-0.06	0.55
2006/07	7574222	3.83	-1.20	-1.08	-0.55
2007/08	5541291	1.14	0.93	-0.07	-1.00
2008/09	-4003512	-0.07	-0.91	-0.30	0.28
Entire period	**9882708**	**0.96**	**0.01**	**-0.33**	**0.36**

Source: Authors' calculations

Table A2: NUTS3 Regions

Country	Region	Code
Czech Republic	Praha	CZ01
	Středočeský	CZ02
	Jihočeský	CZ03
	Plzeňský	CZ04
	Karlovarský	CZ05
	Ústecký	CZ06
	Liberecký	CZ07
	Královéhradecký	CZ08
	Pardubický	CZ09
	Kraj Vysočina	CZ10
	Jihomoravský	CZ11
	Olomoucký	CZ12
	Zlínský	CZ13
	Moravskoslezský	CZ14
Estonia	Põhja-Eesti	EE01
	Lääne-Eesti	EE02
	Kesk-Eesti	EE03
	Kirde-Eesti	EE04
	Lõuna-Eesti	EE05
Hungary	Budapest	HU01
	Pest	HU02
	Fejér	HU03
	Komárom-Esztergom	HU04
	Veszprém	HU05
	Győr-Moson-Sopron	HU06
	Vas	HU07
	Zala	HU08
	Baranya	HU09
	Somogy	HU10
	Tolna	HU11
	Borsod-Abaúj-Zemplén	HU12
	Heves	HU13
	Nógrád	HU14
	Hajdú-Bihar	HU15
	Jász-Nagykun-Szolnok	HU16
	Szabolcs-Szatmár-Bereg	HU17
	Bács-Kiskun	HU18
	Békés	HU19
	Csongrád	HU20
Slovak Republic	Bratislavský	SK01
	Trnavský	SK02
	Trenčiansky	SK03
	Nitriansky	SK04
	Žilinský	SK05
	Banskobystrický	SK06
	Prešovský	SK07
	Košický	SK08
Slovenia	Pomurska	SI01
	Podravska	SI02
	Koroška	SI03
	Savinjska	SI04
	Zasavska	SI05
	Spodnjeposavska	SI06
	Jugovzhodna	SI07
	Notranjsko-kraška	SI08
	Osrednjeslovenska	SI09
	Gorenjska	SI10
	Goriška	SI11
	Obalno-kraška	SI12

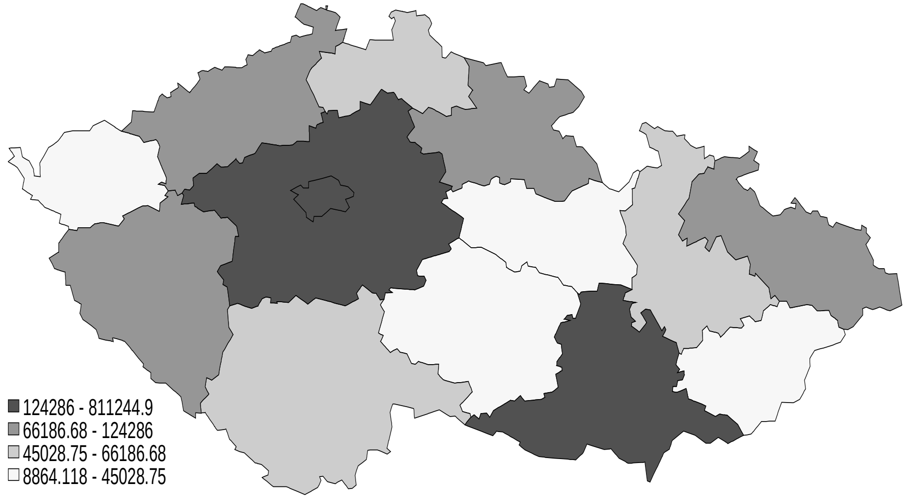
Table A3: Number of firms

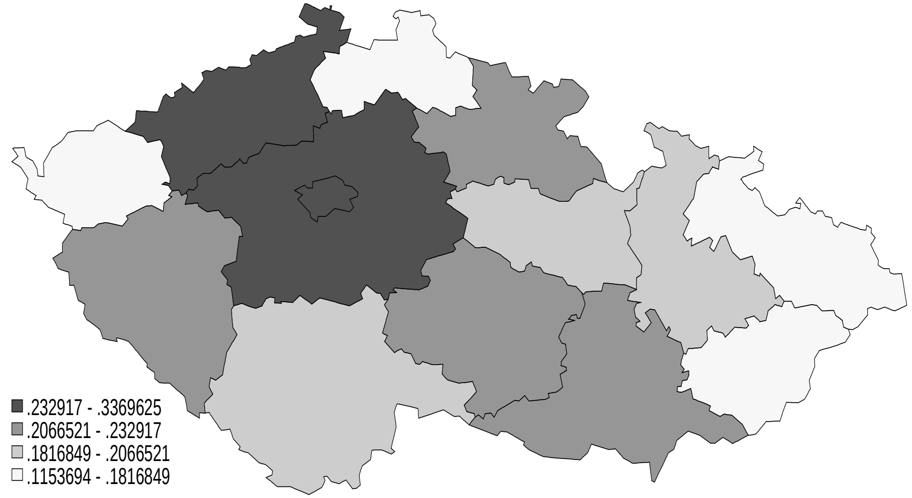
Year	Czech Republic	Estonia	Hungary	Slovak Republic	Slovenia
2004	6992	679	165	1046	1219
2005	7743	782	572	1984	1480
2006	9063	921	854	2582	1968
2007	9457	1073	2968	2618	1976
2008	7735	1168	3488	2127	1909
2009	6793	8825	3349	1607	1670

Figure A1: Average TFP of local firms and share of foreign firms in region 2004-2009

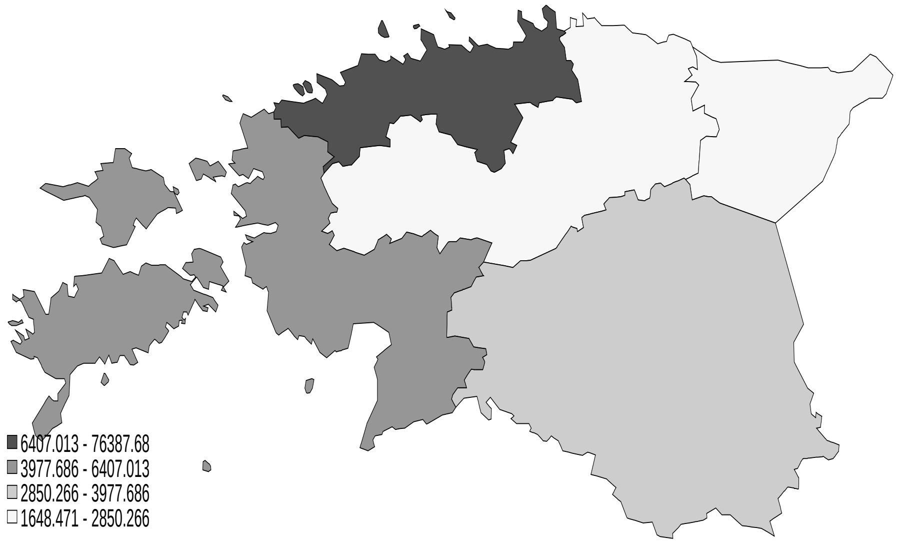
Mean TFP of local firrms	Share of foreign firms

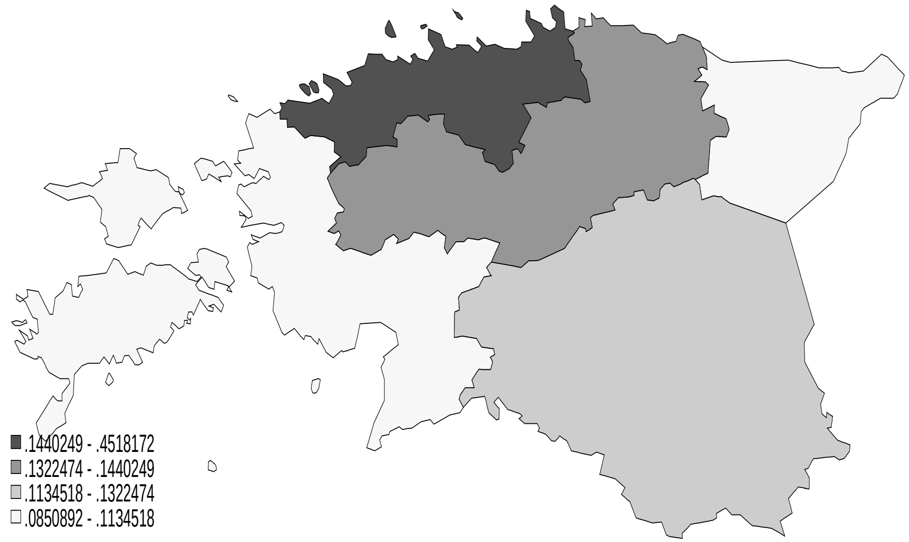
Czech Republic





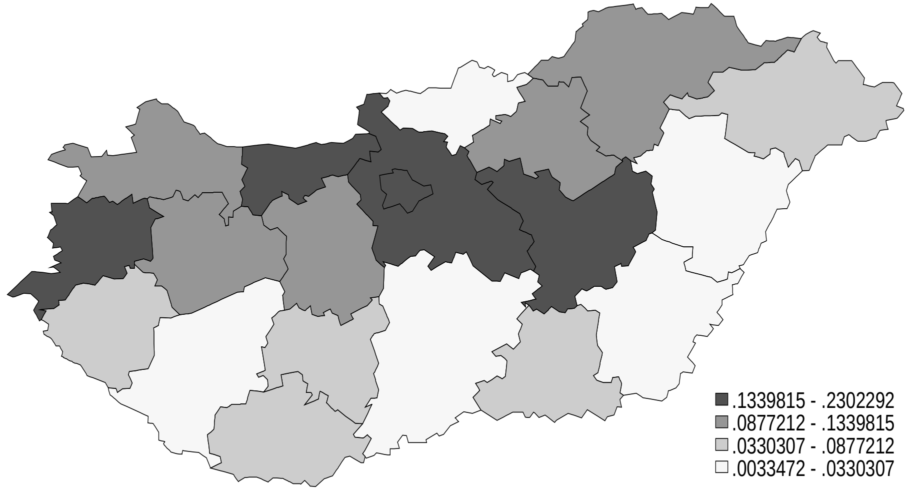
Estonia



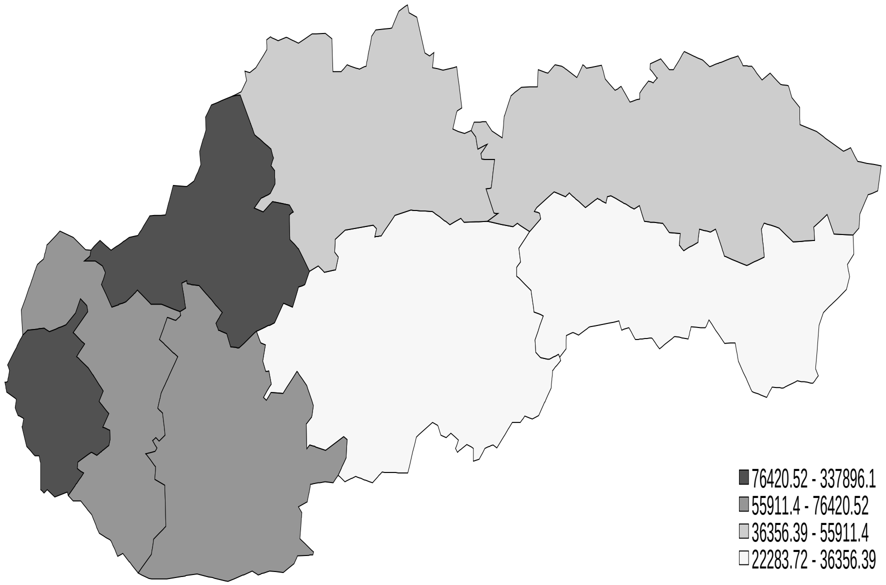


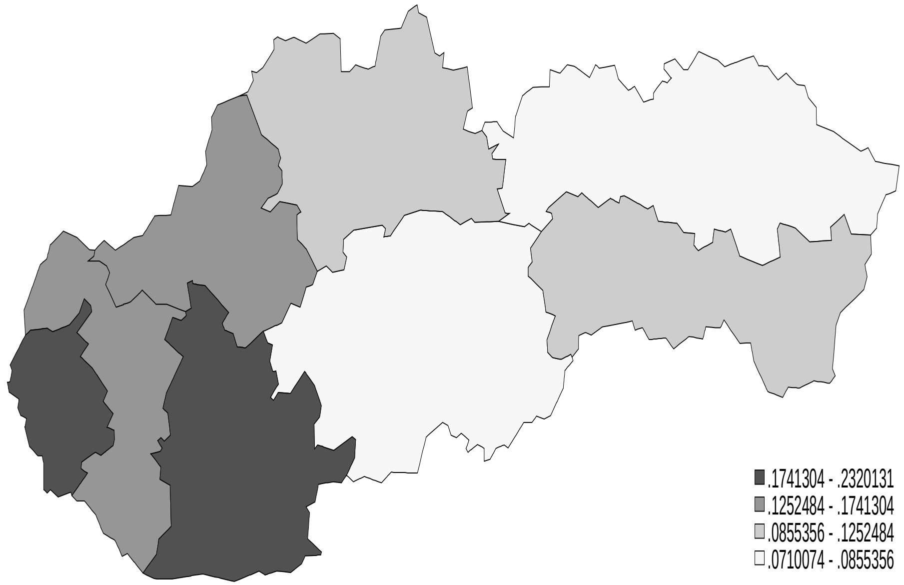
Mean TFP of local firms	Share of foreign firms

Hungary



Slovak Republic





<table>
<tr><td>Mean TFP of local firms</td><td>Share of foreign firms</td></tr>
<tr><td colspan="2">Slovenia</td></tr>
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</table>

Source: Authors' calculations