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INDUSTRY CLUSTER AND REGIONAL ECONOMIC GROWTH: EVIDENCE FROM HUNGARY*

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Abstract

Using census-type data of Hungarian firms, we test major hypotheses of spatial economic theories focusing on the impact of industrial and market concentrations on regional economic growth. Our empirical evidence confirms that both industrial and market concentrations have a significant positive impact on production growth. This finding strongly supports the Marshall-Arrow-Romer model of local knowledge externalities, suggesting that investment-driven regional development prevails in Hungary.

Key words: industry cluster, regional growth, knowledge externalities, Hungary
JEL classifications: J61, L16, O18, O47, P25, R11.

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I. *Introduction*

The geographic concentration of economic activities has attracted attention from economists 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 have recently been examining topics, such as new growth theories, transaction cost economics, and new economic geography.

Knowledge externalities appeared as a key concept in the first regional growth theories developed by Alfred Marshall (1890), which have been elaborated upon during the 20th Century with an evolving intensity in the last decade and at the turn of the millennium. Evidence has been revealed proving the effect of regional specialization (Henderson et al., 1995), local competition (Porter, 1990), and diverse urban environment (Glaeser et al., 1992) on regional growth. However, these theories and empirics are mainly based on developed economies, and they do not sufficiently consider the experiences in other less developed regions.

Transition economies are particularly interesting from this viewpoint because most of them underwent at least 4-5 decades of economic development 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 the central government dominated, and the market mechanism was put aside. Under the planned economy, production was concentrated in large state-owned enterprises in selected locations. After the change of the political regime, greenfield investments by large multinational enterprises (MNEs) were carried out in the tradable and service sectors. Foreign direct investment (FDI) usually started operation with simpler activities that were mainly based on cheap unskilled labor as the local production input. However, MNEs continued investments using more value-producing resources, including skilled labor, local engineering, and research and development (R&D) capacities. Domestic companies played only a marginal role in the supplier networks of these companies; there was an enormous gap between MNEs that were connected directly to the global markets and a big number of less mature small and medium-sized enterprises (SMEs). As a result, newly emerged industry clusters produced a significantly different geographical allocation of workforce and firms from that in the socialist period.

Using annual census-type data of Hungarian firms, we empirically examine the relationship between industry clustering and regional economic growth in the transition period. More specifically, the aim of this paper is to show how geographical concentration of industry and market affects employment and production growth in regions of Hungary. Our empirical results confirm that both organizational and market concentrations have a statistically significant and positive impact on production growth, while employment concentration is negatively related to production growth. These findings broadly support the Marshall-Arrow-Romer (MAR) model of local knowledge externalities, suggesting that investment-driven regional development prevails in Hungary.

The remainder of this paper is organized as follows: Section II gives an account of regional development patterns in Hungary during the transition period. Section III develops a hypothesis based on the theories of agglomeration economies and local knowledge externalities.

Section IV describes the data utilized for this study and empirical methodology. Section V contains estimation results, and Section VI summarizes the major findings and concludes the paper.

II. *Economic Transition, Regional Development, and Industrial Restructuring in Hungary*

The determining role of FDI and the remaining presence of some state-controlled services and stagnating domestic companies are the main features of transition economies that distinguish their current development model (Szanyi, 2003). In the first period of transition, MNEs carried out large investment projects in the tradable and services sectors of Hungary. Automotive and information and communication technology (ICT) industries present good examples. The activity of the new facilities developed over time. Simple, cheap unskilled labor-based activities were developed by additional investments. New, more value-adding activities were launched, which utilized local skilled labor and engineering talent, as well as, in some cases, R&D capacities. Indeed, some of these foreign companies started to locate their R&D functions to their Hungarian sites (Lengyel and Cadil, 2009). From 1995-2003, the growth rate of business R&D spending by foreign affiliates was among the highest in Hungary (UNCTAD, 2005). As a result, the total share of foreign affiliates reached approximately 80% in 2003 (European Commission, 2005). This process suggests that foreign affiliates emerged as pools of potential knowledge spillovers, and, thus, they could serve as the main drivers of regional growth.

Szanyi et al. (2010) described a structural process of shifting activity of MNEs that was complemented by increasing local sourcing. This process contributed to the emergence of some new concentrations of production activity. Foreign-owned companies played a crucial role in spatial industrial dynamics through their supplier networks with indigenous firms. However, decisions about their regional networks were usually determined by the parent company headquarter abroad, and domestic suppliers played only a marginal role (Grosz, 2006; Sass and Szanyi, 2004). In many cases, suppliers of these MNEs are de-novo foreign firms that had followed their main customers' advance into Hungary. Szanyi et al. (2010) also demonstrated the possibility of establishing a cooperating network among local supplier companies, but their development needs more time and effort. However, it is more plausible that a dual structure of economy has evolved in the transition, in which domestic companies only have a trivial role (Farkas, 2000).

The special development of Central European transition economies might have prevailed in their regional development as well, which can be captured mainly by regional industrial dynamics. In this regard, Lengyel and Leydesdorff (2010) showed that, in Hungary, besides industrial dynamics, foreign-owned firms in high-tech and medium-tech industries have restructured regional economic systems. On the other hand, universities play a larger role in shaping the local organization of high-tech knowledge-intensive services (R&D and communication services).

The regional concentration of industries has also evolved accordingly. For example, North-Western Hungary, where most of foreign firms had located, stands out as a leading area in automotive industry concentration (Grosz, 2006), while the ICT industry is spread on a larger scale over the country (Szanyi, 2008) although it is concentrated in Budapest and its neighboring regions (Lengyel, 2010) . Szanyi and Lengyel (2010) conducted an empirical analysis of the determinants of cluster emergence and confirmed that, despite the industrial differences in regional dynamics, the change in geographic labor concentration negatively correlated with the initial degree of labor concentration in all the industries. This result suggests that the more the region was specialized in a certain industry, the more slowly the concentration occurred in terms of employment.

The above arguments indicate that, in Hungary, regional economic growth in the transition period was closely associated with the spatial concentration of industry and market. Therefore, we make an attempt to empirically examine this relationship in the following sections.

III. *Spatial Concentration and Regional Economic Growth: Hypothesis Development*

The spatial concentration and specialization of economic activities have been recognized and analyzed for over a hundred years. Alfred Marshall (1890) studied the determinants of industrial agglomerations and found three decisive factors, i.e., (a) access to developed labor market, (b) deep supplier background, and (c) the possibility of quick knowledge and information transfer among firms. Recent publications also have similar arguments (Krugman, 1991; Venables, 2001), and Marshall's argument on agglomeration economies is further developed, particularly by the new growth theories (Romer, 1986; Rebelo, 1991), which try to explain continuous differences in growth rates and lack of convergence (which contradict the neoclassical paradigm) with the notion of increasing returns on investments in knowledge and technology. Returns are increasing in the economy as a whole due to spillover effects, while individual economic agents may have production functions with decreasing returns.

This is the basis of the MAR model of local externalities. In this view, the regional concentration of specialized industries produces positive externalities because specialized labor and knowledge flow needs a similar technological and cultural background. On the other hand, Jane Jacobs (1969) showed that urban agglomerations provide the possibility for inter-industrial knowledge spillover through the dense social networks and diverse economy present in large cities.

The rationale of spatial concentration consists of achieving agglomeration economies and knowledge spillovers among firms at a given location, which are basically distinguished by the type of spatial knowledge transfer occurring. The MAR type of agglomeration economies relates to firms engaged in similar or inter-linked activities because these firms can learn from each other. For instance, Antonelli (1994) documented that Italian industrial districts provide the base for flexible production systems that can serve volatile markets. Similar association was reported in the Silicon Valley and Route 128 (Saxenian, 1994) and in the UK (Oxford and Cambridge in particular) (Miller et al., 2001).

On the other hand, the Jacobsian type of agglomeration economies is rooted much more in the diversity of economic activity and labor division in spatial concentrations, such as metropolitan areas (Florida, 2002) . This type of externalities of regional and urban concentration concerns all co-located firms and variety of industries in a single location because firms might learn from each other in a complex way and industry borders might be of secondary importance. In this regard, Frenken et al. (2007) suggested that knowledge spillover may emerge only among firms operating in technologically related industries that are capable to learn effectively from each other.

Nevertheless, the two types of knowledge spillover are not mutually exclusive, and they may occur simultaneously in the same area. Moreover, 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. The development of general labor markets and pools of specialized skills, dense interactions between local suppliers and customers, shared infrastructure, and other localized externalities are typical examples. Agglomeration economies arise when such linkages lower the costs and increase the returns of the firms taking part in the local exchange. Presence in agglomerations improves firm performance by reducing transaction costs for both tangible and intangible assets.

Another powerful model that tries to explain existence of spatial concentrations of specialized activities (i.e., industry clusters) is bound to Michael Porter's seminal work (Porter, 1990, 2003). In his "diamond model," four sets of interrelated forces are brought forward to explain industrial dynamics and competitiveness. These are associated with (a) factor input conditions, (b) sophisticated local demand conditions, (c) related and supported industries, and (d) firm structure, strategy, and rivalry. A core notion arose around his model, stressing that a collaborative, mutually supportive group of actors could enhance regional competitiveness in global markets and thus create growth and other benefits. The 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 large number of SMEs more than by a monopolistic or oligopolistic market environment with a small number of large-scale companies, including MNEs. On the other hand, papers using the concepts of localization economies and MAR-type externalities argue that a local monopoly is better for regional growth because firms can internalize and exploit innovative ideas more easily.

Porter (2003) also emphasizes that regional development goes through phases that differ slightly from each other: input-driven, investment-driven, and innovation-driven phases mainly depend on the maturity of the economy in the region. In his view, 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 are much less likely to be realized. Accordingly, measuring the impact of knowledge spillovers on regional growth is particularly difficult, since positive externalities that boost growth in economic concentrations may stem from other sources as well and the spillovers' impact on growth may change over time.

A significant amount of research has been published on regional growth of employment and regional concentration. The current literature basically goes back to Glaeser et al. (1992), who compared the three competing hypotheses on the knowledge spillovers mentioned above. Their results supported the Jacobsian idea of employment growth due to emerging spillovers in less specialized but diversified and competitive environments, such as metropolitan areas in the United States of America. On the other hand, Henderson et al. (1995) showed that, in some cases, the regional concentration of previous years also explained employment growth in subsequent years. They argued that growth patterns varied among different industrial sectors: the evolution of new high-tech industries is more bound to a diverse environment, while mature capital goods industries tend to enjoy MAR-type externalities. These authors found a significant positive effect of a static value of regional concentration on employment growth, which was repeatedly confirmed by many scholars.[1] These findings are also consistent with the notion that new industries prosper in large, diverse metropolitan areas but, with maturity, production decentralizes to smaller and more specialized cities. Moreover, empirical analyses with additional dynamic variables conducted by van Oort et al. (2005) and Weterings (2005) showed that a static regional concentration does not always have a promoting effect on the future growth of employment.

To sum up, three distinct features are discussed in the literature that may influence the emergence of knowledge spillovers and, hence, economic growth in agglomerations. The first is activity concentration, the second is market concentration (monopoly versus competitive market), and the third is the direction of potential spillovers (intra- or inter-industry directions).[2] Therefore, the three hypotheses of the agglomeration economies' effect on regional growth, namely, the MAR hypothesis, the Porter hypothesis, and the Jacobs hypothesis, are focused on.

According to the MAR hypothesis, regional growth is strongly affected by the co-location of similar or related firms because localization externalities and concentration enable knowledge spillovers to prevail across firms in the same industry (Marshall, 1890). In an empirical test, a statistically significant and positive effect of both industrial and market concentrations on regional economic growth supports the MAR hypothesis. The Porter hypothesis expects local competition among spatially concentrated firms in the same branch that forces firms to innovate in order to survive (Porter, 1990). Here, a combination of a positive coefficient of industrial concentration and a negative coefficient of market concentration supports this hypothesis.

Knowledge might also flow from one industry to the other in locations with high population density, and agglomeration externalities follow from the diversity of economic activities (Jacobs, 1969). Empirically, the negative impact of both market concentration and economic diversity on regional growth supports the Jacobs hypothesis. However, it is unlikely that both economic diversification and the SME network had attained a sufficient degree of maturity by the late 1990s and that Jacobsian-type local externality in Hungarian regions except for the capital Budapest had been realized. Thus, although the empirical analysis in this paper treats economic diversification as a potential factor affecting regional growth, we focus on the verification of the MAR and Porter hypotheses.

IV. *Data and Methodology*

The information used for the empirical analysis in this paper was collected from 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 1998 and 2005. The data includes all

[1] See McCann and van Oort (2009) for a historical overview.

[2] The impact of knowledge spillovers on economic growth and, most importantly, on productivity growth has been examined by many scholars. Greenaway and Görg (2001, 2003) produced an excellent survey of empirical literature on this subject. They conclude that, due to various reasons (among them, methodological imperfections), very little convincing evidence was found on increasing growth or productivity due to spillover effects. Most papers in this review, however, did not investigate regional differences or the role of agglomerations.

industries and contains basic information for each sample firm, including the NACE 4-digit industrial classification codes, the annual average number of employees, total turnover, production costs, and other major financial indices. 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 domestic private investors and foreign investors. Tax incentives provided to firms are also present in the data.

To empirically examine the MAR and Porter hypotheses, we aggregate the above firm-level data by industry and by region. We use the industrial classification following the cluster study by Ketels and Sölvell (2005). To deal with the whole national economy in our study, however, we complement their list of industries with few additional sectors.[3] The final list consists of 41 sectors. Regional aggregation is conducted by Hungarian sub-region (so-called “LAU1”). LAU1 accounts for 168 local administrative units in total. We eliminate samples containing missing values and, hence, posing an impediment to our empirical analysis. We also exclude observations if the total annual employment includes fewer than 10 persons. As a result, a total of 2,781 observations remain in our dataset.

Several methods are proposed to measure industrial concentration (Ratanawaraha and Polenske, 2007). Among them, we use the location quotient (LQ) indicator of relative concentration of industry. The LQ indicator is designed to express the relative weight of one single sector in a region to the total weight of the region compared to either the national economy or a larger geographical area. It is similar to Bela Balassa's RCA (revealed comparative advantage) measure.[4]

The indicator for employment concentration (LQ_E) is given by:

$$LQ_{Eij}=\frac{e_{ij}/E_i}{e_j/E}, \tag{1}$$

where e_{ij} is the number of employees in the i th industry of the j th region, e_j is the number of employees in all industries of the j th region, E_i is the number of employees in the i th industry in the country, and E is the number of employees in all industries in the country.

In this paper, the value of the LQ_E indicator reflects the relationship between the share of an industry in a sub-region and the share of the industry in the whole Hungarian national economy in terms of workforce distribution. If the LQ_E indicator is higher than 1, it implies that the employment share of the concerned industry is higher in the sub-region than the country average. Using the same formula, we also calculate the LQ indicator for the concentration of firms (LQ_F).

The above LQ_E and LQ_F indicators complement each other because they report on different aspects of industry clusters. LQ_E describes employment shares without considering firm density of the industry in the given region. It has the same value when the labor force is employed only by one firm or each employee belongs to separate firms. Meanwhile, LQ_F reflects the organizational structure of an industry in the given region compared to the country average: the higher the LQ_F value is, the more the industry is centered in the region. In the empirical analysis, we use the value of LQ_E and LQ_F indicators as variables of the regional employment

[3] Newly added industries consist of (a) public services, (b) real estate services, (c) healthcare services, (d) other manufacturing, and (e) other consumer services.

[4] See Szanyi et al. (2009, 2010) for more details on the LQ indicator.

concentration and regional organizational concentration, respectively.

Further, Nakamura and Morrison Paul (2009) suggest comparing the LQ_E and LQ_F indicators to capture the market environment aspect of industry clusters. They argue that, when LQ_E is higher than LQ_F, it denotes that the region contains relatively large firms. On the contrary, when LQ_E is lower than LQ_F, the region has a large number of relatively small firms. Consequently, when the value of LQ_E divided by LQ_F is higher than 1, the region has a relatively concentrated market structure in terms of firm density, while, when the indicator is lower than 1, the region has a relatively competitive market environment. In the empirical analysis, we use the LQ_E/LQ_F indicator as a proxy of the regional market concentration.

In the case of Hungary, LQ_E (LQ_F) has a range from 0.019 (0.071) to 114.911 (122.852), and its mean value and standard deviation are 1.818 (1.811) and 4.158 (3.617), respectively. LQ_E/LQ_F takes a value from 0.023 to 24.911, and its mean and standard deviation are equal to 1.066 and 1.438, respectively. Figure 1 illustrates the frequency distribution of these three variables. As the figure shows, all the variables tend to skew towards the left-hand side with a very long tail on the right-hand side. In a total of 2,781 observations, the share of samples with a value of 1 or more in terms of LQ_E, LQ_F, and LQ_E/LQ_F, reaches 43.7%, 58.6%, and 33.6%, respectively. These figures indicate that, in 1998, most Hungarian sub-regions were homogeneous from the viewpoint of employment and organizational concentration and there were very few sub-regions with a highly centralized industrial sector(s).

As potential factors affecting economic growth in Hungarian regions, we also pay attention to economic diversity, population density, state support, and capital structure as well as initial conditions. The degree of economic diversity in a sub-region is measured by the cross-sectoral Gini coefficient. In general, diversification of economic activities has the potential to encourage regional growth. We, however, expect a positive but statistically weak impact of this factor on the basis of the reason reported in the previous section and the very limited variance of the Gini coefficient.[5] Population density is calculated as the ratio of the total population to the gross administrative area of a sub-region to examine the impact of urbanization on regional economic growth. With regard to state support, the total tax incentive is employed to test its impact on the regional economy. We expect that the investment-friendly economic policy in Hungary had a positive effect on regional economic growth. To examine the relationship between capital structure and regional economic growth, we use the change in registered total domestic private capital and registered total foreign capital. Previous studies repeatedly verified that private capital investment, FDI in particular, significantly improved the regional economies in Hungary (Iwasaki, 2007). Moreover, using the same data in this study, Iwasaki et al. (2009, 2010) empirically verified technology and knowledge spillovers from MNEs to domestic firms. Hence, we predict that an increase in domestic private capital and foreign capital is positively related to regional economic growth.

As initial conditions of regional economic development, we control total domestic private capital and total foreign capital in 1998 as well as the initial level of the dependent variable. We also control the regional fixed effects taking the initial productivity gap among different counties into consideration.

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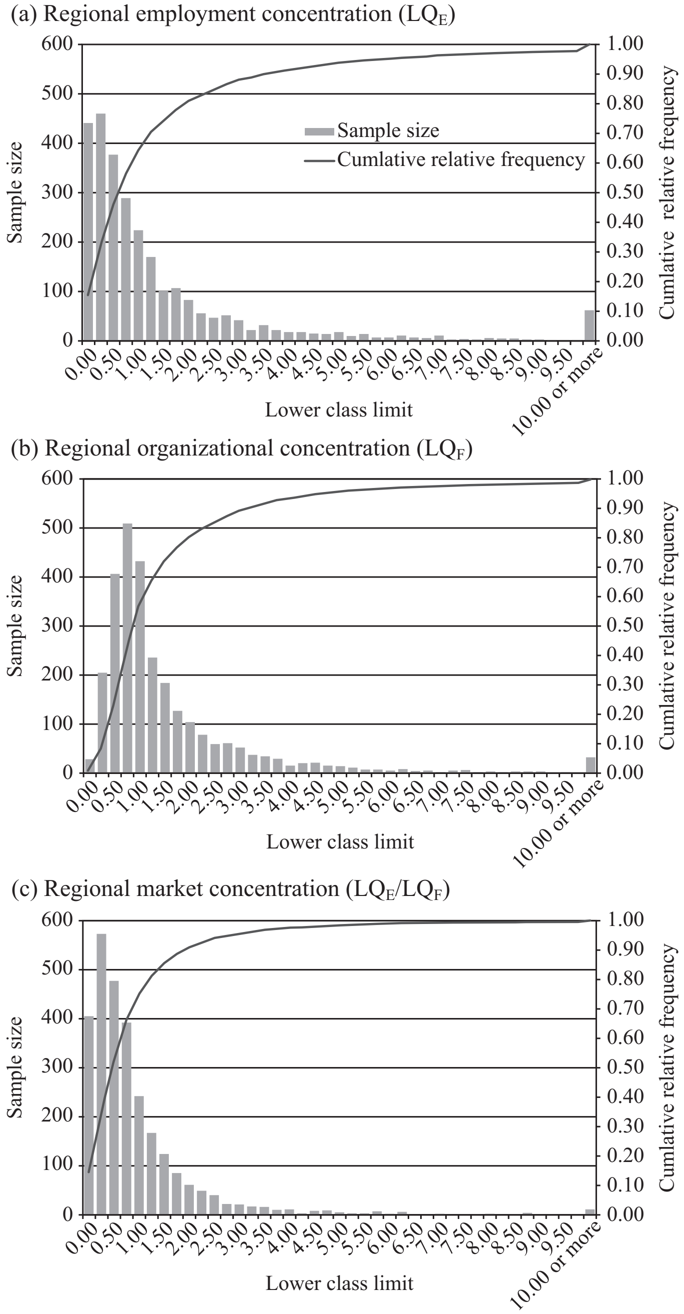
[5] In fact, the mean and standard deviation of the coefficient are 0.040 and 0.011, respectively, and almost all sub-regions take a value between 0.030 and 0.050. This suggests that the deviation of economic diversification was very limited among Hungarian regions in 1998.

FIG. 1. DISTRIBUTION OF THE LOCATION QUOTIENT INDICATOR OF REGIONAL EMPLOYMENT AND ORGANIZATIONAL CONCENTRATION AND THE INDICATOR OF REGIONAL MARKET CONCENTRATION



Note : Total number of observations, 2,781.
Source : Author's illustration based on the annual census-type data of Hungarian firms in 1998.

Table 1. Definition and Descriptive Statistics of the Variables Used in Empirical Analysis

Variable name	Definition	Descriptive statistics		
		Mean	Median	S.D.
Employment growth rate [a]	Growth rate of total employment by sub-region and industry, 1998-2005	1.307	0.341	3.621
Employment growth speed [b]	Natural logarithm of the change in total employment by sub-region and industry, 1998-2005	0.200	0.174	0.355
Production growth rate [a]	Real growth rate of total value-added by sub-region and industry, 1998-2005	166.187	1.873	4143.014
Production growth speed [b]	Natural logarithm of the real change in total value-added by sub-region and industry, 1998-2005	1.254	1.190	2.138
Regional employment concentration (LQ_E)	Location quotient indicator of relative concentration of employment, 1998	1.818	0.829	4.158
Regional organizational concentration (LQ_F)	Location quotient indicator of relative concentration of firm, 1998	1.811	1.120	3.617
Regional market concentration (LQ_E/LQ_F)	The value of LQ_E divided by LQ_F	1.065	0.716	1.438
Economic diversity	Cross-sectoral Gini coefficient by sub-region, 1998	0.040	0.040	0.011
Population density	Natural logarithm of population density by sub-region, 2001	0.030	-0.170	0.785
Tax incentive	Natural logarithm of total tax incentive given to firms by sub-region and industry, 1998	4.220	3.466	2.805
Domestic capital increase	Natural logarithm of the change in total registered domestic private capital by sub-region and industry, 1998-2005	5.994	10.316	9.412
Foreign capital increase	Natural logarithm of the change in total registered foreign capital by region and industry, 1998-2005	1.361	0.000	8.802
Initial domestic private capital	Natural logarithm of total registered domestic private capital by sub-region and industry, 1998	10.467	10.593	2.820
Initial foreign capital	Natural logarithm of total registered foreign capital by sub-region and industry, 1998	6.213	7.170	5.378
Initial total employment	Natural logarithm of total employment by sub-region and industry, 1998	4.947	4.852	1.521
Initial total value-added	Natural logarithm of total value-added by sub-region and industry, 1998	11.482	11.442	2.292

Notes: [a] Given by: $(y_{2005} - y_{1998}) / y_{1998}$, where y_{1998} and y_{2005} are the realized levels in 1998 and 2005, respectively.
[b] Given by: $\ln (y_{2005}/y_{1998})$. If y_{2005}/y_{1998} takes a negative value, the growth speed variable is computed using the formula: $\mathrm{sign}(y_{2005}/y_{1998}) \cdot \ln(|y_{2005}/y_{1998}|)$.
Source: Author's calculation based on the annual census-type data of Hungarian firms in 1998 and 2005.

The goal of our empirical analysis is to regress growth in total employment and total value-added of firms operating in the i th industry of the j th region (Δy_{ij}) into the above explanatory (independent) variables in the form:

$$\Delta y_{ij} = \alpha + \beta \cdot \mathrm{LQ}_{\mathrm{E}ij} + \gamma \cdot \mathrm{LQ}_{\mathrm{F}ij} + \delta \cdot \frac{\mathrm{LQ}_{\mathrm{E}ij}}{\mathrm{LQ}_{\mathrm{F}ij}} + \sum\nolimits_{k=1}^{n} \theta_k \cdot x_k + \varphi_l + \varepsilon_{ij}, \quad (2)$$

TABLE 2. CORRELATION MATRIX OF EXPLANATORY VARIABLES

	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)
(A) Regional employment concentration (LQ_E)	–										
(B) Regional organizational concentration (LQ_F)	0.428	–									
(C) Regional market concentration (LQ_E / LQ_F)	0.508	−0.022	–								
(D) Economic diversity	0.022	0.046	−0.036	–							
(E) Population density	−0.075	−0.113	0.008	−0.268	–						
(F) Tax incentive	0.132	0.014	0.155	−0.073	0.278	–					
(G) Domestic capital increase	−0.129	−0.077	−0.082	0.002	0.082	−0.033	–				
(H) Foreign capital increase	−0.047	−0.038	−0.047	0.018	0.000	−0.057	0.036	–			
(I) Initial domestic private capital	0.043	0.010	0.036	−0.091	0.274	0.451	−0.199	0.003	–		
(J) Initial foreign capital	0.101	0.021	0.123	−0.092	0.319	0.537	−0.017	−0.192	0.368	–	
(K) Initial total employment	0.250	0.040	0.330	−0.114	0.326	0.668	−0.112	−0.030	0.588	0.569	–
(L) Initial total value-added	−0.085	−0.092	−0.069	−0.096	0.295	0.431	0.051	0.038	0.550	0.384	0.541

Source: Author's calculation. For definitions and descriptive statistics of the variables, see Table 1.

where α is a constant term, β, γ, δ, and θ are parameters of explanatory variables, x_k is the k th control variable, φ_l is the fixed effects of the l th county, to which the j th sub-region belongs, and ε is a error term.[6] We estimate the above regression equation using a Huber-White heteroskedasticity-consistent estimator for all specifications. Standard errors are adjusted for sectors by the clustering method.

As explained (dependent) variables, we use two kinds of indicators: growth rate and growth speed. The former expresses the relative scale of incremental growth from the base level ($(y_t - y_{t-1})/y_{t-1}$), and the latter is measured by the natural logarithm of the realized outcome level divided by that in the base year ($ln(y_t/y_{t-1})$).[7] We use both of them to examine the impact of spatial concentration of industry and market on regional economy from different angles.

The detailed definition and descriptive statistics of variables used in the empirical analysis are reported in Table 1. As Table 2 shows, we confirm that the Pearson correlation coefficients for the explanatory variables are well below a threshold of 0.700 for possible multicollinearity in all combinations. We also confirm that variance inflation factors (VIF) for the explanatory

[6] Total value-added is computed by total net turnover — (total material costs + total amortization).

[7] If y_t/y_{t-1} takes a negative value, the growth speed indicator is computed using the following formula: $sign\ (y_t/y_{t-1}) \cdot ln\ (|y_t/y_{t-1}|)$.

TABLE 3. UNIVARIATE COMPARISON OF GROWTH PERFORMANCE AMONG SAMPLE GROUPS CLUSTERED IN TERMS OF THE REGIONAL EMPLOYMENT, ORGANIZATIONAL, AND MARKET CONCENTRATION

(a) Employment growth

Growth performance variable	Employment growth rate			Employment growth speed		
Reference variable for sample grouping	Regional employment concentration (LQ_E)	Regional organizational concentration (LQ_F)	Regional market concentration (LQ_E/LQ_F)	Regional employment concentration (LQ_E)	Regional organizational concentration (LQ_F)	Regional market concentration (LQ_E/LQ_F)
Sample group: range of reference variables						
G1: 0.00-0.25	3.815	3.526	3.163	3.481	2.949	2.830
G2: 0.25-0.50	1.914	2.703	2.043	2.826	2.311	2.483
G3: 0.50-0.75	1.111	2.099	1.163	2.377	2.522	1.678
G4: 0.75-1.00	0.912	1.583	0.894	2.116	2.789	1.978
G5: 1.00-1.25	0.798	1.167	0.453	1.999	1.890	1.385
G6: 1.25-1.50	0.526	1.079	0.472	1.423	1.623	0.279
G7: 1.50-1.75	0.479	0.865	0.443	0.011	0.538	−0.957
G8: 2.00 or more	0.036	0.449	−0.007	−2.080	−0.941	−1.788
Multiple comparison of the 8 sample groups						
ANOVA (F)	52.950***	15.730***	32.670***	95.970***	42.970***	48.130***
Bartlett test (χ^2)	1600.000***	370.819***	1800.000***	277.095***	42.123***	201.719***
Kruskal-Wallis test (χ^2)	711.243***	297.236***	420.977***	402.989***	277.064***	208.779***

(b) Production growth

Growth performance variable	Production growth rate			Production growth speed		
Reference variable for sample grouping	Regional employment concentration (LQ_E)	Regional organizational concentration (LQ_F)	Regional market concentration (LQ_E/LQ_F)	Regional employment concentration (LQ_E)	Regional organizational concentration (LQ_F)	Regional market concentration (LQ_E/LQ_F)
Sample group: range of reference variables						
G1: 0.00-0.25	17.289	62.738	22.479	3.811	5.959	4.249
G2: 0.25-0.50	22.097	48.383	314.523	4.102	4.068	4.110
G3: 0.50-0.75	15.042	48.546	16.039	4.275	4.600	3.387
G4: 0.75-1.00	60.770	119.278	16.276	4.299	4.771	4.634
G5: 1.00-1.25	38.525	38.692	16.568	5.207	4.947	3.465
G6: 1.25-1.50	29.596	610.394	98.155	5.045	4.266	3.629
G7: 1.50-1.75	22.727	30.540	703.089	5.063	5.723	4.837
G8: 2.00 or more	658.097	306.599	289.441	5.388	3.935	8.964
Multiple comparison of the 8 sample groups						
ANOVA (F)	1.590	0.680	0.930	1.010	0.900	7.640***
Bartlett test (χ^2)	1300.000***	670.000***	1100.000***	3.922	5.945	30.525***
Kruskal-Wallis test (χ^2)	36.273***	2.475	104.576***	46.102***	18.826***	109.239***

Note: ***: Significant at the 1% level.
Source: Author's estimation. For definitions and descriptive statistics of the variables, see Table 1.

variables do not exceed the level of possible collinearity with the constant.[8]

In Table 3, we classify samples into eight groups according to the industry cluster-related

[8] In fact, VIF for each explanatory variable never exceeds a threshold of 5.00.

indicators (LQ_E, LQ_F, and LQ_E/LQ_F) reported above and compare these sample groups on the basis of the four growth performance variables. Panel (a) of the table indicates that both the industrial and market concentration are negatively associated with employment growth, and this relationship is statistically significant according to the results of the ANOVA and Kruskal-Wallis test. On the other hand, Panel (b) shows that the industrial and market concentration are positively related to regional production growth measured by total value-added, but the relationship between the two elements is ambiguous in comparison to that in Panel (a).[9]

The aim of the multivariate regression analysis is to confirm whether or not the relationship indicated in Table 3 can be replicated while simultaneously controlling the potential determinants, including the control variables.

V. *Estimation Results*

In this section, we report the estimation results of the employment and production growth models formulated in the previous section. Estimation is performed by observation type (all observations versus observations with positive growth), by the type of growth indicator (growth rate versus growth speed), and by the set of explanatory variables (with and without initial conditions) for robustness check.

Table 4 contains estimation results of the employment growth model. As the table shows, neither of the hypotheses stated in Section III is supported by our results concerning regional employment growth. In other words, neither the MAR nor the Porter hypothesis provides a sufficient explanation about the determinants of employment growth in the Hungarian sub-regions. As a matter of fact, statistically significant coefficients of the industrial concentration variables (both LQ_E and LQ_F) and the regional market competition variable (LQ_E/LQ_F) take a negative value except for the regional employment concentration variable (LQ_E) in Model [2]. Furthermore, in contrast to the weak impact of regional employment concentration, regional organizational concentration (LQ_F) has a significant and negative estimate in Models [1], [2], [5], and [6], which take the employment growth rate as an explained variable. The regional market concentration variable produces a strong and negative estimate in Models [1], [3], and [5]. However, its statistical power is significantly decreased when controlling initial conditions.

The above results are considered to be negative since, based on these findings, agglomeration economies cannot be expected to prevail in Hungary. However, regional development in transition economies may differ from developed ones. We argue that the lower maturity of the regional economy predominates over the relevance of agglomeration economies in most of the sectors. In Hungary, the major industrial sectors are dominated by MNEs, and these foreign firms are highly motivated to invest, taking market potentials into account. Consequently, regional spread is much more likely to occur than regional agglomeration, which we found in most of the industries in previous research (Szanyi and Lengyel, 2010).

As we predicted, economic diversification does not have a significant coefficient, suggesting that the Jacobs model of local externalities does not excise the driving force in promoting regional employment in the case of Hungary. The variable of population density has

[9] We also performed a similar multiple comparison using the Gini coefficient of economic diversification, but no statistically significant association was found with each growth performance variable.

TABLE 4. ESTIMATION OF THE EMPLOYMENT GROWTH MODEL

Observation type	All observations				Observations with positive growth			
Growth indicator	Growth rate		Growth speed		Growth rate		Growth speed	
Model	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Regional employment concentration (LQ_E)	0.009	0.036*	−0.085*	−0.060	0.037	0.047	−0.024	−0.025
	(0.01)	(0.02)	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)	(0.02)
Regional organizational concentration (LQ_F)	−0.058*	−0.049**	−0.054	−0.049	−0.060**	−0.049**	−0.009	−0.020**
	(0.03)	(0.02)	(0.06)	(0.05)	(0.03)	(0.02)	(0.01)	(0.01)
Regional market concentration (LQ_E/LQ_F)	−0.314***	−0.064	−0.498***	−0.248*	−0.559***	−0.163	0.078	−0.045
	(0.06)	(0.04)	(0.12)	(0.13)	(0.13)	(0.10)	(0.05)	(0.05)
Economic diversification	−1.281	−3.063	−3.382	−5.669	0.498	−2.775	−0.772	0.676
	(3.95)	(3.84)	(7.93)	(7.50)	(5.29)	(5.15)	(2.55)	(2.08)
Population density	0.330*	0.696***	0.504**	0.690*	0.477*	0.894***	0.551***	0.253**
	(0.18)	(0.23)	(0.22)	(0.35)	(0.26)	(0.33)	(0.10)	(0.11)
Tax incentive	−0.208***	0.039	−0.155	0.001	−0.326***	0.021	0.204***	−0.007
	(0.05)	(0.03)	(0.11)	(0.06)	(0.07)	(0.06)	(0.04)	(0.02)
Domestic capital increase	0.057***	0.048***	0.182***	0.180***	0.040***	0.048***	0.040***	0.042***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Foreign capital increase	0.053***	0.065***	0.112***	0.129***	0.060***	0.078***	0.038***	0.038***
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)
Initial domestic private capital		0.084		0.179*		0.038		0.057***
		(0.05)		(0.09)		(0.08)		(0.02)
Initial foreign capital		0.077**		0.132***		0.100**		0.042***
		(0.03)		(0.03)		(0.05)		(0.01)
Initial level of dependent variable		−1.163***		−1.154***		−1.360***		0.410***
		(0.18)		(0.30)		(0.25)		(0.07)
Const.	2.016***	5.148***	1.438***	3.454*	3.140***	6.608***	3.203***	1.299***
	(0.37)	(0.85)	(0.46)	(1.74)	(0.50)	(1.10)	(0.23)	(0.34)
Regional fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	2781	2781	2781	2781	1798	1798	1798	1798
Adjusted R^2	0.12	0.20	0.31	0.36	0.10	0.17	0.32	0.44
F test	29.42***	30.18***	113.53***	119.55***	31.43***	24.61***	43.50***	141.66***

Notes: All models are estimated using Huber-White heteroskedasticity-consistent estimator. Standard errors are adjusted for 41 sectors and reported in parentheses beneath regression coefficients.
***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. F test tests the null hypothesis that all coefficients are zero.
Source: Author's estimation. For definitions and descriptive statistics of the variables, see Table 1.

a positive sign with statistical significance at the 10% or less level in all models. Hence, we conjecture that employment is more likely to occur in an urban environment than in less populated regions. Tax incentives show a significant coefficient in Models [1], [5], and [7], but the inclusion of initial condition variables into the right-hand side of the regression equation remarkably reduces its explanatory power. Capital investment has a strong positive impact on employment growth in all models, and the impact does not depend on the financial source.

The estimation results of the production growth model are reported in Table 5. Glaeser et al. (1992) stressed the importance of using output indicators to measure the effects of industrial concentration and agglomeration economies on the regional economy. As the table shows, contrary to employment growth, the MAR-type local externalities seem to visibly prevail in the growth of regional production. This statement is underlined by significant and positive estimates

Table 5. Estimation of the Production Growth Model

Observation type	All observations				Observations with positive growth			
Growth indicator	Growth rate		Growth speed		Growth rate		Growth speed	
Model	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Regional employment concentration (LQ_E)	−169.418***	−173.588***	0.048	−0.030	−176.435***	−179.961***	0.010	0.010
	(26.20)	(25.96)	(0.07)	(0.05)	(32.57)	(31.03)	(0.01)	(0.01)
Regional organizational concentration (LQ_F)	665.135***	655.171***	0.088	−0.075	712.932***	693.844***	0.026***	0.022***
	(177.61)	(173.70)	(0.07)	(0.05)	(152.32)	(147.11)	(0.01)	(0.01)
Regional market concentration (LQ_E/LQ_F)	398.674***	363.881***	0.964***	0.313	420.210***	371.027***	0.115***	0.121***
	(97.22)	(87.86)	(0.27)	(0.22)	(111.72)	(97.50)	(0.03)	(0.03)
Economic diversification	1827.434	495.594	40.429*	18.133	1886.985	1911.865	−0.559	−1.616
	(1994.39)	(1867.71)	(23.06)	(19.59)	(3474.90)	(3808.40)	(2.55)	(2.24)
Population density	509.739***	539.930***	0.950	1.858**	541.082***	667.872**	0.757***	0.519***
	(171.80)	(189.12)	(0.93)	(0.84)	(194.56)	(290.56)	(0.10)	(0.12)
Tax incentive	−71.533**	−46.052	−0.094	0.482***	−78.166**	−35.212	0.256***	0.158***
	(29.22)	(41.66)	(0.37)	(0.15)	(35.06)	(51.82)	(0.02)	(0.02)
Domestic capital increase	20.759**	28.225**	0.096	0.171***	29.464***	46.717***	0.024***	0.027***
	(8.19)	(12.50)	(0.07)	(0.04)	(10.64)	(19.59)	(0.01)	(0.00)
Foreign capital increase	0.017	3.232	0.052	0.132***	−1.684	5.981	0.037***	0.042***
	(5.00)	(5.38)	(0.04)	(0.03)	(7.89)	(7.43)	(0.01)	(0.01)
Initial domestic private capital		91.737		0.710***		138.472		0.075*
		(72.19)		(0.21)		(104.53)		(0.04)
Initial foreign capital		12.012		0.374***		24.037		0.063***
		(22.52)		(0.07)		(31.14)		(0.01)
Initial level of dependent variable		−221.426*		−3.643***		−431.319		0.066**
		(131.53)		(0.33)		(260.78)		(0.03)
Const.	−1002.023***	443.624	1.144	31.959***	−1102.680***	1714.367	11.226***	9.683***
	(273.77)	(911.53)	(1.56)	(3.92)	(283.97)	(1672.70)	(0.20)	(0.55)
Regional fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	2781	2781	2781	2781	1900	1900	1900	1900
Adjusted R^2	0.27	0.28	0.14	0.34	0.29	0.31	0.41	0.46
F test	166.14***	91.21***	14.96***	39.51***	187.95***	94.22***	93.29**	151.68***

Notes: All models are estimated using Huber-White heteroskedasticity-consistent estimator. Standard errors are adjusted for 41 sectors and reported in parentheses beneath regression coefficients.
***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. *F* test tests the null hypothesis that all coefficients are zero.
Source: Author's estimation. For definitions and descriptive statistics of the variables, see Table 1.

of the regional organizational concentration and regional market concentration variables in most models. At the same time, the estimation results in Table 5 also reveal that regional employment concentration is negatively related to the production growth rate.

Two aspects of industrial concentration measured by firm and workforce density have a counter-effect on regional production growth; namely, a relatively high employment concentration does not increase production in industry clusters. On the contrary, clusters with a relatively high number of firms tend to create appropriate environments for local knowledge externalities leading in production growth. Meanwhile, estimates of the regional market concentration variable suggest that successful clusters have a strong tendency to be constituted of relatively large companies that enjoy a large market share in their specialized segments. In other words, the combination of monopolistic market competition and the presence of large-scale companies are more likely to increase output than a group of small firms under competitive market environments. This finding corresponds with the evidence reported in previous literature on the significant impact of FDI and monopolistic market structure on economic recovery in transition economies (Szanyi, 2003; Lengyel and Leydesdorff, 2010). However, it is clear that industries may vary concerning the characteristics of their spatial organizational structure.

Among control variables, population density and domestic capital increase produce a significant and positive estimate, in line with our expectations. Tax incentives and foreign capital increase are also positively related to production growth speed even after controlling initial conditions. Economic diversification has a positive coefficient in all models, but it is statistically insignificant except in Model [3].

As reported above, the estimation results of the employment growth model and the production growth model are inconsistent at first sight. However, we stress that the two explained variables reflect on different aspects of agglomeration economies. Employment growth can either be the result of firm growth in a given location or the entrance of new firms into the region. Hence, the effect of agglomerations on regional economic performance is unpredictable. On the other hand, production growth reflects agglomeration economies much more easily. Co-located firms are able to enhance their output for several reasons. Economies of space, knowledge spillovers, and local (on-site) learning are the most powerful assumptions that encourage production growth. The positive coefficient of the regional organizational concentration variable suggests that co-located firms learn intensively from each other and enjoy intra-industrial knowledge externalities, making the most of geographical proximity advantage.

VI. *Conclusion and Discussion*

In this paper, using census-type data of Hungarian firms in 1998 and 2005, we empirically examined hypothesis of local knowledge externalities focusing on the impact of industrial and market concentration on regional economic growth. The results from univariate and multivariate regression analyses conducted in the previous sections confirm that both organizational and market concentrations are positively related to production growth in Hungarian sub-regions, while employment concentration has a negative impact. These findings broadly support the MAR hypothesis of local knowledge externalities that stresses the role of large firms in a specialized location. Furthermore, our empirical evidence strongly indicates the possible synergy of monopolistic market structure and the presence of big companies for regional production growth. On the contrary, we could not obtain any supporting evidence that industrial and market concentrations promote job creation at the sub-region level in the case of Hungary.

The Porter hypothesis is not supported by our empirical results perhaps due to the dual structure of the Hungarian industry, where foreign companies and their investments are decisive in regional employment and production growth. It is likely that regional economic development, in terms of the Porter hypothesis, is mostly investment-driven, and the motivation to innovate does not significantly influence economic growth in Hungarian regions. This argument offers policy implications for other transition economies as well because similar trends were observed in these countries during transition from the planned system to a market economy. However, in this paper, we do not discriminate between the effect of foreign-owned and domestic firms in the empirical analysis. This is a topic reserved for future research.

Moreover, we confirmed that the Jacobsian-type local externality is very hard to identify in small economies, such as Hungary. The coefficient of the economic diversity variable is insignificant in both the employment and production growth models. In Hungary, most sub-regions are lightly populated and have a low firm density; the only metropolitan area is Budapest. These circumstances may not permit the empirical detection of the Jacobsian-type local externality using a sub-region level dataset. Reconsideration of empirical strategy is another issue for further work.

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