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Industrial Concentration, Regional Employment and Productivity Growth: Evidence from the Late Transition Period of Hungary

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Summary*

This paper investigates how a static value of regional concentration affects employment and productivity growth over time in less-developed regions. Regression models are built to test major hypotheses of regional growth theories, namely the effects of concentration, competition and diversity on employment and productivity growth. Our findings suggest that agglomeration economies might have slimmer relevance in the growth of less-developed regions concerning employment growth. However, regional concentration has strong significant effect on productivity growth in each industry. The evidence found highlights that investments and consequently employment growth are led by local market motivations, while MAR knowledge externalities play a more important role in productivity growth. We will also show that a bunch of co-located small firms are more likely to improve employment; while productivity growth occurs in concentrations with big firms present.

Keywords: regional concentration, employment growth, productivity growth, less-developed regions, transition economy

JEL codes: O18, P25, R11

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Introduction

Geographic concentration of economic activity has attracted economists' attention for centuries. Research has been carried out on the topic with varying intensity since von Thünen's early model of specialization until the latest works of the Nobel Prize winner Paul Krugman. Some important schools of economic thought picked up the topic recently, like new growth theories, institutional economics and new economic geography.

In the current paper we concentrate on the impacts of geographic concentration in two dimensions: employment and productivity. Employment growth and concentration has been on the table of regional analyses for a long time. Knowledge externalities appeared as key concept in the first regional growth theories developed by Alfred Marshall (1890), which has been further elaborated during the 20th century with an evolving intensity in the last decade and at the turn of the century. Evidence was found proving the effect of industry concentration, regional specialization (Glaeser *et al.*, 1992), local competition (Porter, 1990) and diverse urban environment (Jacobs, 1969) on regional growth. However, theories created in developed regions may not prevail in less-developed ones, which have not been analysed sufficiently enough.

Transition economies are particularly interesting, because most of them underwent at least 4-5 decades long economic-development period, which was earmarked by socialist industrialization. This process meant a forced economic restructuring that also largely altered previous spatial patterns of economic activity. In this period bureaucratic coordination of central governments prevailed, market-economic forces were put aside. Hence, the usual logic of spatial concentration was also changed. Many interesting questions emerge. What are the main impacts of spatial concentration in an economy that had been distorted from its organic, market economic development path? Will this economy maintain activity and spatial structure, or will it return to an older pattern? Or economic restructuring would rather mean the creation of a completely new pattern based on the development logic of globalized industries? Or will there be a mixture of the three? Since economic restructuring was most vibrant in transition economies, we hoped to obtain clear evidence on the original questions about impacts of geographic concentration.

In this paper we analyse the late transition period of Hungary using an entire firm level database aggregated on the level of 168 sub-regions of the whole economy. Our data concerns the 1998–2005 period, in which industries followed a wide variety of growth paths. Our aim is to show how regional concentration of industries have affected regional employment and productivity growth. We build regression models to identify the effects of initial stages of industry concentration, regional competition and diversity on concentration and employment and productivity growth.

Our finding suggest that initial concentration strongly but negatively affect regional employment growth but have positive effect on productivity growth

over the period. This finding implies that less-developed regions might follow different paths of development, where investments and locations of new firms are not led by agglomeration economies but other factors (possibly new market opportunities). In this sense foreign-owned firms that were reported many times to be decisive in Hungarian value creation might be led by other location motives than domestic companies. On the other hand, we find evidence that productivity growth is positively affected by MAR type of agglomeration economies.

The remaining of the paper starts with a theoretical overview on agglomeration economies, knowledge spillover and different phases of regional development. The characteristics of Hungarian transition in terms of the role of foreign-owned firms are outlined in the third section. The fourth section contains the description of main methodological tools used. This is followed by the two main bodies of results in the fifth section. Our conclusions are drawn in the sixth section, where theoretical questions are also discussed.

1) Theoretical background

Spatial concentration and specialization of economic activities has been recognized and analyzed for over a hundred years. Alfred Marshall (1890) studied determinants of industrial agglomerations and found three decisive factors: (i) access to developed labour market, (ii) to deep supplier background and (iii) possibility of quick knowledge and information transfer among firms. More recent publications have similar arguments (Krugman, 1991, Venables, 2001). Marshall's argument on agglomeration economies was implemented by new growth theories. The latter tries to explain continuous differences in growth rates and the lack of convergence (that contradicts the neoclassical paradigm) with the notion of increasing returns on investments in knowledge and technology (Romer, 1986; Rebelo, 1991). Returns are increasing in the economy as a whole due to spillover effects, meanwhile individual economic agents may have production functions with decreasing returns. This is the basis of the Marshall–Arrow–Romer (MAR) model.

In the MAR view, regional concentration of specialized industries produce positive externalities, because specialized labour and knowledge flow needs similar technological and cultural background. On the other hand, Jane Jacobs (1969) showed that urban agglomerations provide the possibility for inter-industrial knowledge spillover as well through the dense social networks and the diverse economy in big cities (urbanization externalities).

The main rationale of spatial concentration is achieving agglomeration economies, which are basically distinguished by type of spatial knowledge transfer occurring. The MAR type of agglomeration economies are based on localization externalities that relate to firms engaged in similar or inter-linked activities, because these firms can learn from each other. For example, Italian industrial districts provide the base for flexible production systems that can serve volatile markets (Antonelli, 1994). Similar association were reported in the Silicon Valley and Route 128 (Saxenian, 1994) and in

the UK (Oxford and Cambridge, particularly) (Miller, 2001). Meanwhile, Jacobsian type of agglomeration economies are rooted in urbanization externalities that originate much more in the diversity of economic activity and labour division in spatial concentrations, like metropolitan areas (Florida, 2002). This type of externalities of regional and urban concentration concerns all co-located firms and industries in a single location, because firms might learn from each other in a complex way and industry borders might be of secondary importance. More recently, it has been showed that knowledge spills over only among firms from related industries that can learn from each other (Frenken *et al.*, 2007).

In both cases agglomeration economies are rooted in functioning processes where linkages among firms, institutions and infrastructure of a given location give rise to economies of scale and scope. For example, the development of general labour markets and pools of specialized skills, dense interactions between local suppliers and customers, shared infrastructure and other localized externalities. Agglomeration economies arise when such links lower the costs and increase the returns of the firms taking part in the local exchange. Presence in agglomerations improves performance by reducing the costs of transactions for both tangibles and intangibles.

If, however, agglomeration economies exist and continuously attract firms, why do agglomerations stop growing after a while, why do some of them decline over time? The boundaries of spatial concentration were addressed by both the new institutionalist theories and the new economic geography. Based especially on Williamson's transaction cost theory (Williamson, 1981), we can argue, that just like in the case of individual firms there should be an upper-size limit of agglomeration. With growing size of urban settlements negative externalities appear and costs increase that may counterbalance the perceived and actual benefits of agglomeration economies. This size limit may change over time, especially if technologies develop, since much of the transaction costs can be reduced by using up-to-date communication and data-exchange technologies. However, the current "death of time and distance" does not necessarily mean that limits of agglomerations disappeared. On the contrary, Venables (2001) and more recently Maignan *et al.* (2003) proved that there is a new status quo of centripetal and centrifugal forces of agglomerations, and this new equilibrium point does not necessarily attract more activity than the one at the previous techno-economic paradigm. From the viewpoint of our research it is important to note that agglomerations do not grow endless.

Another powerful model that tries to explain the existence of spatial concentrations of specialized activities (clusters) is bound to Michael Porter's seminal work (Porter, 1990, 2003). In his "diamond model" four sets of interrelated forces were brought forward to explain industrial dynamics and competitiveness. These were associated with factor input conditions, sophisticated local demand conditions, related and supported industries and firm structure, strategy and rivalry. A core notion arose around his model stressing that collaborative, mutually supportive group of actors could enhance regional competitiveness in global markets,

and thus creates growth and other benefits. Scale and scope economies of agglomerations may also be enjoyed by cluster members, but they are completed by synergies of cooperation. In this view, regional development comes from the innovation pressure of local companies, which is helped by a competitive environment constituted by a big amount of small firms better than a monopolistic or oligopolistic environment with a small number of large firms. On the contrary, papers using the concepts of localisation economies and MAR externalities argue that local monopoly is better for regional growth because companies can internalize and exploit innovative ideas easier.

Porter (2003) also emphasizes that regional development goes through phases that differ slightly from each other: input driven, investments driven and innovation driven phases mainly depends on the maturity of the economy in the region. While innovation is the key mechanism in developed regions, cost efficiency is the leading force in less-developed regions by attracting economic activities. Consequently, the explaining power of knowledge externalities might vary across regions; investments coming from outside the region and accumulated capital might determine regional growth in less-developed regions, where knowledge externalities do not prevail.

There is a whole amount of research published on regional growth of employment and regional concentration, respectively. The current literature basically goes back to Glaeser *et al.* (1992), where regional concentration of employment was proved to have significant effect on employment growth of US metropolitan areas. Henderson *et al.* (1995) also showed that the regional condition of previous years explains employment growth in following years. These authors found significant positive effect of a static value of regional concentration on employment growth, which was further elaborated by many scholars (see McCann and van Oort, 2009 for historical overview). However, analyses carried out with additional dynamic variables showed that static regional concentration does not always have positive effect on the future growth of employment (van Oort *et al.*, 2005, Weterings, 2005). Contradicting results of empirical surveys may be partly explained by the problems in interpretation of the seminal work of Glaeser *et al.* (1992).

Since only employment data was accessible for most of the analyses, but no investment, sales or value-added figures, they could catch only one aspect of regional development: employment growth. Glaeser and his colleagues (1992, at p. 1132 and p. 1146) stressed, that the more proper research would require the analysis of other aspects, most importantly productivity development. Their exercise deals with one specific localization externality, or rather about measuring the impact of agglomerations on one specific development feature: employment growth. But it should not be considered as a thorough analysis of the reasons why and how spatial concentrations are established.

To sum up, two distinct features are discussed in the literature that may influence the emergence of knowledge spillovers and hence employment growth in agglomerations. The first is market structure (monopoly versus competitive market), the second the direction of potential spillovers (intra- or inter-industry direc-

tions). The conclusion of the Glaeser *et al.* (1992) paper is that competitive markets promote the emergence of new ideas and innovation, and knowledge spillovers may be more important in inter-industry relations.[1] Therefore, the following three hypotheses are stressed in the literature of agglomeration economies effect on regional growth. Regional growth is strongly affected by the co-location of similar or related firms, because localisation externalities and concentration enable knowledge spillovers to prevail across firms in the same industry (Marshall, 1890). However, knowledge might also flow from one industry to the other in locations with high population density; urbanization externalities follow from the concentration of a diversity of economic activities (Jacobs, 1969). The cluster literature highlights that local competition forces firms to innovate in order to survive (Porter, 1990).

Our research is organized around these hypotheses; we intend to answer the following question. What effect does regional concentration have on regional employment and productivity growth? Our results suggest that innovation, and knowledge externalities might have less effect on regional employment growth in less-developed regions than investments and market potentials have. On the other hand, we show new evidence on MAR agglomeration externalities effect on productivity growth.

[1] The impacts of positive spillovers on economic growth, and most importantly on productivity growth was investigated by many scholars. Greenaway and Görg (2001, 2003) provide an extensive analysis of the existing empirical surveys. They conclude that due to various reasons (among them also methodological imperfections) very little convincing evidence was found on more growth or increasing productivity due to spillover effects. But most papers included in their overview did not survey regional differences or the role of agglomerations.

3) Previous research in Hungary

The determining role of foreign direct investments and the remaining presence of some state-controlled companies and services are the main features of transition economies that distinguishes their current development model (Szanyi, 2003). Greenfield investments by large multinational companies have been realized after the change of regime in the tradable and service sectors (*e.g.* automotive and ICT industries). After a climatisation period, some of these companies started to locate their R&D functions to their Hungarian sites (Lengyel and Cadil, 2009). In the period of 1995–2003, the growth of the share of foreign affiliates in business R&D spending was among the highest in Hungary (UNCTAD, 2005, p. 127). The share of foreign affiliates in business R&D is around 80 per cent (EC, 2005). Foreign-owned companies play a crucial role in spatial industrial dynamics through their supplier networks. However, their regional networks are usually determined by the parent company headquarter abroad, and local suppliers usually play only a marginal role, especially in the higher levels (Grosz, 2006, Sass and Szanyi, 2004).

Previous research showed that industries differ in terms of regional spread in Hungary. For example, North-Western Hungary stands out as a leading area in automotive industry concentration (Grosz,

2006) while telecommunication and computer equipment manufacturing spread on a larger scale over the country with the exception of Budapest agglomeration, respectively (Szanyi, 2008). Another paper on Hungarian regional innovation systems showed that high-tech and medium-tech industries were led by foreign-owned companies in Hungary, and close location did matter in those manufacturing sectors (Lengyel and Leydesdorff, 2010). On the other hand, knowledge-intensive services do not need physical proximity; these services can be provided from a bigger distance as well. Clustering, in the first case, builds on supply chains, while the ICT services counteract on the concentration trends of the ICT manufacturing. Consequently, medium-tech industries are more likely to form regional clusters in areas with localization externalities than ICT industry. Urbanization externalities might lead concentration of ICT in big-city regions; this happens faster than in other regions and other industries in Hungary. Large multinational companies in knowledge-intensive industries (Nokia-Siemens Networks, Ericsson) located their R&D sites in Budapest.

A detailed analysis of the data that is used for the current research also showed that cross-industrial difference was visible in the regional distribution of automotive and ICT industries (Lengyel, 2010). Automotive industries tend to concentrate in areas where foreign-owned firms had located their sites, and new firms that enter those regions are attracted by localization externalities. On the other hand, ICT concentrates in Budapest and its agglomeration; urbanization externalities might occur when new firms come off and enter ICT industry.

3) Data and methods

The database consists of the annual census-type data of Hungarian firms, which were compiled from financial statements associated with tax reporting submitted to the National Tax Authority in Hungary by legal entities using double-entry bookkeeping. The observation period covers years 1998 and 2005. The data include all industries and contain basic information for each sample firm including the NACE 4-digit codes, the annual average number of employees, overseas turnover and other major financial indices. In addition, the locations of the sample firms are identifiable. Information about the ownership structure includes the total amount of equity capital at the end of the term and the proportional share held by the state, domestic private investors and foreign investors. Tax incentives and direct government support are also present in the data. Empirical analyses have been built on this dataset several times, results were also published in Hungarian and in international literature as well (Iwasaki *et al.*, 2009, 2010, Szanyi, 2008).

Company level data were aggregated by two axes: industrial sectors and regions. Sectors were identified following Ketels and Sölvell (2005) in order to be able to compare results with further research aiming cluster emergence. We complemented the list of industries with few additional sectors, thus the whole economy is present in the analysis. Geo-

graphical regions have been defined by the Hungarian sub-regions. These are LAU 1 (local administrative unit) regions accounted for 168 in the year 2005.

There are several methods to measure regional concentration; Ratanawaraha and Polenske (2007, p. 46) give a detailed overview of the indicators. Basically, there are two types of indexes: the ones that do not consider spillover effects and the ones that also take external effects on scale into consideration. In this paper we limit the analysis on the following simple tools.

Location quotient (LQ) measures relative concentration of employment in a region based on a calculated ratio of the industry employment of the economy of the reference unit:

$$LQ_{ij} = \frac{e_{ij} / E_i}{e_j / E} \quad \text{, where} \qquad (1)$$

e_{ij} is the number of employees in industry i of region j,

e_j is the number of employees in all industries of region j,

E_i is the number of employees in industry i in the country,

E is the number of employees in all industries in the country.

The value of LQ informs us about the relation between the share of an industry in the region and the share of this industry in the country. If the regional LQ value is higher than 1, then the share of industry is higher in the region than in the country average. This indicator is commonly used for employment concentration that we indicate with $LQ_{EMPLOYMENT}$ (LQ_E). In this research we extend the LQ application and also calculate LQ_{FIRMS} in the industry (LQ_F).

LQ_E and LQ_F give insight to the labour and organizational concentration of an industry in a given region compared to the country average. These indicators complement each other because they report on different aspects of concentration. For example, LQ_E reflects on employment shares without considering organizational structure of the industry in the given region: it has the same value when the labour force is employed only by one firm or each employee belongs to separate firms. On the other hand, the value of LQ_F informs us about the organizational structure of an industry in the given region compared to the country average. The higher the indicator is the more the industry is scattered in the region; thus, we use organizational concentration in the Italian industrial districts aspect, where SMEs are the leading force of regional concentration. However, one is able to analyse cross-industrial (and regional) differences with this tool, and show other types of concentrations with combination of the two indicators.

For example, Nakamura and Morrison Paul (2009) suggest to comparing LQ_E and LQ_F indicators. When LQ_E is higher than LQ_F, the region contains relatively large firms. On the contrary, when LQ_E is lower than LQ_F, the region has a big number of relatively small firms. Consequently when LQ_E/LQ_F is higher than 1, the region has a monopolistic structure; when the indicator is lower than 1, the local environment is competitive in the region. Single LQ_E and LQ_F indicators will be used in both phases of the analysis, while the LQ_E/LQ_F indicator will be used in the regression models.

Most of the indicators used in the regression analysis were calculated on subregional level for each industry. These variables include 6888 cases (41 industries × 168 subregions), respectively. We define CONCENTRATION as a location quotient of employment of each economic activity in the region. This measure was extensively discussed in the previous sections. Our indicator for COMPETITION is location quotient of employment (LQ_E) divided by the location quotient of the number of firms (LQ_F). This variable informs us about the type of market in the given sector and region (Nakamura *et al.*, 2009). If the variable is lower than 1, competitive market is expected, if the variable is higher than 1, monopolistic competition is expected.

The major problem of Location Quotient is that it is independent from the size of industry in the region it concerns. The size of industry in the whole country affects regional LQs, and it is likely to have similar LQ values when an industry is vague in the country and in the region too, and another has much higher volumes of employment in regional and national level. Therefore, we also apply static and dynamic indicators for employment size. INITIAL EMPLOYMENT represents the volume of employment in the given sector. TOTAL GROWTH indicates the growth of employment when the investigated sector is excluded from the variable.

Indicators of ownership structure are also included in the models: the initial state of registered foreign-, domestic- and state-owned capital, and their change over time. According to the previously discussed transition period, we expect that these latter variables have also strong effect on regional growth. The natural log of TAX incentives is also included as control variable, because we expect that economic policy has positive effect on regional growth.

Other types of indicators were calculated only at the sub-region level, and the same set of 168 cases was used to measure their effect in each industry. These variables include DIVERSITY, POPULATION DENSITY, HIGHER EDUCATION and DISTANCE FROM BUDAPEST. DIVERSITY of economic activity in the region is calculated as a cross-sectoral Gini indicator. Gini coefficient is commonly used as a proxy for regional concentration of employment in industries at a higher aggregation level (mostly at country level). We aggregated the employment shares on regional level, thus this type of Gini measures the extent of employment concentration in sectors in the region (Nakamura *et al.*, 2009). The value of 1 indicates that the regional economy concentrates in one sector, the value of 0 means that employment distribution in the regions has the same pattern than the employment distribution on the country level. POPULATION DENSITY is included in order to mark urban regions. The variable of higher education is constituted from the number of employees with a BA or higher degree. Distance from Budapest is defined by the time need to drive from the sub-region's centre to Budapest. (*Table 1*)

PRODUCTIVITY was calculated as value added over employment. Value added was aggregated on regional level but previously calculated from company-balance data as it follows:

Value Added = Net Turnover – Material Costs – Amortization (2)

Dependent variables are EMPLOYMENT GROWTH and PRODUCTIVITY GROWTH. The first is defined as the change in the natural log of employment over the 1998–2005 period. The latter is the change in the natural log of the volume of the value added over employment. In order to improve the normal distribution of variables natural log was calculated from every independent variables except DIVERSITY, COMPETITION and DISTANCE FROM BUDAPEST. (*Table 2*)

The Pearson correlation co-efficients (Table 2) do not seem to be unreasonably high, thus, can be included in the following models.

4) Results

It is widely accepted to explain employment growth by a static state of regional concentration of the industry (Glaeser *et al.*, 1992, Henderson *et al.*, 1995). Simple linear regression models were set up here to test the hypotheses outlined in Section 1 concerning employment and productivity growth and agglomeration economies in a transition economy. A positive coefficient of CONCENTRATION and a positive coefficient of COMPETITION support the MAR hypothesis: this case is characterized by companies that locate to specialized regions, and monopolies have bigger role in agglomeration than a cohort of small firms. A positive coefficient of CONCENTRATION and a negative coefficient of COMPETITION support the Porter hypothesis, in which localization economies and specialized regions (clusters) play crucial role but a competitive environment is essential for innovation and growth. A negative coefficient of DIVERSITY and a negative coefficient of COMPETITION support the Jacobs hypothesis (van Oort *et al.*, 2005); this latter concerns to urban environment, where not the specialization of the region but the diversely concentrated economy cause externalities. The complex network of small firms make the knowledge spillover intensive in this case.

4.1. Employment growth

Neither of these hypotheses has been further supported by our results concerning employment growth. As a matter of fact, negative coefficient was found for CONCENTRATION and COMPETITION variables, while DIVERSITY did not seem to have significant effect on employment growth (*Table 3*).

The first results concern to 3823 cases, sectors and regions with more than zero employees. Initial CONCENTRATION of employment has a significant and strongly negative effect on employment growth. Static variables of concentration had also negative effect on regional growth in ICT industry of the Netherlands (van Oort *et al.*, 2005, Weterings, 2005). However, CONCENTRATION coefficients show a much stronger negative relation between the initial state of regional concentration and employment growth in Hungary. The robustness of this result will be further elaborated later on in the sectoral decomposition of the model.

How could it be that the more the industry was concentrated in the region the

less extent it increased over time? Theoretically speaking, this is bad news, because one cannot expect agglomeration economies to prevail in Hungary. However, regional development in transition economies may differ from developed ones. We would argue that the lower maturity of the economy predominates the relevance of agglomeration economies in most of the sectors: the industry is dominated by foreign investors; foreign firms are motivated to invest by market potentials in most of the sectors. Consequently, we might face a regional spread instead of regional agglomeration, which we found in the data in most of the industries. One might seek agglomeration effects with other indicators (value added, accumulated capital, *etc.*), which may capture characteristics of transition economies better.

If we enter INITIAL EMPLOYMENT in the last model we find that it also has significant negative effect on employment growth. This latter degraded the explaining power of CONCENTRATION; these variables are strongly correlated. COMPETITION has a significant negative effect on regional growth, which implies the higher the firms size is the less growth is expected. Consequently, competitive structures are determining in regional growth in Hungary; small firms have had bigger effect on regional employment growth over the investigated period than big companies in most of the cases. This effect varies along sectors that we will touch upon later. POPULATION DENSITY was entered to the model to control the effect of urban regions. This variable remains insignificant when the model describes all the sectors together. However, it brings us significant information about the effect of urbanization, when the sectors are handled separately. (*Table 4*)

Growth of employment in the region except the investigated sector has a significant positive effect on employment growth (Table 4). Previous studies highlighted that this effect of TOTAL GROWTH is due to the growing regional demand; the more the regional employment is growing the higher the local demand will be for products and services produced in the region. This multiplicator effect occurs in the contracted sample with all the industries, and prevails in separate sectoral models as well.

Domestic initial capital and domestic investments explain employment growth stronger than foreign initial capital and foreign investments. However, strong cross-sectoral differences may exist. The presence of highly-educated employees has a positive although weak effect on employment growth. HIGHER EDUCATION might also play different roles in the sectors.

Similarly to the cumulated sample, CONCENTRATION has significant and strong negative effect on employment growth in almost every industry (*Table 5*). The *footwear industry* is the only one out of 41 sectors where initial regional concentration has positive significant effect on employment growth. This is the only case when the hypotheses have a chance to be tested: both the DIVERSITY and COMPETITION variables have negative though insignificant effect. Consequently, Porter hypothesis seems to prevail in the Hungarian footwear industry. (Table 5)

Agglomeration economies are not likely to result employment growth in all other sectors. On the contrary, the more the sector is concentrated in the region the

slower growth is expected in there. This happens in 26 sectors out of 41, which marks the robustness of the finding. Concentration has insignificant effect on regional employment growth in the remaining industries.

The effect of COMPETITION variable varies across sectors. Employment rises because of competitive structure in the case of *distribution services*, *mining*, and *tourism* industries; while monopolistic environment and big companies might take effect on growth in the case of *automotive*, *communications equipment*, *medical devices*, *sporting and recreation*, and *transportation* industries. DIVERSITY of economic activity in the region is insignificant in explaining regional growth in most of the sectors. This variable turns to have negative significant effect in *biopharmaceuticals* and *other consumer services* industry: the more homogeneous the region is the more likely are these industries to grow there.

Urban environment does not seem to be important for all of the sectors in order to grow. POPULATION DENSITY has positive significant effect on employment growth in the case of *building services*, *business services*, *communications equipment*, *distribution services*, *education and knowledge creation*, *tourism*, and *information technology*. These sectors need urban environment to grow in Hungary, but can be divided by the need for local consumption. Only communications equipment, information technology and education and knowledge creation sectors have grown independently from the local market: TOTAL EMPLOYMENT variable does not have a positive effect on growth only in these cases of urbanized industries. Therefore we assume that these sectors have strong multiplicator effects on the local economy, which accords with our previous results (Lengyel and Leydesdorff, 2010).

4.2. Productivity growth

Output indicators were suggested to being used to measure the effects of industrial concentration and agglomeration economies (Glaeser *et al.*, 1992). In this section we turn the attention to output indicators and show the regression models describing regional productivity growth.

In the first step VALUE ADDED GROWTH appears as dependent variable in the analysis. CONCENTRATION has a positive significant effect, just as COMPETITION variable; the co-efficient of DIVERSITY variable is not significant. INITIAL VALUE ADDED has very strong negative effect on VALUE ADDED GROWTH. Thus, MAR externalities seem to be present in industrial concentrations, which describe value added growth. However, the argument might refer to results in PRODUCTIVITY GROWTH (*Table 6*).

CONCENTRATION has a positive and significant effect on PRODUCTIVITY GROWTH. This result is very robust, because the co-efficient remains positive and significant after entering several variables into the model (*Table 7*), and the co-efficient has similar values across the various industrial sectors (*Table 8*). This finding might be contradictory for the first view, when being compared with results found for employment growth. However, the two dependent variables

reflect on two different aspects of agglomeration economies. Employment growth can be either the result of firm growth in a given location or the entrance of new firms into the region. Thus, the effect of agglomerations on regional performance is not clear. On the other hand, productivity growth reflects agglomeration economies better. Though, co-located firms could enhance their output over employees for several reasons; agglomeration economies, knowledge externalities and local learning are the most powerful assumptions that underlies growth. The positive value of CONCENTRATION coefficient implies that co-located firms from the industry learn from each other, or intra-industrial knowledge externalities occur.

Our results concerning productivity growth in industrial concentrations strengthens the MAR hypothesis. Besides the positive effect of CONCENTRATION, COMPETITION variable is also positive. The latter means that monopolistic market structure and big firms describe local productivity growth better than competitive environment and a bunch of small firms. This result implies that big firms have bigger chance to improve their productivity than small firms. Therefore, agglomeration economies occur easier when big firms are present in the region. However, one must respect that industries vary concerning the characteristics of spatial organizational structure. (Table 7)

In addition, INITIAL PRODUCTIVITY was entered to the model in order to measure the effect the state of productivity in the beginning of the period. The strong negative effect marks that productivity grows slower in concentrations where it is already high than in concentrations with relatively low productivity. This significant negative effect becomes increasingly stronger when new variables are entered to the model. The effect EMPLOYMENT GROWTH in productivity growth is positive and significant. Since productivity was defined as value added over employment, this latter result implies that value added growth is faster than employment growth. Consequently, productivity growth is led by growth in value added, in which concentrations with high-level productivity are likely to slow down.

POPULATION DENSITY has significant positive effect until HEDU variable is introduced to the model. This latter indicator measures the share of employees with Ba degree or above. These two variables are very much interconnected, the educated labour force lives in regions with higher population density. However, this indicator remains very important over the model: the presence of educated labour force is a significant source of productivity growth.

Both the initial state and the growth of FOREIGN and DOMESTIC STAKE have positive significant effect on productivity growth. Investments are important elements of growth, however, we are not able to tell the effects of these two types of ownership in the model. TAX INCENTIVES also seem to affect regional productivity growth positively. Nonetheless, the static value of such measures is not sufficient to evaluate economic policy. (Table 8)

Regression models built in each industry strengthens the role of our CONCENTRATION measure in regional productivity growth: it has positive significant effect in 37 industries; has insignificant effect in one industry; the remaining industries are

not enough spread in space to calculate co-efficient measures. This result hangs with the finding concerned the whole economy, and proves that the effect of CONCENTRATION on productivity growth is robust. Nevertheless, COMPETITION variable does not have positive and significant effect in all the cases. In fact, the indicator has positive significant value only in *agricultural products, biopharmaceuticals, heavy construction and processed food* industries. Big firms are more important than small firms for productivity growth; MAR externalities are expected to occur in these industries in Hungary. COMPETITION has negative significant effect in *distribution services* industry; a bunch of small firms is more important for growth than big firms; this sector might follow Porter-type regional competition. In all the other industries our COMPETITON variable has insignificant effect.

Despite DIVERSITY is not significant on the level of the whole economy, it turns to have significant effect on productivity in separate industries. A diverse environment seems to be important for productivity growth in *analytical instruments, chemical products, education and knowledge creation, entertainment, heavy machinery, information technology, leather products, medical devices, public services* industries. The co-efficient is negative in these cases. Therefore the Gini index has its' only acceptable effect in the regression. However, the presence of Jacobs externalities have not been proved, because COMPETITION is not significant in these industries.

INITIAL PRODUCTIVITY has a very strong negative effect in almost all of the sectors, and EMPLOYMENT GROWTH seems to affect productivity growth positively. Therefore our previous statement that productivity growth is led by value added growth and not by employment decrease is true for separate industries as well. The higher the productivity level was in the beginning of the period the slower growth occurred. POPULATION DENSITY has positive significant effect in almost all the cases except *biopharmaceuticals, fishing, footwear and leather products*.

5) Conclusion and discussion

Regional concentration of industries has had a significant and strongly negative effect on employment growth in Hungary in the 1998–2005 period, but affected productivity growth positively at the same time. The robustness of these findings was shown with industrial decompositions as well. While the first results do not support any of the regional growth hypotheses coming from the literature, our further findings support mainly the MAR hypothesis of local knowledge externalities. Productivity growth depends on big firms with a higher degree than on small firms. On the other hand, employment growth is more likely to occur in concentration with a bunch of small firms than in concentration with a few big firms present. This is an original finding and the major contribution of the paper.

The negative effect of industrial concentration in terms of employment is of higher significance than was found ever before. Meanwhile, the growth of local demand and investments also proved to

have a significant positive effect on concentration and regional growth. So, the effect found might be due to the transition features of Hungary: market opportunities and cost efficiency may be more important in less-developed regions than knowledge spillover and specialized labour market.

In addition, both analyses showed that initial stages of employment and productivity have strong negative effect on aspects of regional growth. The higher the volumes of employment and productivity was in the beginning the slower growth occurred through the period. Consequently, there might be natural limits for agglomeration economies, which was shown before in the literature. These limits might also be strengthened by the low maturity of the region's economy that we have stressed above.

* * * * *

References

Antonelli, C. (1994) 'Technology Districts, Localized Spillovers, and Productivity Growth: the Italian Evidence on Technological Externalities in Core Regions'. *International Review of Applied Economics*, 12, pp. 18–30.

EC (2005) *Towards an European Research Area, Science, Technology and Innovation*. Key Figures 2005. European Comission, DG Research, Brussels.

Fingleton, B., Igliori, D. C., Moore, B., Odedra, R. (2007) 'Employment Growth and Clusters Dynamics of Creative Industries in Great Britain'. In Polenske K R (ed) *The Economic Geography of Innovation*, pp. 60–84. Cambridge University Press, Cambridge.

Florida, R. (2002) *The Rise of the Creative Class*. Basic Books, New York.

Frenken, K., van Oort, F., Verburg, T. (2007) 'Related Variety, Unrelated Variety and Regional Economic Growth'. *Regional Studies*, 41, pp. 685–697.

Glaeser, E., Kallal, H. D., Scheinkman, J. D., Shleifer, A. (1992) 'Growth in Cities'. *Journal of Political Economy* 100, pp. 1126–1152.

Görg, H., Greenaway, D. (2001) *Foreign Direct Investment and Intra-Industry Spillovers*. Presentation at the UNECE/EBRD Expert Meeting on Financing for Development: "Enhancing the Benefits of FDI and Improving the Flow of Corporate Finance in the Transition Economies". Geneva, December 3.

Görg H., Greenaway, D. (2003) 'Much Ado about Nothing? Do Domestic Firms Really Benefit from Foreign Direct Investment?' *World Bank Research Observer* 19. pp. 171–197.

Grosz, A. (2006) *Clusterization Processes in the Automotive Industry*. Discussion Papers, 52, Centre for Regional Studies, Hungarian Academy of Sciences, Pécs.

Henderson, J. V., Kuncoro, A., Turner, M. (1995) 'Industrial Development in Cities'. *Journal of Political Economy*, 103, pp. 1067–1085.

Iwasaki, I., Csizmadia, P., Illéssy, M., Makó, Cs. and Szanyi, M. (2009) *The Concentric-Circle Model of FDI Spillover*

Effects: Estimation Using Hungarian Panel Data. Discussion Paper Series A No.521, The Institue of Economic Research Hitotsubashi University.

Iwasaki, I., Csizmadia, P., Illéssy, M., Makó, Cs. and Szanyi, M. (2010) *Foreign Direct Investment, Information Spillover, and Export Decision: the Concentric-Circle Model with Application to Hungarian Firm-Level data*. Discussion Paper Series A No.527, The Institue of Economic Research Hitotsubashi University.

Jacobs, J. (1969) *The Economy of Cities*. Random House, New York.

Ketels, C., Sölvell, Ö. (2005) *Clusters in the EU 10 New Member Countries*. Europe INNOVA, Center for Strategy and Competitiveness, Stockholm.

Krugman, P. (1991) *Geography and Trade*, Cambridge MA: MIT Press.

Lengyel, B., Cadil, V. (2009) 'Innovation Policy Challenges in Transition Countries: Foreign Business R&D in the Czech Republic and Hungary'. *Transition Studies Review 16*, pp. 174–188.

Lengyel, B., Ságvári, B. (2009) *Creative Workforce and Knowledge Bases in the Hungarian Regional Innovation Syst*ems. Paper presented at "Creative Industries, Scenes, Cities, Places: Idiosyncratic Dimensions of the Cultural Economy", 22–23 April, 2009, Cardiff, UK.

Lengyel, B., Leydesdorff, L. (2010) 'Regional Innovation Systems in Hungary: the Failing Synergy at the National Level'. *Regional Studies*, forthcoming.

Lengyel, B. (2010) *Regional Clustering Tendencies of the Hungarian Automotive and ICT Industries in the First Half of the 2000's*. Research paper to be prepared in the frame of the project: "EU-Strukturwandel, regionale Innovationsdynamik und Clusterbildungsoptionen in der Wissensgesellschaft"

Maignan, C., Pinelli, D., Ottaviano, G. (2003) 'ICT, Clusters and Regional Cohesion: A Summary of Theoretical and Empirical Research'. *NOTA DI LAVORO* 58.2003 Fondazione ENI Enrico Mattei.

Marshall, A. [1890] (1920) *Principles of Economics*. 8th edition, London, Macmillan.

McCann, P., van Oort, F. (2009) 'Theories of Agglomeration and Regional Economic Growth: a Historical Review'. In Capello, R., Nijkamp, P. (eds.) *Handbook of Regional Growth and Development Theories*, Edward-Elgar, Cheltenham–Northampton, pp. 19–32.

Miller, P. (2001) *Business Clusters in the UK – A First Assessment*. DTI, London. www.dti.gov.uk/clusters/map

Nakamura, R., Morrison Paul, C. J. (2009) 'Measuring Agglomeration'. In Capello, R., Nijkamp, P. (eds.) *Handbook of Regional Growth and Development Theories*, Edward-Elgar, Cheltenham–Northampton, pp. 305–328.

Porter, M. (1990) *The Competitive Advantage of Nations*. New York: The Free Press.

Porter, M. (2003) 'The Economic Performance of Regions'. *Regional Studies*, 37, pp. 549–578.

Ratanawaraha, A., Polenske, K. R. (2007) 'Measuring the Geography of Innovation: a Literature Review'. In Polenske,

K. R. (ed.) *The Economic Geography of Innovation*, Cambridge University Press, Cambridge. pp. 30–59.

Rebelo, S. (1991) 'Long-Run Policy Analysis and Long-Run Growth'. *Journal of Political Economy*, 99, pp. 500–521.

Romer, P. (1986) 'Increasing Returns and Long-Run Growth'. *Journal of Political Economy*, 94, pp. 1002–1037.

Sass, M., Szanyi, M. (2004) 'A hazai cégek és a multinacionális vállalatok közötti beszállítói kapcsolatok alakulása'. *Külgazdaság*, vol. XLVIII. No. 9. pp. 4–23

Saxenian, A. (1994) *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*. Harvard University Press, Cambridge.

Szanyi, M. (2003) *An FDI-based Development Model for Hungary – New Challenges?* IWE Working Papers No. 141. December.

Szanyi, M. (2008) *A versenyképesség javítása együttműködéssel: regionális klaszterek*. Napvilág Kiadó, Budapest.

Szanyi, M., Csizmadia, P., Illéssy, M., Iwasaki, I., Makó, Cs. (2009) 'A gazdasági tevékenység sűrűsödési pontjainak vizsgálata'. *Statisztikai Szemle*, 87, pp. 921–935

van Oort, F., van Soest, D. P., Gerking, S. D. (2005) 'Dynamic Information Externalities and Employment Growth in the Netherlands'. In Boschma, R. A., Kloosterman, R. C. (eds.) *Learning from Clusters: a Critical Assessment from an Economic-Geographical Perspective*, Spinger, Dordrecht, pp. 303–332.

UNCTAD (2005) *World Investment Report 2005. Transnational Corporations and the Internationalization of R&D*. United Nations, New York and Geneva.

Venables, A. J. (2001) *Geography and International Inequalities: the Impact of New Technologies.* Paper prepared for World Bank Annual Conference on Development Economics, Washington.

Weterings, A. (2005) 'The Spatial Clustering of Knowledge-intensive Services: Computing Services in the Netherlands'. In Boschma, R. A., Kloosterman, R. C. (eds.) *Learning from Clusters: a Critical Assessment from an Economic–Geographical Perspective*, Spinger, Dordrecht, pp. 275–302.

Williamson, Oliver E. (1981) 'The Economics of Organization: The Transaction Cost Approach'. *The American Journal of Sociology*, 87(3), pp. 548–577.

Table 1
Definition of the variables and descriptive statistics

Variable	Description	N	Min.	Max.	Mean	St. Dev.
Employment growth	Change in the natural log of employment in the 1998–2005 period	3823	-7.23	6.08	0.45	1.36
Productivity growth	Change in the natural log of value added over employment in the 1998–2005 period	3460	-1.34	2.02	0.1042	0.24
Competition	LQ_E devided by LQ_F , 1998	4243	0.00	30.88	0.85	1.47
Concentration	Natural log of LQ_E, 1998	4034	-5.92	4.74	-0.62	1.51
Diversity	Cross-sectoral Gini in the region in year 1998	6888	0.03	0.16	0.0413	0.01
Initial employment	Natural log of employment volumes per region and industry, 1998	4034	0.00	11.52	4.07	2.03
Population density	Natural log of population density, 2001	6888	-1.48	3.48	-0.22	0.67
Higher education	Natural log of employees with Ba or MA in the region, 2001	6888	5.39	12.31	7.39	1.05
Total growth	Change in the natural log of employment in the region, when the investigated industry is excluded, 1998–2005 period	6888	-1.99	2.06	0.16	0.38
Initial foreign	Natural log of registered foreign capital per region and industry, 1998	2070	2.48	19.32	9.88	2.72
Initial domestic	Natural log of registered domestic capital per region and industry, 1998	3971	1.61	19.08	9.90	2.41
Initial state	Natural log of registered state capital per region and industry, 1998	985	0.69	19.66	9.97	2.77
Foreign growth	Change in the natural log of registered foreign capital per region and industry, 1998–2005	1552	-10.22	9.87	0.36	2.31
Domestic growth	Change in the natural log of registered domestic capital per region and industry, 1998–2005	3788	-9.48	11.69	0.90	1.75
State growth	Change in the natural log of registered state capital per region and industry, 1998–2005	667	-11.60	11.67	0.25	2.5
Distance to Budapest	Distance in minutes from the subregion's centre to the capital	6888	0.00	226.62	114.97	50.22
Tax incentives	Natural log of the sum of tax incentives per region and industry, 1998	3428	0.00	16.51	4.00	2.65
Initial productivity	Natural log of value added over employment per region and industry, 1998	3931	0.09	3.02	2.3533	0.25
Initial value added	Natural log of value added per region and industry, 1998	3931	1.10	20.56	10.825	2.46
Value added growth	Change in the natural log of value added per region and industry, 1998–2005	3460	-7.54	12.04	1.0906	2.32

Table 2
Pearson correlation values among variables

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Empl. growth	1																		
2	Product. growth	.258**	1																	
3	Competition	-.316**	.133**	1																
4	Concentration	-.543**	.093**	.529**	1															
5	Diversity	.016	.000	-.047**	-.026	1														
6	In.employment	-.482**	.013	.390**	.771**	-.117**	1													
7	Pop.density	.019	-.005	.059**	.017	-.259**	.330**	1												
8	Hedu	-.006	.000	.059**	-.012	-.279**	.405**	.810**	1											
9	Total growth	.089**	.013	.065**	.101**	-.079**	.016	.316**	.181**	1										
10	Initial foreign	-.214**	.156**	.253**	.342**	-.108**	.558**	.342**	.359**	.013	1									
11	In. domestic	-.262**	-.077**	.221**	.437**	-.109**	.762**	.335**	.391**	.031	.436**	1								
12	Initial state	-.139**	.148**	.194**	.264**	-.069**	.446**	.340**	.386**	-.041	.279**	.272**	1							
13	For.growth	.298**	.056*	-.101**	-.144**	.021	-.113**	-.018	-.028	.032	-.375**	-.016	-.016	1						
14	Dom. growth	.517**	.202**	-.113**	-.252**	.029	-.250**	.002	-.023	.087**	-.148**	-.454**	.021	.090**	1					
15	State growth	.109**	.044	.012	.001	-.048	-.099**	-.076*	-.077	.029	-.105*	-.088*	-.404**	.120*	.027	1				
16	Distance to Bp	-.055**	-.040*	-.011	.001	.160**	-.087**	-.438**	-.303**	-.356**	-.143**	-.110**	-.110**	-.050*	-.041*	.028	1			
17	Tax inc.	-.226**	.005	.267**	.430**	-.081	.676**	.290**	.339**	.014	.582**	.573**	.245**	-.142**	-.160**	-.099*	-.056**	1		
18	Initial productivity	-.086**	-.672**	.038*	.189**	-.075**	.505**	.272**	.317***	.066**	.197**	.545**	.148**	.011	-.098**	-.066	-.079**	.392**	1	
19	Initial value added	-.083**	-.623**	.039*	.198**	-.085**	.541**	.304**	.353**	.067**	.226**	.591**	.162**	.015	-.103**	-.070	-.087**	.426**	.975**	1
20	Value added growth	.252**	.965**	.163**	.126**	-.015	.069**	.036*	.045**	.021	.209**	-.036*	.190**	.061*	.200**	.038	-.064**	.063**	-.599**	-.591**

Note: Coefficient values are significant on ** 0.01%. and on * 0.05%.

Table 3
Employment growth and agglomeration economies

	Employment growth	Employment growth	Employment growth
Constant	0.169**	0.125	1.005***
	(-2.154)	(1.592)	(9.516)
Competition	-0.33**	-0.34**	-0.035**
	(-2.02)	(-2.114)	(-2.226)
Concentration LQ	-0.525***	-0.525***	-0.337***
	(-32.554)	(-32.546)	(-15.462)
Diversity	0.04	0.13	0.1
	(0.277)	(0.914)	(0.702)
Population density		0.033**	0.116
		(2.369)	(7.579)
Initial employment			-0.266***
			(-12.563)
N	3823	3823	3823
R^2	0.296	0.297	0.324
F	533.957***	402.355***	366.67***
Durbin–Watson	1.443	1.445	1.458

Note: coefficients are significant at *** 1%, ** 5%, * 10%.

Table 4
Determinants of regional growth

	Employment growth	Employment growth	Employment growth	Employment growth	Employment growth
Constant	0.763***	0.371	-0.768***	-0.665**	-0.489
	(6.999)	(1.446)	(-2.875)	(-2.486)	(-1.074)
Competition	-0.34**	-0.035**	0.006	0.007	0.016
	(-2.194)	(-2.248)	(0.268)	(0.331)	(0.34)
Concentration LQ	-0.383***	-0.37***	-0.233***	-0.248***	-0.147**
	(-17.123)	(-15.678)	(-7.514)	(-7.901)	(-2.573)
Diversity	0.009	0.012	-0.004	-0.007	0.009
	(0.635)	(0.879)	(-0.217)	(-0.380)	(0.229)
Population density	0.066***	0.035	0.023	0.028	0.094
	(4.017)	(1.406)	(0.639)	(0.703)	(0.904)
Initial employment	-0.218***	-0.234***	-0.605***	-0.607***	-0.631***
	(-9.993)	(-9.837)	(-15.226)	(-14.767)	(-7.986)
Total growth	0.116***	0.117***	0.052***	0.059***	-0.028
	(7.989)	(8.09)	(2.692)	(2.869)	(-0.657)
HEDU		0.045*	0.015	0.006	0.129
		(1.694)	(0.378)	(0.153)	(1.183)
Initial foreign			0.135***	0.140***	0.06
			(6.429)	(5.441)	(1.047)
Initial domestic			0.403***	0.396***	0.488***
			(13.080)	(12.842)	(6.884)
Initial state					-0.083*
					(-1.703)
Foreign growth			0.217***	0.220***	0.146***
			(11.275)	(11.195)	(3.417)
Domestic growth			0.426***	0.411***	0.482***
			(19.544)	(18.573)	(9.625)
State growth					0.011
					(0.266)
Access				0.006	-0.014
				(0.288)	(-0.299)
Tax incentives				0.046*	-0.076
				(1.866)	(-1.418)
N	3823	3823	1460	1420	405
R^2	0.336	0.336	0.568	0.564	0.5
F	321.224***	275.88***	173.206***	139.930***	25.946***
Durbin–Watson	1.447	1.444	1.550	1.558	1.437

Note: coefficients are significant at ***1%, **5%, *10%.

Table 5a
Regional employment growth by industries

Sector	Agricultural products	Mining	Analytical instruments	Apparel	Automotive	Biopharmaceuticals	Building	Business services	Chemical products	Communications equipment
Constant	-0.442	-4.559	1.131	-1.682*	2.113	8.019*	1.709***	0.762	-0.977	-1.617
	(-1.058)	(-1.359)	(0.441)	(-1.774)	(1.305)	(1.757)	(4.486)	(1.329)	(-0.314)	(-0.966)
Initial employment	-0.4	0.273	-0.17	0.093	-0.492	-0.594	-0.435***	-0.172	-0.103	-0.011
	(-0.372)	(0.734)	(-0.385)	(0.482)	(-1.389)	(-0.683)	(-4.036)	(-1.051)	(-0.264)	(-0.041)
Total employment	0.123	0.304**	-0.003	0.068	-0.115	-0.246	0.202***	0.227***	-0.112	0.046
	(1.304)	(2.414)	(-0.016)	(0.681)	(-0.809)	(-1.115)	(4.339)	(3.351)	(-0.701)	(0.422)
Competition	-0.116	-0.44***	-0.083	0.067	0.34**	0.471	-0.045	-0.078	-0.464***	0.316***
	(-1.249)	(-3.396)	(-0.548)	(0.548)	(2.141)	(1.551)	(-0.948)	(-0.908)	(-3.369)	(2.768)
Concentration LQ	-0.194	-0.668*	-0.428	-0.493**	-0.231	-0.11	-0.543***	-0.675***	-0.081	-0.798***
	(-1.155)	(-1.695)	(-1.076)	(-2.458)	(-0.686)	(-0.176)	(-5.642)	(-3.985)	(-0.227)	(-3.33)
Diversity	0.11	0.216	-0.073	0.081	-0.079	-0.593*	0.01	-0.009	0.078	-0.054
	(1.391)	(1.322)	(-0.462)	(0.969)	(-0.7)	(-2.096)	(0.251)	(-0.164)	(0.487)	(-0.614)
Population density	0.071	-0.067	0.174	0.068	0.031	-0.25	0.195***	0.389***	-0.024	0.265*
	(0.487)	(-0.357)	(0.796)	(0.505)	(0.151)	(-0.547)	(3.055)	(4.368)	(-0.113)	(1.892)
N	167	55	54	134	67	23	153	161	54	88
R2	0.95	0.493	0.386	0.186	0.284	0.444	0.788	0.553	0.353	0.401
F	2.815**	7.776***	4.931***	4.835***	3.96***	2.131	90.378***	31.719	4.279***	9.047***
Durbin–Watson	1.938	2.147	2.375	1.766	1.677	1.663	1.613	1.986	2.277	1.845

Note: coefficients are significant at ***1%, **5%, *10%.

Table 5b
Regional employment growth by industries

Sector	Construction materials	Distribution services	Education and knowledge creation	Entertainment	Financial services	Fishing and fishing products	Footwear	Forest products	Furniture	Heavy construction
Constant	2.661	1.411***	3.201*	3.451**	-1.035	1.207**	5.048	-1.616	0.688	1.418***
	(0.501)	(3.895)	(1.933)	(2.181)	(-1.419)	(2.323)	(1.441)	(-2.002)	(1.157)	(3.208)
Initial employment	-0.775	-0.291***	-0.41	-0.382*	0.096	-0.799**	-0.707**	0.415*	-0.166	-0.365***
	(-1.417)	(-2.707)	(-1.66)	(-1.882)	(0.762)	(-2.133)	(-2.121)	(1.757)	(-1.126)	(-3.189)
Total employment	0.003	0.462***	0.099	0.182**	0.259***	-0.048	-0.403**	0.321***	0.054	0.294***
	(0.015)	(6.04)	(1.019)	(2.00)	(2.703)	(-0.239)	(-2.579)	(3.626)	(0.693)	(4.298)
Competition	0.117	-0.187*	0.149	0.069	0.146	0.071	-0.286	0.098	0.104	0.042
	(0.444)	(-1.897)	(1.442)	(0.755)	(1.323)	(0.357)	(-1.355)	(1.018)	(1.221)	(0.47)
Concentration LQ	0.309	-0.41***	-0.683***	-0.514**	-0.498***	0.333	0.84**	-1.035***	-0.544***	-0.417***
	(0.585)	(-3.229)	(-3.932)	(-3.357)	(-3.16)	(0.765)	(2.006)	(-4.946)	(-3.64)	(-3.548)
Diversity	-0.043	-0.038	-0.193	-0.232**	0.027	-0.063	-0.264	-0.04	-0.015	0.013
	(-0.163)	(-0.636)	(-1.619)	(-2.086)	(0.335)	-(0.396)	(-1.058)	(-0.53)	(-0.225)	(0.228)
Population density	0.392	0.287***	0.229*	0.168	0.043	0.227	0.226	-0.211	0.11	0.208**
	(1.185)	(3.032)	(1.712)	(1.412)	(0.332)	(0.72)	(0.878)	(-1.529)	(1.008)	(2.235)
N	43	168	76	118	140	38	55	109	156	164
R2	0.186	0.475	0.613	0.454	0.213	0.27	0.235	0.473	0.404	0.496
F	1.372	24.241***	18.24***	15.404***	6.014	1.914	2.459**	15.234***	16.808	25.727***
Durbin–Watson	1.932	2.044	2.043	1.975	2.097	2.062	1.606	2.141	1.862	2.36

Note: coefficients are significant at ***1%, **5%, *10%.

Table 5c
Regional employment growth by industries

Sector	Heavy machin-ery	Hospitality and tourism	Information technology	Jewelry and precious metals	Leatther products	Lighting and electrical equipment	Medical devices	Metal manu-facturing	Plastics	Power genera-tion and transmission
Constant	-0.888	1.986***	1.658	6.52	8.823	-5.702	1.179	-0.242	0.126	-0.326
	(-0.936)	(4.814)	(0.338)	(1.119)	(0.993)	(-0.954)	(0.537)	(-0.29)	(0.143)	(-0.417)
Initial employment	0.09	-0.372***	-0.631	-1.393	-1.272	1.058	0.368	0.034	-0.19	0.1
	(0.465)	(-3.076)	(-1.58)	(-1.507)	(-1.602)	(1.602)	(0.945)	(0.186)	(-0.907)	(0.441)
Total employment	0.222**	0.207***	-0.217*	-0.313	-0.296	0.151	0.024	0.256***	0.264***	-0.005
	(2.557)	(3.387)	(-1.735)	(-0.962)	(-0.96)	(0.567)	(0.153)	(3.009)	(2.736)	(-0.044)
Competition	0.095	-0.114**	-0.147	-1.337**	0.344	0.148	0.363**	0.029	0.145	-0.018
	(0.954)	(-2.015)	(-1.05)	(-2.76)	(1.071)	(0.519)	(2.217)	(0.287)	(1.263)	(-0.169)
Concentration LQ	-0.71***	-0.512***	0.067	1.129	1.1	-1.645**	-1.169***	-0.633***	-0.457**	-0.262
	(-3.657)	(-4.744)	(0.162)	(1.52)	(1.186)	(-2.346)	(-3.222)	(-3.58)	(-2.511)	(-1.37)
Diversity	-0.016	-0.036	0.05	-0.259	-0.317	0.054	-0.186	-0.007	0.071	0.025
	(-0.209)	(-0.715)	(0.352)	(-0.754)	(-0.809)	(0.215)	(-1.242)	(-0.101)	(0.889)	(0.262)
Population density	0.02	0.215**	0.575***	1.617**	0.453	-0.468	-0.318	-0.041	0.095	0.58
	(0.168)	(2.599)	(3.509)	(2.473)	(1.063)	(-1.467)	(-1.521)	(-0.367)	(0.742)	(0.407)
N	122	148	53	14	26	32	46	137	107	124
R2	0.369	0.669	0.601	0.759	0.183	0.297	0.564	0.384	0.398	0.046
F	11.185***	47.533***	11.54***	3.682	0.71	1.761	8.402***	13.516***	11.036***	0.939
Durbin–Watson	2.087	1.706	2.343	1.828	2.298	1.898	2.139	2.04	2.177	2.029

Note: coefficients are significant at ***1%, **5%, *10%.

Table 5d
Regional employment growth by industries

Sector	Processed food	Publishing and printing	Sporting, rec-reational and children's goods	Textiles	Transportation and logistics	Public services	Real estate	Healthcare	Other consumer services
Constant	0.533	-0.48	0.682	-1.392	0.003	3.755*	-0.136	2.169***	5.257***
	(1.175)	(-0.662)	(0.259)	(-1.296)	(0.005)	(1.888)	(-0.208)	(6.318)	(2.71)
Initial employment	-0.227*	-0.005	-0.073	0.159	-0.153	-0.18	0.092	-0.287*	-0.319
	(-1.677)	(-0.025)	(-0.28)	(0.658)	(-1.023)	(-0.918)	(0.571)	(-2.589)	(-1.271)
Total employment	0.326***	0.176*	0.374***	0.169*	0.289***	0.143*	0.224***	0.348***	0.184**
	(4.853)	(1.866)	(3.565)	(1.726)	(4.774)	(1.726)	(3.206)	(5.636)	(2.269)
Competition	-0.016	0.039	0.463***	-0.096	0.131*	-0.083	-0.118	0.066	-0.101
	(-0.206)	(0.39)	(3.444)	(-0.881)	(1.762)	(-0.892)	(-1.538)	(1.102)	(-0.997)
Concentration LQ	-0.48***	-0.729***	-0.966***	-0.747***	-0.827***	-0.63***	-0.807***	-0.633***	-0.513**
	(-4.328)	(-4.294)	(-3.721)	(-3.295)	(-6.263)	(-4.074)	(-5.612)	(-6.369)	(-2.442)
Diversity	0.004	0.029	-0.068	0.028	-0.03	-0.099	0.027	-0.024	-0.334***
	(0.069)	(0.375)	(-0.583)	(0.342)	(-0.615)	(-0.973)	(0.497)	(-0.468)	(-3.208)
Population density	0.021	0.179	0.097	-0.119	0.089	0.134	0.135	-0.003	0.099
	(0.229)	(1.297)	(0.68)	(-0.857)	(1.072)	(0.11)	(1.41)	(-0.039)	(0.867)
N	162	106	59	93	162	69	134	127	71
R2	0.533	0.462	0.699	0.452	0.652	0.748	0.645	0.711	0.68
F	29.451***	14.17***	20.109***	11.817***	48.389***	30.712***	38.414***	49.185***	22.661***
Durbin–Watson	1.86	1.854	2.292	2.144	2.056	1.952	1.623	2.269	2.145

Note: coefficients are significant at ***1%, **5%, *10%.

Table 6
Value added, productivity growth and agglomeration economies

	Value-added growth	Value-added growth	Productivity growth	Productivity growth	Productivity growth
Constant	0.924***	8.927***	0.082***	0.902***	1.905***
	(5.521)	(45.619)	(4.851)	(45.923)	(58.475)
Competition	0.138***	0.031**	0.130***	0.022	0.017
	(6.812)	(2.083)	(6.413)	(1.483)	(1.123)
Concentration LQ	0.051**	0.243***	0.023	0.218***	0.223***
	(2.535)	(15.813)	(1.144)	(14.252)	(15.364)
Diversity	0.002	0.000	0.005	0.002	0.002
	(0.127)	(-0.009)	(0.254)	(0.163)	(0.135)
Population density	0.028	0.251***	-0.011	0.216***	0.201***
	(1.557)	(18.209)	(-0.613)	(15.763)	(15.609)
Initial value added		-0.720***		-0.731***	
		(-52.753)		(-53.835)	
Initial productivity					-0.763***
					(-59.995)
N	3338	3338	3338	3338	3338
R^2	0.174	0.687	0.144	0.690	0.728
F	26.127***	594.923***	17.694***	606.101***	749.318***
Durbin–Watson	1.486	1.415	1.599	1.525	1.483

Note: coefficients are significant at ***1%, **5%, *10%.

Table 7
Determinants of productivity growth

	Productivity growth	Productivity growth	Productivity growth	Productivity growth	Productivity growth
Constant	0.903***	0.400***	0.293***	0.367***	0.423***
	(55.630)	(12.484)	(9.043)	(11.427)	(7.113)
Competition	0.31**	0.019	0.054***	0.058***	0.053*
	(2.436)	(1.585)	(3.177)	(3.516)	(1.691)
Concentration LQ	0.457***	0.486***	0.214***	0.164***	0.074**
	(31.636)	(34.965)	(10.250)	(8.025)	(2.037)
Diversity	-0.005	0.021**	0.027*	0.021	0.003
	(-0.483)	(2.008)	(1.907)	(1.581)	(0.131)
Population density	0.202***	-0.53***	-0.048*	-0.041	0.012
	(17.634)	(-2.956)	(-1.834)	(-1.466)	(0.184)
Initial productivity	-0.750***	-0.795***	-0.988***	-0.997***	-1.050***
	(-65.907)	(-71.274)	(-55.793)	(-58.228)	(-30.957)
Employment growth	0.446***	0.462***	0.283***	0.289***	0.143***
	(35.657)	(38.583)	(14.850)	(15.648)	(4.428)
HEDU		0.333***	0.251***	0.221***	0.188***
		(17.913)	(8.944)	(7.914)	(2.665)
Initial foreign			0.264***	0.207***	0.253***
			(14.607)	(10.845)	(6.355)
Initial domestic			0.297***	0.264***	0.198***
			(13.048)	(11.982)	(4.137)
Initial state					0.105***
					(3.146)
Foreign growth			0.115***	0.103***	0.141***
			(7.433)	(6.768)	(4.705)
Domestic growth			0.121***	0.102***	0.106***
			(6.653)	(5.821)	(2.911)
State growth					0.013
					(0.468)
Access				0.000	0.000
				(-0.31)	(-0.031)
Tax incentives				0.152***	0.107***
				(8.522)	(2.958)
N	3319	3319	1358	1323	384
R^2	0.797	0.817	0.872	0.883	0.881
F	959.853***	948.033***	387.327***	357.176***	85.464***
Durbin–Watson	1.424	1.263	1.297	1.306	1.154

Note: coefficients are significant at ***1%, **5%, *10%.

Table 8a
Productivity growth by industries

Sector	Agricultural products	Mining	Analytical instruments	Apparel	Automotive	Biopharmaceuticals	Building	Business services	Chemical products	Communications equipment
Constant	1.975***	2.684***	2.649***	2.085***	1.722***	2.425***	2.136***	1.926***	2.816***	2.411***
	(8.344)	(8.418)	(9.417)	(13.770)	(4.522)	(7.098)	(20.612)	(17.808)	(7.461)	(13.575)
Initial productivity	-0.605***	-0.642***	-0.927***	-0.707***	-0.412***	-0.601***	-1.125***	-1.157***	-0.833***	-0.865***
	(-9.317)	(-10.128)	(-12.570)	(-14.542)	(-4.476)	(-9.150)	(-21.313)	(-20.236)	(-10.416)	(-14.889)
Employment growth	0.169***	0.601***	0.549***	0.582***	0.628***	0.457***	0.251***	0.363***	0.586***	0.521***
	(2.828)	(9.153)	(7.396)	(12.557)	(7.572)	(6.326)	(3.640)	(6.661)	(6.602)	(8.703)
Competition	0.145***	0.062	0.040	0.056	0.045	0.189**	-0.045	0.002	0.043	0.009
	(1.904)	(0.854)	(0.516)	(0.866)	(0.401)	(2.328)	(-0.945)	(0.026)	(0.476)	(1.134)
Concentration LQ	0.437***	0.755***	0.755***	0.598***	0.707***	0.494***	0.477***	0.606***	0.582***	0.443***
	(4.119)	(9.196)	(8.336)	(8.266)	(5.821)	(5.963)	(6.114)	(6.309)	(7.086)	(5.130)
Diversity	0.031	-0.174**	-0.209***	-0.017	0.089	-0.103	0.015	0.001	-0.177*	0.047
	(0.511)	(-2.288)	(-2.793)	-0.400	(1.144)	(-1.308)	(0.380)	(0.036)	((-1.891))	(0.953)
Population density	0.446***	0.216***	0.161**	0.208***	0.241**	0.150	0.300***	0.208***	0.229**	0.218***
	(4.554)	(2.843)	(2.126)	(4.126)	(2.529)	(1.672)	(6.161)	(3.654)	(2.630)	(3.952)
N	119	47	52	123	62	21	147	155	45	80
R2	0.789	0.936	0.922	0.894	0.833	0.981	0.895	0.882	0.904	0.919
F	30.775***	47.449***	42.338***	76.612***	20.735***	61.246***	94.074***	86.178***	28.229***	66.328***
Durbin–Watson	2.052	2.081	1.837	2.016	2.067	0.774	1.923	2.177	1.936	1.976

Note: coefficients are significant at ***1%, **5%, *10%.

Table 8b
Productivity growth by industries

Sector	Construction materials	Distribution services	Education and knowledge creation	Entertainment	Financial services	Fishing and fishing products	Footwear	Forest products	Furniture	Heavy construction
Constant	2.895***	1.921***	3.329***	2.900***	2.943***	1.824***	2.158***	2.308***	2.095***	1.906***
	(8.568)	(14.787)	(12.073)	(11.976)	(7.516)	(8.092)	(6.030)	(15.798)	(17.604)	(15.456)
Initial productivity	-0.970***	-0.967***	-1.082***	-1.067***	-0.884***	-0.764***	-0.687***	-0.782***	-0.846***	-0.938***
	(-9.902)	(-15.473)	(-16.929)	(-15.277)	(-10.393)	(-8.412)	(-7.532)	(-15.879)	(-18.255)	(-16.048)
Employment growth	0.535***	0.290***	0.006	0.262***	0.555***	0.182*	0.582***	0.538***	0.496***	0.287***
	(5.547)	(5.372)	(0.077)	(4.232)	(7.090)	(1.902)	(6.839)	(8.901)	(9.857)	(5.371)
Competition	0.170	-0.313***	0.080	-0.059	0.025	0.111	0.041	0.002	0.041	0.127*
	(1.316)	(-3.523)	(1.108)	(-0.940)	(0.207)	(0.952)	(0.292)	(0.033)	(0.741)	(1.734)
Concentration LQ	0.771***	0.500***	0.001	0.331***	0.472***	0.327**	0.550***	0.700***	0.502***	0.309***
	(4.582)	(5.407)	(0.007)	(4.095)	(3.527)	(2.772)	(3.345)	(9.542)	(7.587)	(3.659)
Diversity	-0.202*	-0.018	-0.269***	-0.252***	-0.143	0.035	-0.184	0.033	-0.010	-0.046
	(-1.731)	(-0.358)	(-4.108)	(-3.716)	(-1.532)	(0.387)	(-1.263)	(0.656)	(-0.250)	(-1.018)
Population density	0.406***	0.452***	0.287***	0.200***	0.202*	0.117	0.215	0.286***	0.285***	0.350***
	(3.163)	(7.218)	(4.199)	(3.063)	(1.846)	(1.219)	(1.688)	(5.344)	(5.934)	(6.525)
N	30	166	64	107	56	23	42	99	142	162
R2	0.924	0.808	0.929	0.873	0.875	0.939	0.883	0.895	0.890	0.837
F	22.452***	49.748***	59.707***	53.269***	26.612***	19.878***	20.627***	61.574***	86.157***	60.435***
Durbin–Watson	2.106	2.065	2.070	2.035	1.723	2.201	2.080	2.037	1.707	1.800

Note: coefficients are significant at ***1%, **5%, *10%.

Table 8c
Productivity growth by industries

Sector	Heavy machinery	Hospitality and tourism	Information technology	Jewelry and precious metals	Leatther products	Lighting and electrical equipment	Medical devices	Metal manufacturing	Plastics	Power generation and transmission
Constant	3.057***	2.007***	2.785***		3.267**	1.868***	2.818***	2.082***	2.092***	2.313***
	(16.894)	(18.775)	(9.388)		(2.315)	(3.890)	(14.650)	(14.330)	(14.439)	(12.691)
Initial productivity	-0.950	-1.023***	-0.903***		-0.190	-0.540***	-1.090***	-0.817***	-0.891***	-0.705***
	(-23.730)	(-19.004)	(-16.063)		(-1.096)	(-5.357)	(-20.938)	(-14.358)	(-13.207)	(-11.215)
Employment growth	0.484***	0.199***	0.640***		0.591***	0.620***	0.426***	0.659***	0.500***	0.535***
	(13.226)	(3.080)	(8.255)		(3.932)	(6.803)	(6.680)	(11.832)	(7.191)	(9.117)
Competition	-0.030	0.031	-0.058		-0.054	-0.104	0.016	0.063	0.124	-0.058
	(-0.679)	(0.588)	(-0.769)		(-0.265)	(0.806)	(0.239)	(0.908)	(1.522)	(-0.871)
Concentration LQ	0.543***	0.217***	0.671***		0.539**	0.839***	0.469***	0.652***	0.623***	0.638***
	(11.477)	(2.949)	(7.588)		(2.422)	5.880	(5.085)	(7.896)	(6.447)	(8.773)
Diversity	-0.195***	-0.047	-0.151**		-0.418*	0.078	-0.177***	-0.004	-0.038	-0.005
	(-4.943)	(-1.047)	(-2.082)		(-1.978)	(0.674)	(-3.443)	(-0.082)	(-0.650)	(-0.084)
Population density	0.170***	0.320***	0.184**		-0.232	0.275**	0.203***	0.280***	0.267***	0.225***
	(4.538)	(6.440)	(2.611)		(-1.213)	(2.276)	(3.786)	(5.371)	(4.044)	(3.667)
N	111	133	44	13	21	29	42	125	99	110
R2	0.958	0.877	0.950		0.866	0.916	0.970	0.871	0.844	0.826
F	193.628***	69.625***	56.593***		6.991***	19.165***	93.632***	61.732***	37.832***	36.728***
Durbin–Watson	1.960	2.126	2.224		2.501	1.625	1.686	1.798	1.972	1.936

Note: coefficients are significant at ***1%, **5%, *10%.

Table 8d
Productivity growth by industries

Sector	Processed food	Publishing and printing	Sporting, rec-reational and children's goods	Textiles	Transportation and logistics	Public services	Real estate	Healthcare	Other consumer services
Constant	2.046***	1.907***	2.727***	2.304***	2.466***	2.944***	2.141***	2.218***	2.881***
	(17.745)	(12.808)	(6.061)	(9.227)	(20.989)	(15.468)	(15.508)	(31.244)	(8.299)
Initial productivity	-0.829***	-0.812***	-1.062***	-0.640***	-1.043***	-1.005***	-0.994***	-1.031***	-0.840***
	(-17.544)	(-12.238)	(-9.950)	(-8.679)	(-22.069)	(-26.534)	(-16.288)	(-29.899)	(-10.821)
Employment growth	0.260***	0.655***	0.237*	0.633***	0.419***	0.228***	0.529***	0.190***	0.430***
	(5.077)	(9.730)	(2.061)	(7.173)	(7.431)	(3.275)	(6.469)	(3.928)	(3.580)
Competition	0.240***	0.040	-0.205	0.069	0.005	0.14	-0.023	0.053	-0.032
	(4.203)	(0.535)	(1.280)	(0.796)	(0.082)	(0.274)	(-0.328)	(1.437)	(-0.309)
Concentration LQ	0.408***	0.474***	0.467**	0.776***	0.659***	0.176**	0.549***	0.228***	0.566***
	(6.388)	(5.274)	(2.505)	(7.447)	(8.592)	(2.447)	(5.968)	(4.241)	(4.356)
Diversity	0.007	-0.070	-0.129	-0.023	-0.017	-0.151***	0.001	-0.030	-0.108
	(0.172)	(-1.240)	(1.219)	(-0.345)	(-0.430)	(-2.937)	(0.017)	(-0.970)	(-1.267)
Population density	0.316***	0.230***	0.277**	0.282***	0.269***	0.216***	0.294***	0.243***	0.263***
	(6.334)	(3.257)	(2.781)	(3.767)	(5.366)	(4.423)	(4.538)	(6.918)	(3.040)
N	147	89	32	82	151	56	109	117	60
R2	0.872	0.871	0.923	0.828	0.893	0.968	0.874	0.948	0.872
F	74.335***	43.110***	23.819***	27.257***	94.693***	122.449***	55.020***	162.975***	28.156***
Durbin–Watson	2.094	1.849	2.029	2.244	1.963	1.626	1.945	1.921	1.856

Note: coefficients are significant at ***1%, **5%, *10%.