Institut für Wirtschaftsforschung Halle *Halle Institute for Economic Research*

Urban Growth in Germany – The Impact of Localization and Urbanization Economies

Annette Illy, Christoph Hornych, Michael Schwartz, Martin T. W. Rosenfeld

December 2009 No. 19

IWH-Diskussionspapiere

IWH-Discussion Papers

Urban Growth in Germany –
The Impact of Localization and Urbanization Economies

Annette Illy, Christoph Hornych, Michael Schwartz, Martin T. W. Rosenfeld

December 2009 No. 19

Authors: *Annette Illy*
Martin-Luther-University Halle-Wittenberg; Chair for Econometrics
E-mail: Annette.Illy@wiwi.uni-halle.de
Phone: +49 (0) 345 55 23 388

Christoph Hornych
Department of Urban Economics
E-mail: Christoph.Hornych@iwh-halle.de
Phone: +49 (0) 345 7753-743

Michael Schwartz
Department of Urban Economics
E-mail: Michael.Schwartz@iwh-halle.de
Phone: +49 (0) 345 7753-794

Martin T. W. Rosenfeld
Department of Urban Economics
E-mail: Martin.Rosenfeld@iwh-halle.de
Phone: +49 (0) 345 7753-750

Editor:
Halle Institute for Economic Research – IWH
Prof Dr Dr h. c. Ulrich Blum (President), Dr Hubert Gabrisch (Research Director)
The IWH is a member of the Leibniz Association.

Address: Kleine Maerkerstrasse 8, D-06108 Halle (Saale), Germany
Postal Address: P.O. Box 11 03 61, D-06017 Halle (Saale), Germany
Phone: +49 (0) 345 7753-60
Fax: + 49 (0) 345 7753-820
Internet: http://www.iwh-halle.de

Urban Growth in Germany – The Impact of Localization and Urbanization Economies

Abstract

This study examines the impact of localization and urbanization economies as well as the impact of city size on urban growth in German cities from 2003 to 2007. Although, from a theoretical perspective, agglomeration economies are supposed to have positive impacts on regional growth, prior empirical studies do not show consistent results. Especially little is known about agglomeration economies in Germany, where interregional support policy and the characteristics of the federal system are further determinants of urban growth. The results of the econometric analysis show a U-shaped relationship between specialization and urban growth, which particularly holds for manufacturing industries. We do not find evidence for the impact of Jacobs-externalities; however, city size shows a positive (but decreasing) effect on urban growth.

Keywords: Agglomeration; Localization economies, Urbanization economies, Urban Growth, Specialization, Diversification

JEL-Classification: O18, R11, R12, R15

Urban Growth in Germany – The Impact of Localization and Urbanization Economies

Zusammenfassung

Diese Studie untersucht den Einfluss von Lokalisations- und Urbanisierungseffekten sowie den Einfluss der Stadtgröße auf das Wachstum deutscher Städte im Zeitraum von 2003 bis 2007. Obwohl aus theoretischer Sicht Agglomerationsvorteile als förderlich für regionales Wachstum gelten, ergeben bisherige empirische Untersuchungen diesbezüglich kein einheitliches Bild. Insbesondere liegen bisher kaum Ergebnisse für Deutschland vor. Hier stellen auch die interregionale Ausgleichspolitik sowie die Besonderheiten des föderalen Systems Determinanten des Stadtwachstums dar. Die Ergebnisse der durchgeführten ökonometrischen Untersuchung für die Städte in Deutschland deuten auf eine U-förmige Beziehung zwischen Spezialisierung und Stadtwachstum hin. Dieser Zusammenhang zeigt sich insbesondere im Verarbeitenden Gewerbe. Hinweise auf die Wirkung von Jacobs-Externalitäten können nicht nachgewiesen werden, wenngleich von der Stadtgröße ein positiver (jedoch abnehmender) Effekt auf das urbane Wachstum ausgeht.

Schlagworte: Agglomeration, Lokalisationseffekte, Urbanisierungseffekte, Städtewachstum, Spezialisierung, Diversifikation

JEL-Klassifikation: O18, R11, R12, R15

Urban Growth in Germany - The Impact of Localization and Urbanization Economies

1 Introduction

Today, cities and urban areas are usually regarded as the main locations for industrial activities, for innovation processes, and for economic growth within an economy. On the one hand, there is a widespread agreement in urban economics that agglomeration economies have an important impact for the development of this spatial pattern. But on the other hand, despite a vast theoretical and empirical discussion (e. g. *Rosenthal* and *Strange*, 2004; *de Groot et al.*, 2007 and *Beaudry* and *Schiffauerova* 2009), there is still a significant lack of knowledge in urban economics about the 'anatomy' of agglomeration economies and about the importance of their main categories (localization economies, urbanization economies and city size in general). And we still don't know much about the determining factors of these different categories and the question which 'ingredients' within an urban area (e. g. the existence of business incubators, headquarters, schools and universities, a 'creative class') are able to stimulate agglomeration economies (e.g. *Florida* 2002, *Blum* 2008, *Franz* 2008, *Schwartz* and *Hornych* 2008).

More knowledge about agglomeration economies would not only be important for improving economic theory, but also for economic policy. If national and local policymakers knew more about the 'anatomy' of agglomeration economies, especially the recent attempts of 'cluster policy' and the ongoing discussion on its potential benefits in many countries and regions (see *Rosenfeld, Franz* and *Heimpold* 2007) would get a better theoretical basis than today. Even more general, the discussion on interregional support policy versus policy of supporting urban agglomerations (see *Rosenfeld* 2006) could benefit from better knowledge on agglomeration economies.

Especially in Germany, the discussion on 'cluster policy' and 'interregional support policy' has led, in recent years, to a highly controversial academic and political debate at all levels of government. But up to now, there are only a few empirical studies on the impact of localization economies, and urbanization economies and city size on urban economic growth (*Südekum* and *Blien* 2005; *Blien, Südekum* and *Wolf* 2006), while for other leading industrialized countries, much more empirical evidence is presented in the existing literature. Are there specific conditions in Germany in the field of agglomeration economies? This paper presents first empirical results from a larger research project on the impact of agglomeration economies on urban economic growth in Germany for the years 2003 to 2007. The following Section 2 gives a short theoretical overlook on the main categories of agglomeration economies. Hypothesis are formulated that will be testes in the empirical part of the paper. After discussing a selection of existing studies in Section 3 (with a special focus on the already mentioned studies for Germany), Section 4 describes the economic growth (measured with employment figures) in the major German cities and presents empirical results on the potential of these cities for different categories of agglomeration economies. In Section 5, the results of an econometric analysis on the question which of these categories are able to explain urban economic growth in the major German cities are presented. After a discussion of these results in Section 6, the final Section 7 draws some conclusions.

2 Theory of Localization and Urbanization Economies

As stated in the introduction, there are two general dimensions of agglomeration economies with both receiving a great deal of attention in the academic world and by governmental policy. First, there is the concept of urbanization economies. This concept highlights variety benefits of a diversified economy for the exchange of complementary knowledge between economic actors (*Isard* 1956; *Jacobs* 1969). Ideas and innovation are considered to be the result of an exchange process between different fields of knowledge. As pointed out by Jacobs (1969), relevant sources of knowledge are often not necessarily found within, but rather beyond the own industrial environment. A more diversified industrial structure may provide access to different and complementary technological knowledge and therefore favor innovative activities. These explanations result in the following hypothesis:

Hypothesis 1: Diversification of economic activity in a city is positively associated with urban growth

Accordingly, supporters of this view emphasize the benefits resulting from a strong diversified industrial structure. However, urbanization economies also describe the benefits of the extent and of the density of a region in general, and therefore underscore the importance of the size of an agglomerated region. Both subcategories of urbanization economies, that is size and diversification, are strongly interconnected. Diversified patterns of regional economic activity are most likely to occur in densely populated regions. Large urban areas additionally provide large-scale markets with a high number of potential customers and suppliers as well as transportation and communication infrastructure at the technological forefront. Hence, large urban areas favor lower transportation costs. Accordingly, we propose the following hypothesis:[1]

1 More recently, a new approach extends this original urbanization framework. It is argued that variety itself must be accompanied by shared competencies and knowledge between different industries. If complementarities, that is so-called 'related variety', exist, knowledge will spill over more effectively (*Frenken et al., 2007*; *Boschma and Immarino*, 2009).

Hypothesis 2: City size is positively associated with urban growth.

Another dimension of agglomeration economies emphasizes the importance of one (or few closely related) spatially concentrated industry for regional knowledge spillovers, firm competitiveness and innovation (*Marshall*, 1920; *Arrow*, 1962; *Romer*, 1986). The general assumption behind this research stream is that the most important knowledge spillovers may occur between geographically proximate firms of the same industry. Taking into account that knowledge spillovers seem to be geographically bounded (e.g. *Jaffe, Trajtenberg* and *Henderson* 1993; *Anselin et al.*, 1997; *Zucker, Darby* and *Brewer* 1998), locating in close vicinity to the sources of spillovers becomes crucial for their exploitation (*Audretsch* and *Feldman* 1996). Thus, a more homogenous distribution of firms' knowledge and skills within industrial agglomerations creates a strong basis for intense communication and co-operation processes.

Following Marshall, a specialized labor market, specialized suppliers and service firms allowing for intra-industry linkages are key factors determining the advantages of those localization economies (also called Marshall-Arrow-Romer (MAR) externalities, *Glaeser et al.*, 1992). In addition, *Porter* (1990) emphasizes the positive effects of intensified local competition, which might be conducive to growth and innovation activities. Considering innovation efforts in particular, a spatially concentrated industry acts as catalyst for the exchange of experiences, and the transfer of valuable information and knowledge, particularly non-codified tacit knowledge (*Baptista* and *Swann* 1998). The transfer of this kind of knowledge requires frequent personal interactions between actors and is difficult to realize over great distances (*Malmberg* and *Maskell* 1997). Another important channel for the transfer of innovation-related knowledge within industrial agglomerations is the effect resulting from higher mobility of skilled workers (*Marshall* 1920; *Krugman* 1991). Search costs for employers and workers as well decline in industrial agglomerations.[2] Thus, knowledge spillovers are generated via the transmission and diffusion of knowledge and skills embodied in individuals (for instance, engineers or researchers). These arguments lead us to formulate the following hypothesis:

Hypothesis 3: Specialization of economic activity in a city is positively associated with urban growth.

These theoretical concepts of agglomeration economies must not be understood as mutually exclusive, with pure localization economies being present in one region and pure urbanization economies in another region. Particularly large urban areas provide fertile grounds for the presence of both alternatives, maybe one reinforcing the other. A particular city with a high specialization in a specific industry can generate MAR-economies in this field, while at the same time a well-balanced mixture of the other industries can

---

2 Research has shown that knowledge flows from job mobility seem to be limited to a spatially concentrated job market (*Saxenian* 1991; *Almeida and Kogut* 1999), and workers with innovation-related knowledge and skills tend to choose their employers locally (*Breschi and Lissoni* 2001).

generate Jacobs-economies. The following section presents a brief overview over empirical studies trying to disentangle the complex relationship between agglomeration economies and regional growth.

3 Prior Empirical Evidence

There is a huge body of empirical literature regarding the impact of agglomeration economies on economic growth on both the firm as well as the regional level (for overviews and reviews, see *Rosenthal and Strange*, 2004; *de Groot et al.*, 2007 and *Beaudry* and *Schiffauerova* 2009). To date there is only little evidence for Germany. As in other countries as well, it remains unclear whether agglomeration economies (localization and urbanization) have positive, negative or even not any effects on regional growth. A comprehensive literature review is not the primary focus of this paper. Below we present results of seminal as well as more recent studies that are suitable to illustrate the status quo of the urbanization versus localization debate. We differentiate between employment growth, productivity growth and innovative performance as dependent variables of regional growth.

Agglomeration economies and employment growth

Among existing measures of regional economic growth, resulting from the availability of data, employment growth (in absolute and relative terms) is the most frequent dependent variable in empirical studies of agglomeration economies (*Beaudry* and *Schiffauerova*, 2009). Investigating growth of large industries in 170 U.S. cities, in a seminal paper *Glaeser et al.* (1992) do not find evidence for the importance of intra-industry technological spillovers for industry employment growth. However, Jacobs-externalities are found to exert a positive impact, and local competition is also conducive to industry employment growth. They assume that regional specialization might be less important for mature industries than for industries at the beginning of their life-cycle. *Usai* and *Paci* (2003) identify a negative relationship between specialized labor-market regions in Italy and regional employment growth, and a positive impact of a diversified industry structure. *Forni* and *Paba* (2002), however, also find evidence of positive MAR-externalities in Italy. *Combes* (2000a) differentiates between manufacturing industries and services in France. While for manufacturing industries negative externalities of both types (MAR- as well as Jacobs-externalities) are found, the service sector shows positive urbanization effects.

For Germany in particular, there exists little empirical evidence so far. Regarding the growth of employment, *Suedekum* and *Blien* (2005) state that externalities play an important role. They find that MAR-externalities are only present in the service sector. *Blien, Suedekum* and *Wolf* (2006), on the other hand, find positive MAR-externalities for both manufacturing and service sectors. In both studies, positive Jacobs-externalities are detected.

Agglomeration economies and productivity

A minority of empirical studies measure productivity directly as dependent variable to study the impact of agglomeration economies. For instance, *Cingano* and *Schivardi* (2004) argue that the detection of negative MAR-externalities might result from using employment growth and not productivity as indicator of regional growth. They underpin this argument by showing for Italian labor-market regions that employment growth is negatively related to specialization and diversification. Productivity growth, in contrast, is positively affected by specialization.

Similar findings are obtained by *de Lucio, Herce* and *Goicolea* (2002), *Dekle* (2002) and *Henderson* (2003) although restricted to specific industries. For instance, *Henderson* (2003) confirms localization advantages (measured as the number of own-industry plants) for high-tech industries only, but not in other manufacturing industries. He finds no evidence for urbanization advantages in these high-tech industries. Another approach that links industry-life cycles and agglomeration economies is presented by *Neffke et al.* (2008). They assume that specifically young industries are affected by regional diversity, but this dependence decreases as standardization processes increase. Using 30-year data on the evolution of Swedish labor-market regions, their results indicate that while Jacobs-externalities become less important with increasing maturity, the importance of MAR-externalities is increasing. In general, studies using productivity tend to find positive localization economies, but rarely urbanization economies.

Agglomeration economies and innovative performance

In their well-known paper, *Feldman and Audretsch* (1999) give no empirical support for the thesis that specialization of one particular industry in one region (measured in terms of a specialization rate as already used in *Glaeser et al.* (1992)) promotes innovative output of firms in that region. In contrast, their investigation of the determinants of product innovations in U.S. cities manufacturing industries reveals a positive impact of a diversified economic activity. In a more recent analysis of patent productivity in U.S. metropolitan areas, *Lobo and Strumsky* (2008) notice a statistically positive relationship between patent productivity of metropolitan areas and the extent to which technologies and industries are specialized in that region. With respect to Germany, two recent studies relate industry specialization to regional innovative performance and the efficiency of regional innovation systems respectively (*Fritsch* and *Slavtchev*, 2009; *Hornych* and *Schwartz*, 2009). In both cases, the authors confirm positive effects of MAR-externalities, but they also find an inverse-U relationship. This means regional industrial specialization beyond a maximum seems to lower regional innovative performance.

Investigating innovative performance on the firm-level in particular, mixed results with regard to the relationship between firms' location in industry clusters and their innovative performance (measured as product innovation) are provided by *Gilbert et al.* (2008). While studying performance of 127 new independent ventures from the information technology industry in the U.S., the authors do find firms in cluster locations to have a higher innovation output. However, considering technological knowledge spillovers, other factors might be more influential in determining firms' innovation performance. *Folta et al.* (2006) measure the size of clusters in the biotechnology industry (number of biotechnology firms in 85 U.S. Metropolitan Statistical Areas). Inter alia, they find benefits of increasing cluster size with respect to patenting, but at the same time decreasing marginal benefits. Their results suggest agglomeration disadvantages with respect to innovation if clusters evolve beyond a critical size. *Baptista* and *Swann* (1998) investigate innovative performance of 248 British manufacturing firms over an eight-year period. They find that firm location within an industrial cluster (measured in terms of firms' industry employment in the respective region) is positively associated with innovation output, and therefore supporting the importance of industry agglomerations.

4 City Size, Specialization, and Diversification of German Cities

Before the econometric analysis, this chapter presents some facts about the potentials of localization and urbanization effects of German cities. The following sub-sections describe urban growth (4.1) – which is defined as the growth of employment within a city –, the extent of economic specialization (4.2), the extent of economic diversification (4.3), and some facts about the size (4.4) of German cities. Sub-section 4.5 examines the interrelation between these issues.

To measure both employment development and industrial structures of German cities we refer to official employment data. These data were gained from the German Social Insurance Statistics. Our data set covers information on an annual basis from the period 2003 to 2007. This database meets with the NACE Rev.1 classification of economic activities and contains the number of employees for each firm at the NUTS-3 level (see *Fritsch* and *Brixy* 2004 for a description). While this database has the huge benefit of recording separate locations of multi-establishment enterprises, a disadvantage is that only employees participating in the German social insurance system are recorded. Freelancers or self-employed persons are not considered. Since the share of self-employed persons differs between industries, this fact may bias the results since industries with a high share of self-employed persons (like the media industry, *Scott* 2000) are rather located in urban agglomerations than in rural areas as well as rather in big cities than in smaller cities. However, assuming a non-varying proportion between employees participating in the social insurance system and self-employed persons at least the comparison of the dynamics of specific industries in different cities is not affected.

4.1 Urban Growth in Germany – Employment Dynamics in German Cities

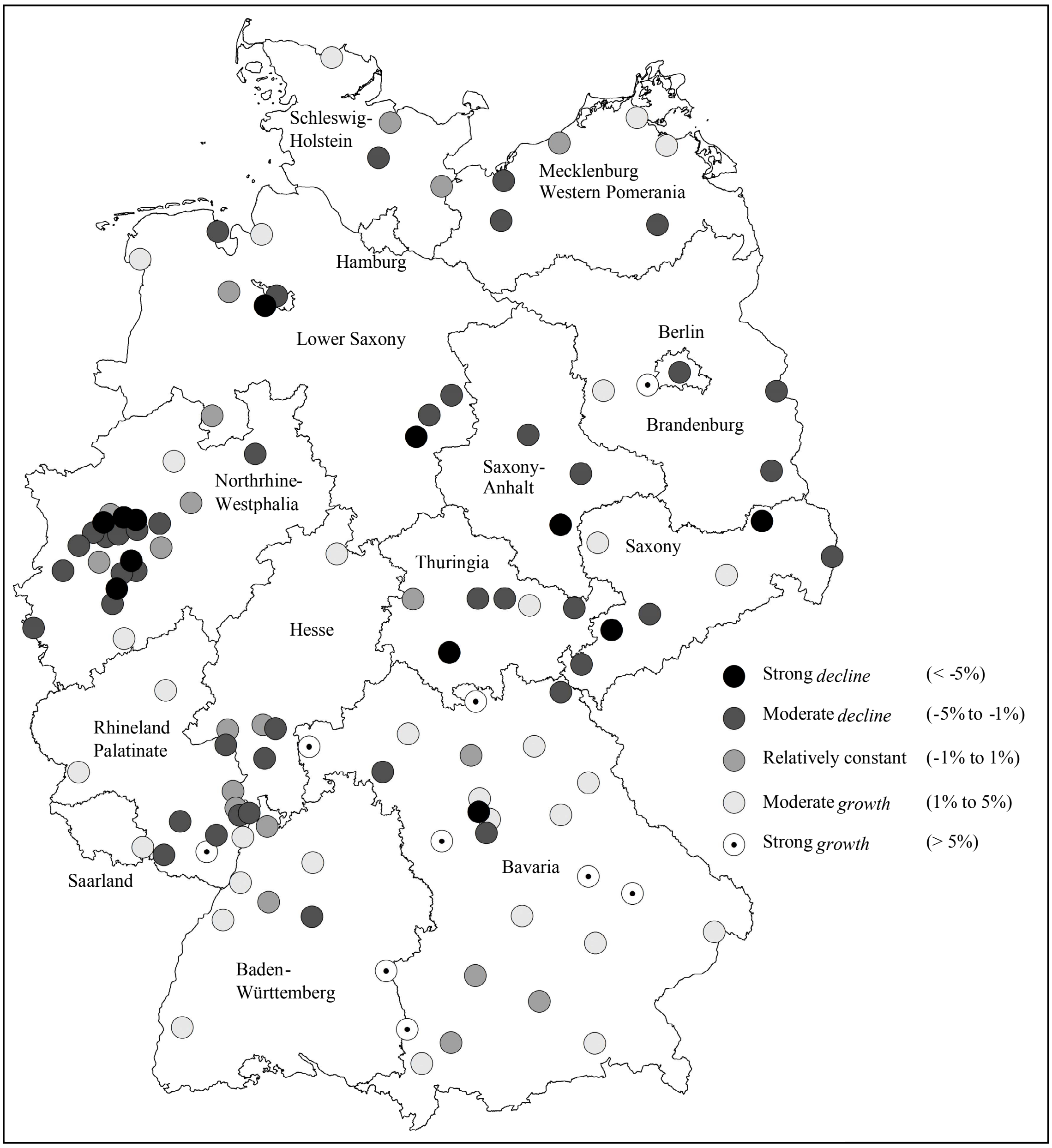
Our analysis covers all 116 German free towns (i.e. municipality not associated with a county, which – aside from a few exceptions like Hannover – generally are the largest towns in Germany). With about 10.5 million employees in 2007, our sample accounts for 39.2 percent of the overall employment in Germany. Figure 1 gives a first impression of the development of the employment of 116 German cities in the period from 2003 to 2007. It differentiates between cites with strong or moderate changes and cities with a relative constant number of employees. All in all, total employment declines about 0.69 percent on average for all cities in the four-year period under observation. This is a higher decline compared to the overall German employment (city and counties), which shrinks by 0.38 percent on average. Figure 1 also reveals heterogeneous patterns of urban growth. While 49 cities were able to provide new jobs, the employment opportunities in 66 cities were reduced. The most striking positive development is found in Aschaffenburg (Bavaria) and Potsdam (Brandenburg) with an increase in each case of more than 10 percent. The most distinctive shrinkage has taken place in Hoyerswerda (Saxony, −13.9 percent) and Fürth (Bavaria, -9.2 percent). Regarding the distribution of growing and shrinking cities, Figure 4.1 shows that although all cities in Eastern Germany (the former German Democratic Republic) were confronted with a far-reaching structural transformation and migration since 1990, there are some cities which succeed stopping downgrade in the observed period. Moreover, in the south of Germany (Bavaria, Baden-Württemberg) there are mainly growing cities, while most of the cities in Northrhine-Westphalia (Western Germany), especially in the Ruhr area, are shrinking.

4.2 Economic Specialization of German Cities

As stated in the theoretical section, industry specialization in a city can promote MAR economies. There is a multiplicity of indicators, which capture the degree of industry specialization of economic activities. On the level of Industry-Region-Combinations (IRC) (a specific industry in a specific region) we use the specialization rate (or location quotient) to represent the degree of economic specialization (see also *Hornych* and *Schwartz* 2009 for more details). The specialization rate is defined as the share of total regional employment accounted for by one particular industry employment in that region (L_{ir} / L_r) relative to this share in the German economy (L_i / L) (Equation 1).

$$LQ_{ir} = \frac{L_{ir} / L_r}{L_i / L} \qquad (1)$$

Figure 4.1:
Development of the employment in German cities 2003-2007



Source: Bundesagentur für Arbeit; authors' calculation and illustration.

A specialization rate larger than one indicates a relevance of an industry above average in this particular city. The higher the resulting value for a given IRC, the more specialized is the respective industry in the corresponding city. The specialization rate allows measuring the potentials for MAR externalities on the level of IRC. Regarding these potentials on the level of a city, we must aggregate these potentials for all industries. The more sectors in a city show high specialization rates, the more the city's overall economic structure diverges from the average economic structure of a superior area (in our case Germany). This indicates that the particular city realizes a specific task in the system of cities (*Lösch* 1940), which may by based upon the generation of localization economies. We apply the Krugman Specialization Index (KSI) to measure the overall degree of economic specialization of the German cities (see *Krugman* 1991, p. 75f.). The KSI of a city *r* arises from the sum of the absolute values of the differences of the share of employment of an industry *i* in the specific city (L_{ir} / L_r) and the share of employment of the industry *i* in overall Germany (L_i / L) (Equation 2).

$$KSI_r = \sum_{i=1}^{I} \left| \frac{L_{i,r}}{L_r} - \frac{L_i}{L} \right| \tag{2}$$

The KSI ranges from 0 to 2. A high KSI indicates a strong deviation from the overall economic structure (in our case Germany). A KSI of zero corresponds to an identical industry structure of the city and Germany.

Table 4.1:
Economic structure of German cities: Most and least specialized cities (2003)

City	KSI	Industries primarily specialized in (specialization rate)
Most specialized cities		
Wolfsburg	1.14	Manufacture of motor vehicles, trailers, and semi trailers (23.5) Sale, maintenance and repair of motor vehicles (1.2)
Ludwigshafen	0.91	Manufacture of chemicals and chemical products (29.5) Computer and related activities (1.9)
Emden	0.89	Water transport (19.1) Manufacture of motor vehicles, trailers, and semi trailers (14.9)
Ingolstadt	0.83	Manufacture of motor vehicles, trailers, and semi trailers (17.0) Manufacture of wearing, apparel, dressing and dyeing of fur (6.0)
Erlangen	0.77	Manufacture of radio, television, and communication equipment (20.5) Electricity, gas, steam, and hot water supply (9.1)
Least specialized cities		
Bremen	0.34	Water transport (5.5) Manufacture of other transport equipment (4.5)
Mönchengladbach	0.34	Manufacture of wearing, apparel, dressing and dyeing of fur (8.7) Manufacture of textiles (5.4)
Mannheim	0.33	Manufacture of coke, refined petroleum products and nuclear fuel (5.6) Manufacture of office machinery and computers (4.7)
Bielefeld	0.33	Manufacture of wearing, apparel, dressing and dyeing of fur (5.9) Tanning and dressing of leather (4.8)
Augsburg	0.32	Manufacture of office machinery and computers (21.0) Manufacture of other transport equipment (3.5)

Source: Bundesagentur für Arbeit, authors' calculation.

Table 4.1 shows the five most and five least specialized cities in Germany in the year 2003. It also presents the KSI as well as the particular industries, the cities are most specialized in (specialization rate in parentheses). As in the following econometric analysis, not all industries are used; agriculture, fishing and mining as well as the public sector, private households and exterritorial organizations are excluded since employment in these industries is determined by other factors than agglomeration economies. The cities with the most distinctive economic profiles are mostly characterized by a strong specialization in one specific industry, like the automotive industry in Wolfsburg or the chemical industry in Ludwigshafen. Also, cities with an average economic profile show at least medium specialization in single industries.

4.3 Economic Diversification of German Cities

As an indicator of the degree of economic diversification we apply the Hirschman-Herfindahl index, which is the most common measure for Jacobs externalities (*Beaudry* and *Schiffauerova* 2009). The Hirschman-Herfindahl index (HHI) of a city *r* arises from the sum of the squared shares of employment of the several industries *i* in the specific city ($L_{i,r}$ / L_r) (Equation 3). A low HHI indicates a strong diversification of the city`s economic structure. Table 4.2 shows the five German cities with the highest and with the lowest economic diversification.

$$HHI_r = \sum_{i=1}^{I} \left(L_{ir}^{03} / L_r^{03} \right)^2 \qquad (3)$$

A comparison of the results presented in Table 4.1 and in Table 4.2 shows that those cities with a high economic specialization are often also the least diversified cities. Note, that even though these relationships seem obvious, they are not straight-forward. Actually, localization and urbanization economies are not mutually exclusive; they can be present simultaneously (*Beaudry* and *Schiffauerova* 2009).

Table 4.2:
Economic structure of German cities: Most and least diversified cities (2003)

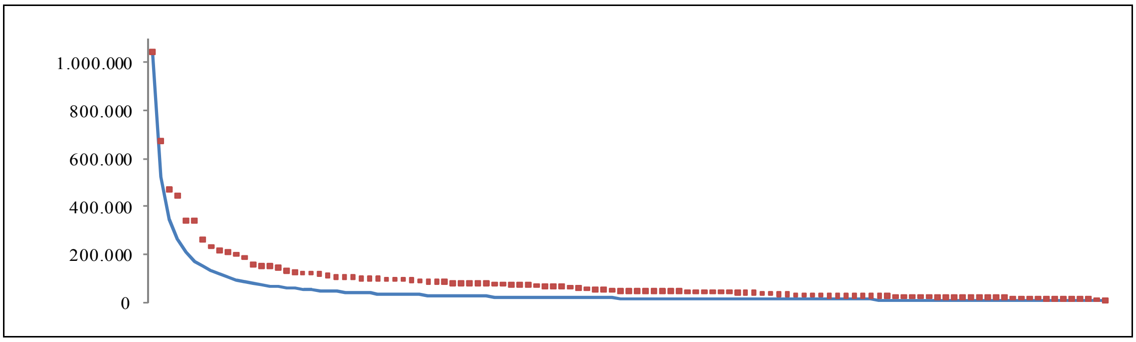
Most diversified cities		Least diversified cities	
City	HHI	City	HHI
Mannheim	0.052	Wolfsburg	0.415
Heilbronn	0.054	Ludwigshafen	0.263
Wuppertal	0.060	Ingolstadt	0.234
Bremen	0.057	Schweinfurt	0.207
Köln	0.057	Emden	0.186

Source: Bundesagentur für Arbeit, authors’ calculation.

4.4 City Size

As state above, we are measuring city size by the number of employment within a city. Figure 4.2 shows the distribution of size of the cities of our sample. Moreover, it shows the expected distribution according to the rank-size rule (continuous line). The rank size rule in the case of city size states that the resulting distribution in a country will be characterized by a largest city, with other cities decreasing in size respective to it. If one takes the cities of a country according to their size in a sequence, then the relation of the cities size corresponds to the inverse ratio of their ranking (*Auerbach* 1913). Compared with the expected distribution according to the rank-size rule, we find relatively more large and mid-size towns in Germany. The tradition of a federal system in Germany, with own capital cities in each region, is one reason for these results.

Figure 4.2:
City size of German cities



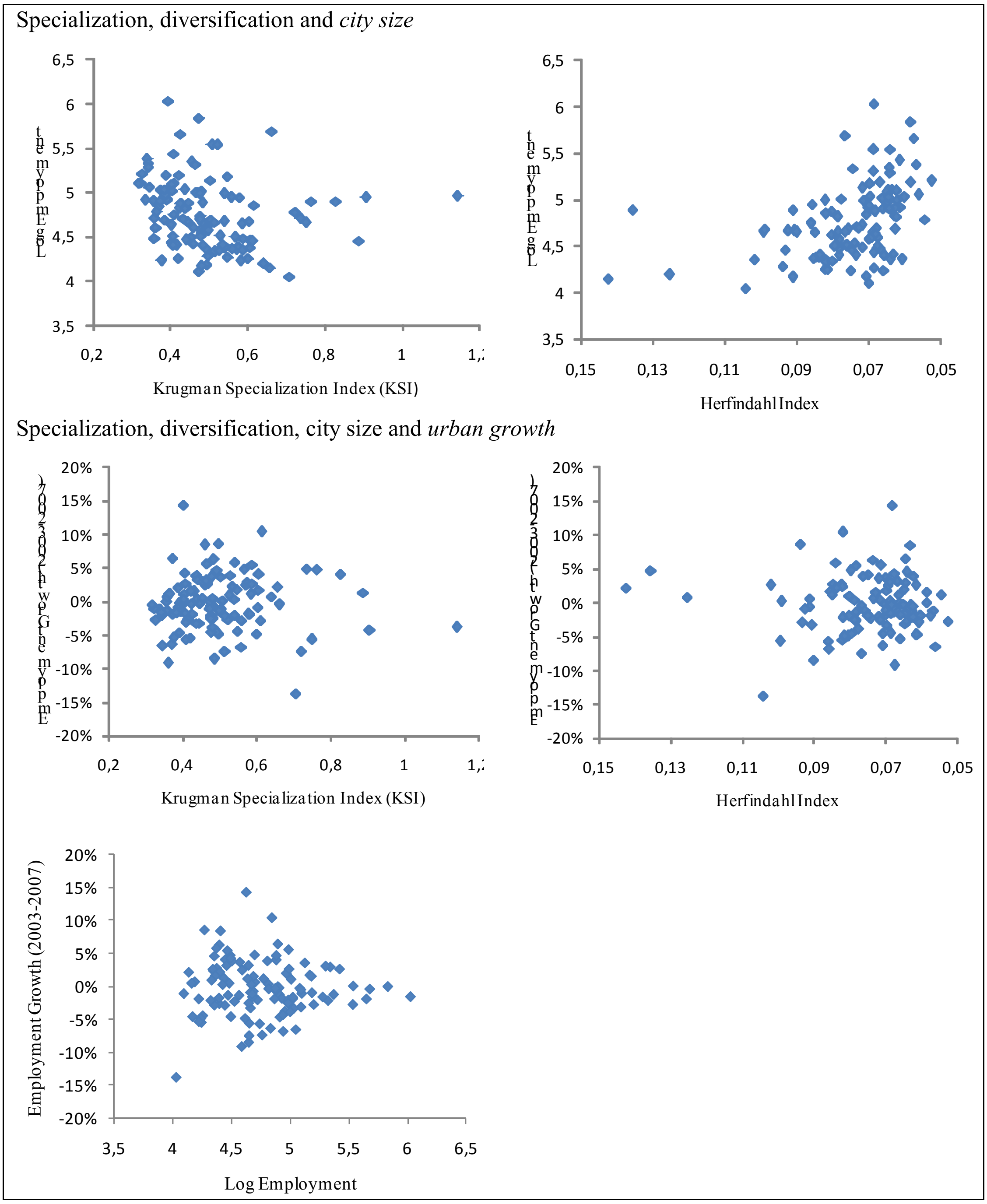
Source: Bundesagentur für Arbeit, authors' calculation.

4.5 Specialization, Diversification, City Size and Employment Development of German cities

In this subsection we examine the relationship between city size as well as the economic specialization and diversification of German cities in 2003 and their employment growth in the following years. The graph on the upper-left side of Figure 4.3 shows the relationship between city size and economic specialization. According to this, cities with a distinct economic profile are primarily midsize cities. However, the results do not indicate a correlation between city size and economic specialization.

On the middle-right side of Figure 4.3 we examine the relationship between city size and economic diversification. For the purpose of a clear graphical presentation, we exclude some outliers. The results indicate that the biggest cities have the most diversified economic structure. However, regarding the mid-size cities, the relationship between city size and economic diversification is not visible.

Figure 4.3:
Development of the employment in German cities 2003-2007



Source: Bundesagentur für Arbeit, authors' calculation.

The graph on the middle-right side of Figure 4.3 presents the link between the KSI of the German cities and their employment growth in the period 2003 to 2007. A positive (negative) relation would be an indicator of a favorable (unfavorable) impact of economic specialization and therefore of positive (negative) localization economies. However, the results do not give clear evidence that there is a connection between economic specialization and employment growth. Similar results are obtained bringing together employment growth and economic diversification (lower-right side of Figure 4.3, excluding outliers). The results do not indicate a linkage between urban growth and economic diversification. Finally, the graph on the lower-left side of Figure 4.3 presents the relationship between city size and employment development.

5 Econometric Analysis

5.1 Variables and Methodology

In the following section an econometric model will be estimated to analyze the impact of agglomeration effects and city size on urban growth in Germany. The first section contains a description of the variables and the methodology, followed by the presentation of the results in Section 5.2.

Variables

The analysis will be carried out for different German spatial entities. Two sets of regressions are based on the NUTS-3 regions, that is the counties and free cities. A third set of regressions analyses the German planning regions, which comprise one or more counties and free cities. The focus is on free cities; counties and planning regions are used as a control of the influence of spatial delimitation. The dependent variable is the approximate growth rate of employment in an IRC (Equation 4), where L is employment, $I = 1,\ldots,49$ an index for the industry and $r = 1,\ldots,116$ an index for the region. The growth rate is normalized by the industry growth rate to ensure comparability across industries (*Combes*, 2000b:5). This normalization is applied to all variables on the IRC-level.

$$\hat{L}_{ir} = \frac{L_{ir}^{07} / L_{ir}^{03}}{L_{i}^{07} / L_{i}^{03}} \tag{4}$$

As a measure of MAR-externalities we include the location quotient LQ_{ir} (see Equation 1). To test for positive but decreasing effects of MAR-externalities, the square of the location quotient LQ_{ir}^2 is also included in the regression. An alternative indicator, which is often used in the literature, is the absolute size of IRC-employment L_{ir}^{03}. This will be used to check the robustness of the results and will show whether absolute or relative specialization matters. According to Hypothesis 3, a positive coefficient is expected for the location quotient and IRC-employment and a negative coefficient for its square.

As in most other studies (*Beaudry* and *Schiffauerova*, 2009), Jacobs-externalities are operationalized by an inverse relative Hirschman-Herfindahl index (Equation 5), where

$j = 1,\ldots,49$ is again an index for the industry. In contrary to Equation 3, own-industry-employment is excluded so that the HHI of IRC in one region differ. Higher HHI values indicate relatively high diversification. Therefore the coefficient is expected to be positive (Hypothesis 1).

$$HHI_{ir} = \frac{1/\sum_{\substack{j=1\\ j\neq i}}^{J}\left(L_{jr}^{03}/(L_{r}^{03}-L_{ir}^{03})\right)^{2}}{1/\sum_{\substack{j=1\\ j\neq i}}^{J}\left(L_{j}^{03}/(L^{03}-L_{i}^{03})\right)^{2}} \tag{5}$$

To measure the effect of city size, regional employment L_r^{03} and its square are used. We expect the effect of size to be positive but decreasing (Hypothesis 2). An alternative measure for city size is employment *density*. This measure is especially useful in analyzing counties and planning regions since these consist of several towns and cities. Since density and regional employment are highly correlated they cannot be used in the regression simultaneously. Instead, two dummies for the settlement structure as developed by the Federal Office for Building and Regional Planning, *density1* and *density2* are substituted when running regressions for counties and planning regions. *Density1* refers to agglomerated areas and *density2* to urbanized areas. The base category is rural areas.

As mentioned in the theoretical discussion, local competition might be both a driving force (*Porter* 1990) and an obstacle (*Marshall* 1920) to regional economic growth. Testing for possible competition effects, we follow *Combes* (2000a) to measure competition by the Herfindahl-index for the concentration of employment (Equation 6), where n is the number of firms and the index $g = 1,\ldots,7$ stands for different size ranges of firms in terms of employees.[3] A positive coefficient would support the MAR-hypothesis of competition, a negative coefficient the Porter-hypothesis.

$$competition_{ir} = \frac{\sum_{g=1}^{G}\left(\left(\frac{L_{irg}^{03}/n_{irg}^{03}}{L_{ir}}\right)^{2} * n_{irg}^{03}\right)}{\sum_{g=1}^{G}\left(\left(\frac{L_{ig}^{03}/n_{ig}^{03}}{L_{ig}}\right)^{2} * n_{ig}^{03}\right)} \tag{6}$$

Several other control variables are used in the regression analysis. '*growth$_r$*' is the approximate growth rate of all other industries in one region, with a positive coefficient hinting at spread effects. The average firm size '*fsize$_{ir}$*' is included as a proxy for internal

3 The Social Insurance Statistics records for each sector in a region the number of firms and the number of employees in companies with 1-5, 6-9, 10-19, 20-49, 50-99, 100-499 and more than 500 employees.

scale economies of industry *i* in region *r* as possible source of growth (*Combes*, 2000a). The number of headquarters of the top 100 companies (according to revenues) *HQ* is a measure of the existence of innovation. Since most R&D departments are located at headquarters, regions with more headquarters should experience higher innovation rates leading to higher regional growth. This variable could also represent good location conditions (*Bode*, 1998). According to the new growth theory, human capital is an important denominator of growth. Therefore, the share of highly educated persons $educ_r$ (having a college degree) is included. Surveys among firms have shown that access of a location is an important location factor (*de Vor* and *de Groot*, 2008). The proxy used here, *agglomeration*, is the distance to the next agglomeration in minutes. Finally, industry dummies *d_wz** and dummies for the provinces (that is *Laender*) *d_*** are included[4] as well as a dummy for a region being the capital of a province *capital.*

To test for differences in MAR- and Jacobs-externalities due to different city sizes, the location quotient and Herfindahl-index are interacted with dummy variables for the different levels of regional employment (Table 5.1). Descriptive measures of all variables used in the regression models can be found in Appendix 2.

Table 5.1:
Interaction variables for LQ/HHI and regional employment

Free cities and counties		Planning regions	
LQ_35	LQ in IRC with less than 35 000 employees, otherwise 0	***LQ_150***	LQ in IRC with less than 150 000 employees, otherwise 0
LQ_90+	LQ in IRC with more than 90 000 employees, otherwise 0	*LQ_300+*	LQ in IRC with more than 300 000 employees, otherwise 0
HHI_35	HHI in IRC with less than 35 000 employees, otherwise 0	*HHI_150*	HHI in IRC with less than 150 000 employees, otherwise 0
HHI_90+	HHI in IRC with more than 90 000 employees, otherwise 0	*HHI_300+*	HHI in IRC with more than 300 000 employees, otherwise 0

Source: authors' illustration

Methodology

In the literature, the resulting linear equation is often estimated by ordinary least squares. However, since the model suffers from inherent heteroscedasticity[5] (*Suedekum* and *Blien*, 2005), it will be estimated using weighted least squares (WLS), with the employment of an IRC as weight, and robust standard errors. We include only those IRC in the estimation that have non-zero employment in 2003 and 2007. All variables are used in logs (except dummy variables).

4 See appendix 1.

5 See figure in appendix 3.

Moran's *I* is used as a test for spatial autocorrelation (cf. *Anselin*, 2006:932). The test statistic is

$$I = \frac{\hat{\varepsilon}' W \hat{\varepsilon}}{\hat{\varepsilon}' \hat{\varepsilon}} \tag{7}$$

where $\hat{\varepsilon}$ are the error terms of the regression and W is a row-standardized spatial weights matrix. For planning regions, a binary contiguity matrix is used. Thus, for regions sharing a common border $w_{ij} = 1$ and otherwise $w_{ij} = 0$. The problem here is that the units of observation are not regions but IRC. Therefore, the weights matrix has to include the industry-dimension as well. One could either assume that interdependencies only exist within industries. Then the elements of *W* are one for the same industries in neighboring regions. Alternatively, spillovers can be allowed between different industries in neighboring regions. In either case, the dimension of *W* will be the number of regions times the number of industries. Since this model could not be estimated, a simplification is used. If spatial autocorrelation is only allowed within an industry, separate regressions can be estimated for each industry. In testing for spatial autocorrelation, the simple weights matrix with dimension $r \times r$ can then be applied. If the test does not indicate the presence of spatial autocorrelation, it is assumed that no spatial interdependencies exist between different industries, either.

In the case of the free cities, the spatial structure underlying the weights matrix is also based on the planning regions. For cities that belong to the same planning region w_{ij} is set to one.

5.2 Results

First, the regression results for free cities are presented. In Table 5.2 the unweighted and the weighted model are compared (industry and regional dummies are omitted but complete regression results can be found in Appendix 6). The size, and sometimes the signs, of the coefficients differ considerably. The White test for the unweighted regression confirms the existence of heteroscedasticity (see Appendix 4) so that the following analysis is based on model II. The test for spatial autocorrelation was significant in only four industries (results can be found in Appendix 5). Therefore, the model is estimated without taking into account spatial interdependencies.

Contrary to the expectations, specialization has a significantly negative effect on employment growth. However, the squared term indicates that at high levels of specialization, the effect becomes positive. Thus, there is evidence of a U-shaped relationship. An alternative specification with an absolute measure of specialization resulted again in a negative, but insignificant coefficient (see Appendix 7). The second type of agglomeration economies, urbanization economies, was found to be insignificant.

Table 5.2:
Regression results of the unweighted (I) and weighted (II) regression for free cities

	(I) Cities			(II) Cities		
	Coefficient	p-value		Coefficient	p-value	
LQ	-0.0150	0.438		-0.0364	0.071	*
LQ^2	0.0344	0.000	***	0.0224	0.005	***
HHI	0.0316	0.278		-0.0128	0.589	
L_r	-0.0675	0.784		0.2566	0.144	
L_r^2	0.0036	0.747		-0.0122	0.094	*
growth	-0.5910	0.005	***	-1.6707	0.000	***
competition	-0.0379	0.029	**	-0.0500	0.000	***
fsize	-0.0710	0.004	***	-0.0414	0.138	
educ	-0.0325	0.377		0.0525	0.214	
HQ	-0.0166	0.068	*	-0.0101	0.001	***
agglomeration	-0.0613	0.051	*	0.0081	0.770	
capital	0.0179	0.564		-0.0182	0.208	
constant	0.6767	0.629		-1.0753	0.338	
N	5.018			5.018		
$F(74, 4943)$	9.990	0.000		2.390	0.000	
R^2 / Adj. R^2	0.130 / 0.117			0.321		

Source: Authors' calculations.

Considering city size, that is regional employment, only the squared variable is significant. The insignificant coefficient for the linear term could be due to multicollinearity, indicated by the high correlation coefficients and variance inflation factors (Appendix 8 and 9). An F-test for joint impact of the two variables was significant (Appendix 10). As expected, employment growth depends positively on regional employment but at some point agglomeration diseconomies dominate. Thus, there is evidence of an inverted U-shaped relationship. Alternative specifications using employment density and regional population also support this finding. The coefficient on density is negative; the coefficients for population are insignificant but have the same signs as the coefficients for regional employment. Of the other control variables growth, competition, and headquarters exert a significantly negative effect on employment growth. The coefficient for growth indicates backwash effects. The sign for the competition variable supports the Porter-hypothesis according to which competition promotes growth because the innovation pressure is higher. The coefficient of the share of highly educated workers in the region is positive but insignificant. The results for all counties and the planning regions are very similar to those for free cities (Appendix 11).

The model was also estimated for manufacturing and service sectors separately. The results for manufacturing (Table 5.3) are similar to those found for all industries, especially in planning regions. In cities the variables for regional employment and in counties the variables for specialization are not significant anymore. Overall, however, there still seems to be a negative influence of specialization for low levels of specialization and a positive influence for high levels of specialization. Diversification never has a significant influence on employment growth.

Table 5.3:
Regression results of the weighted regression for manufacturing industries for free cities (Va), counties (VIa) and planning regions (VIIa)

	(Va) Cities			(VIa) Counties			(VIIa) Planning regions		
	Coefficient	p-value		Coefficient	p-value		Coefficient	p-value	
LQ	-0.0082	0.842		0.0010	0.971		-0.2300	0.072	*
LQ^2	0.0309	0.005	***	0.0019	0.754		0.0230	0.037	**
HHI	-0.1386	0.158		-0.0526	0.367		-0.0753	0.531	
L_r	-0.0058	0.992		0.5838	0.072	*	0.8626	0.018	**
L_r^2	0.0020	0.933		-0.0246	0.084	*	-0.0398	0.007	***
growth	-2.4584	0.000	***	-1.9446	0.000	***	-1.1165	0.023	**
competition	0.0255	0.477		-0.0204	0.400		-0.1525	0.000	***
fsize	-0.0528	0.220		0.0001	0.998		0.1880	0.137	
educ	-0.0017	0.989		-0.0677	0.315		-0.0069	0.891	
HQ	-0.0164	0.337		-0.0042	0.727		0.0001	0.983	
agglomeration	0.0761	0.363		-0.0315	0.620				
capital	0.0045	0.953		0.0000	1.000				
density1				0.0679	0.086	*	0.0610	0.210	
density2				0.0435	0.260		0.0784	0.052	*
constant	-0.7698	0.824		-3.4316	0.076	*	-4.0196	0.078	*
N	2.120			8.139			2.016		
F	4.500	0.000		6.600	0.000		7.190	0.000	
R^2	0.323			0.171			0.222		

Source: Authors' calculations.

The results for service sectors (Table 5.4) differ more from the joint regression. For cities, an inverted U-shaped relationship is found between specialization and employment growth. Most control variables still have the same sign and significance level. However, the share of highly educated is positively significant in cities. In counties and planning regions neither specialization nor diversification are significant.

In a third model, the specialization and diversification parameters are allowed to vary with regional employment (Table 5.5). The base group is middle-sized regions. For cities, none of the specialization variables is significant. However, the F-test indicates joint significance (Appendix 15). Besides, the parameters for the base groups have the same signs as before. The HHI is again insignificant. But the interaction term for small cities is significantly negative. Diversification dampens growth in small cities compared to middle-sized cities. No such effect is found for counties. In planning regions, diversification leads to higher growth in large regions than in middle-sized regions. Furthermore, the location quotient and its square are significant in regression X. The signs and significance levels of the control variables changed only slightly compared to regressions II to IV.

Table 5.4:
Regression results of the weighted regression for service sectors for free cities (Vb), counties (VIb) and planning regions (VIIb)

	(Vb) Cities			(VIb) Counties			(VIIb) Planning regions		
	Coefficient	p-value		Coefficient	p-value		Coefficient	p-value	
LQ	0.018	0.522		-0.0228	0.170		-0.0019	0.966	
LQ^2	-0.068	0.021	**	-0.0129	0.340		0.0156	0.594	
HHI	-0.032	0.246		0.0148	0.404		0.0723	0.103	
L_r	0.098	0.538		0.2180	0.073	*	0.2596	0.113	
L_r^2	-0.005	0.407		-0.0099	0.062	*	-0.0103	0.113	
growth	-1.215	0.000	***	-0.5285	0.001	***	-0.5944	0.004	***
competition	-0.054	0.000	***	-0.0394	0.000	***	0.0039	0.834	
fsize	-0.094	0.015	**	-0.0348	0.221		-0.0643	0.164	
educ	0.064	0.067	*	0.0141	0.437		0.0138	0.467	
HQ	-0.012	0.000	***	-0.0064	0.007	***	-0.0016	0.404	
agglomeration	0.000	0.994		-0.0029	0.802				
capital	-0.021	0.080	*	-0.0381	0.007	***			
density1				-0.0134	0.247		-0.0274	0.132	
density2				-0.0109	0.253		-0.0131	0.288	
constant	0.187	0.862		-1.1170	0.101		-1.6254	0.125	
N	2.898			10.948			2.555		
F	2.910	0.000		3.100	0.000		2.960	0.000	
R^2	0.421			0.296			0.327		

Source: Authors' calculations.

Table 5.5:
Regression results of the weighted regression with interaction terms for free cities (VIII), counties (IX) and planning regions (X)

	(VIII) Cities			(IX) Counties			(X) Planning regions		
	Coefficient	p-value		Coeffi-cient	p-value		Coeffi-cient	p-value	
LQ	-0.0245	0.624		-0.0210	0.540		-0.1030	0.034	**
LQ_35/LQ_150	-0.0354	0.617		-0.0267	0.432		0.0079	0.779	
LQ_90+/LQ_300+	-0.0085	0.865		-0.0122	0.722		0.0173	0.406	
LQ^2	0.0230	0.295		0.0053	0.711		0.0337	0.002	***
LQ^2_35/LQ^2_150	0.0329	0.257		0.0126	0.429		-0.0180	0.261	
LQ_90+/LQ^2_300+	-0.0011	0.963		0.0033	0.832		-0.0193	0.171	
HHI	-0.0508	0.177		-0.0174	0.444		-0.0448	0.235	
HHI_35/HHI_150	-0.1311	0.070	*	-0.0081	0.788		0.0070	0.828	
HHI_90+/HHI_300+	0.0514	0.238		0.0318	0.233		0.1105	0.018	**
L_r	0.6035	0.021	**	0.4076	0.027	**	0.4862	0.014	**
L_r^2	-0.0260	0.016	**	-0.0175	0.026	**	-0.0211	0.006	***
growth	-1.6948	0.000	***	-1.0926	0.000	***	-0.8353	0.000	***
competition	-0.0482	0.000	***	-0.0366	0.000	***	-0.0512	0.002	***
fsize	-0.0484	0.089	*	-0.0078	0.720		0.0420	0.368	
educ	0.0487	0.230		-0.0103	0.601		0.0227	0.230	
HQ	-0.0090	0.003	***	-0.0044	0.099	*	-0.0012	0.501	
agglomeration	0.0177	0.516		-0.0223	0.216				
capital	-0.0211	0.134		-0.0083	0.440				
density1				-0.0498	0.009	***	-0.0185	0.336	
density2				0.0014	0.927		0.0003	0.978	
constant	-3.2899	0.046	**	-2.0947	0.049	**	-2.5121	0.052	*
N	5.018			19.087			4.571		
F	2.610	0.000		2.930	0.000		3.520	0.000	
R^2	0.325			0.209			0.252		

Source: Authors' calculations.

6 Discussion

This chapter provides a discussion of the empirical results presented above. Regarding MAR-Externalities, in most of our regression-models we found a U-shaped relationship between specialization and urban or regional growth, comparable to the results of *de Lucio et al.* (2002). This result indicates that only strong industry concentration beyond a certain threshold has positive effects. Further regressions show that this relationship holds for the manufacturing industries only. For service sectors, we find only little statistical significant relationships. One exception is the model regarding the service sector solely in cities, where we find a significant inverse U-shaped relationship between specialization and growth. Most other studies either find a significant linear positive effect of specialization on employment growth (e.g. *Henderson*, 1997; *Forni* and *Paba*, 2002) or a linear significant negative effect (e.g. *Glaeser et al.*, 1992; *Usai* and *Paci*, 2003). Therefore, our hypothesis 3 is only partially confirmed.

Our findings on the impact of MAR-externalities are contrary to existing empirical results for Germany. *Suedekum* and *Blien* (2005) find a negative impact of specialization in manufacturing industries and a positive impact of specialization for service sectors in Germany. The study of *Blien et al.* (2006) indicates positive MAR-externalities in the short run. Since both employ a different research design, there are several potential reasons for these discrepancies: First of all, both *Suedekum* and *Blien* (2005) and *Blien et al.* (2006) do not control for non-linear relationships between specialization and growth. Second, whereas our analysis covers almost 50 industries and therefore the large part of economic activities, the other two studies are restricted to 25 and 21 industries respectively. Since the effects of MAR-externalities may differ between industries, this could be a source for our contrary results.

Third, the periods under observation differ as well as the time span covered by the growth-variable. By now it is unclear which time span agglomeration economies need to unfold their effects. Estimating models that allow for different time-lags in the analysis clearly would shed some light on this aspect, but in most cases availability of appropriate data with sufficient long-term time horizon are not available for small geographical units, such as cities. Varying general economic conditions might also affect the growth prospects of industries within different periods of time. *Blien et al.* (2006) study a panel, thus pooling data from different years. Industry growth might be correlated with the position in its technology-/industry life cycle. We expect young, emerging industries to have different growth patterns than more mature industries. We would also expect industries that are more reliant on general purpose technologies to be more important for overall urban growth than industries based upon converging technologies. Fourth, *Blien et al.* (2006) study the effect of a change in the specialization on employment growth.

Regarding prior empirical results for Germany or parts of Germany MAR-externalities show different effects on innovation and growth. *Fritsch* and *Slavtchev* (2009) and *Hornych* and *Schwartz* (2009) report an inverted U-shaped relationship between specialization and innovation outcome.

In our analysis we do not find statistically significant effects of Jacobs-externalities. We therefore do not confirm hypothesis 1. Thus, our results for Germany are in opposite to the majority of prior empirical findings. Results of *Beaudry* and *Schiffauerovas'* (2009) work suggest that if employment growth is used as dependent variable, there is a slight tendency to identify urbanization effects rather than localization effects, particularly if a broad industry classification, that is 2-digits, is used; all 11 reviewed studies that use these 2-digits industry classification and that focus simultaneously on NUTS-3 regions find positive Jacobs-externalities. Interestingly, none of these studies applies a more detailed industry classification on this geographical level. Only 10% of reviewed studies find evidence for a negative relationship between Jacobs-externalities and employment growth. Overall, they state (p. 330): 'An overwhelming number of the studies found evidence of some externalities when using this performance indicator, most frequently only Jacobs-externalities, while only a few observed uniquely Marshall effects. Favorable results for both these types of externalities are detected simultaneously in many regressions as well (…)'.

Our results do not necessarily reject effects of Jacobs-externalities in Germany. Possibly, urbanization economies arise only from certain industries, for instance those with a similar technological base and business services (*Forni* and *Paba,* 2002). A consideration of shared competencies and overlapping knowledge bases between different industries, the so-called 'related variety', may lead to different results (*Frenken et al., 2007*; *Boschma* and *Immarino*, 2009). Since – to the best of our knowledge – there is no such analysis that combines measures of specialization, diversification and 'related variety' for German cities or regions, this might indicate an interesting field of future work.

Our findings for city size are in line with the literature. Regional employment has a positive effect on employment growth. In contrast to many studies that did not include a squared term, however, our results, like those of *Viladecans-Marsal* (2004), hint at the existence of agglomeration diseconomies once a city becomes too large. Hypothesis 2 is only partially confirmed.

The results of the separate regressions for free cities, counties, and planning regressions show, that our findings regarding the effects of MAR-externalities do hold for cities and planning regions, but not for counties. However, our results do not indicate that city size influences the effects of agglomeration economies in Germany.

7 Conclusion

What are the implications of our empirical findings for urban economic theory and for practical economic policy? Firstly, the results for Germany that only high levels of specialization have positive impacts on urban growth is quite in line with the findings for some (but not for all) other countries. From a political point of view, the findings could be used to legitimate a very high degree of urban economic specialization. But in the long rung – as could be illustrated with many examples – a highly specialized local economy is a rather risky option (see e. g. *Grabher* 1993).

Secondly, the findings on city size could support the German and European views of the benefits from a polycentric system of urban agglomerations. But the existing city system in Germany is partially the result of interregional support policy, which includes mainly the transfer of resources from the main centers of economic growth to the cities lagging behind. The negative impact of rather big cities on economic growth could also be a result of this policy – without the loss of resources, one could probably expect other results for the variable city size. Future studies could try to separate the (political decision on the) loss of resources from other determinants of urban growth. Another task for future research would be to use data for longer periods of time, as it is possible that time has relevant impacts of agglomeration economies.

Literature

Almeida, P.; Kogut, B. (1999): Localization of Knowledge and the Mobility of Engineers in Regional Networks. Management Science 45, 905-917.

Anselin, L.; Varga, A.; Acs, Z. (1997): Local geographic spillovers between university research and high technology innovations, Journal of Urban Economics 42, 422-448.

Anselin, L. (2006): Spatial Econometrics. In T. C. Mills & K. Patterson, (Eds.), Palgrave Handbook of Econometrics. Basingstoke, Hampshire: Palgrave Macmillan, 901-969.

Arrow, K.J. (1962): The economic implications of learning by doing. The review of economic studies 29, 155-173.

Auerbach, F. (1913): Das Gesetz der Bevölkerungskonzentration, Petermanns Geographische Mitteilungen, 59:74-6.

Audretsch, D.B.; Feldman, M.P. (1996): R&D spillovers and the geography of innovation and production. American Economic Review 86, 630-640.

Baptista, R.; Swann, P. (1998): Do firms in clusters innovate more? Research Policy 27, 525-540.

Beaudry, C.; Schiffauerova, A. (2009): Who's right, Marshall or Jacobs? The localization versus urbanization debate. Research Policy 38, 318-337.

Blien, U.; Suedekum, J.; Wolf, K. (2006): Local employment growth in West Germany: A dynamic panel approach. Labour Economics 13, 445-458.

Blum, U. (2007): Der Einfluß von Führungsfunktionen auf das Regionaleinkommen: eine ökonometrische Analyse deutscher Regionen. Economy in Change, 6/2007, 187-194.

Bode, E. (1998): Lokale Wissensdiffusion und regionale Divergenz in Deutschland, Tübingen: Mohr Siebeck.

Boschma, R.A.; Iammarino, S. (2009): Related Variety, Trade Linkages and Regional Growth. Economic Geography 85, 289-311.

Breschi, S.; Lissoni, F. (2001): Knowledge Spillovers and Local Innovation Systems: A Critical Survey. Industrial and Corporate Change 10, 975-1005.

Cingano, F.; Schivardi, F. (2004): Identifying the Sources of Local Productivity Growth. Journal of the European Economic Association 2, 720-742.

Combes, P. (2000a): Economic Structure and Local Growth: France, 1984-1993. Journal of Urban Economics 47, 329-355.

Combes, P. (2000b): Marshall-Arrow-Romer Externalities and City Growth. CERAS working paper n°99-06.

de Groot, H.L.F.; Poot, J.; Smit, M.J. (2007): Agglomeration, Innovation and Regional Development: Theoretical Perspectives and Meta-Analysis, Tinbergen Institute Discussion Paper, no. TI 2007-079/3, Amsterdam-Rotterdam.

de Lucio, J.J.; Herce, J.A.; Goicolea, A. (2002): The effects of externalities on productivity growth in Spanish industry. Regional Science and Urban Economics 32, 241-258.

de Vor, F.; de Groot, H.L. (2008): Agglomeration Externalities and Localized Employment Growth. Tinbergen Institute Discussion Paper No. 08-033/3.

Dekle, R. (2002): Industrial Concentration and Regional Growth: Evidence from the Prefectures. The Review of Economics and Statistics 84, 310-315.

Feldman, M.P.; Audretsch, D.B. (1999): Innovation in cities: Science-based diversity, specialization and localized competition. European Economic Review 43, 409-429.

Florida, R. (2002): The rise of the creative class – And how it's transforming work, leisure, community, and everyday life. Basic Books: New York.

Folta, T.B.; Cooper, A.C.; Baik, Y.-S. (2006): Geographic cluster size and firm performance. Journal of Business Venturing 21, 217-242.

Forni, M.; Paba, S. (2002): Spillovers and the Growth of Local Industries. The Journal of Industrial Economics 50, 151-171.

Franz, P. (2008): From University Town to Knowledge City: Strategies and Regulatory Hurdles in Germany. in: Yigitcanlar, T., Velibeyoglu, K.; Baum, S. (Eds.), Knowledge-Based Urban Development: Planning and Applications in the Information Era, IGI Global, Hershey/PA, 101-115.

Frenken, K.; van Oort, F.G.; Verburg, T. (2007): Related variety, unrelated variety and regional economic growth. Regional Studies 41, 685-697.

Fritsch, M.; Brixy, U. (2004): The Establishment File of the German Social Insurance Statistic. Journal of Applied Social Science Studies 124, 183-190.

Fritsch, M.; Slavtchev, V. (2009): Determinants of the Efficiency of Regional Innovation Systems. Regional Studies, forthcoming.

Gilbert, B.A.; McDougall, P.P.; Audretsch, D.B. (2008): Clusters, knowledge spillovers and new venture performance: An empirical examination. Journal of Business Venturing 23, 405-422.

Glaeser, E.L.; Kallal, H.D.; Scheinkman, J.A.; Shleifer, A. (1992): Growth in cities. Journal of political economy 100, 1126-1152.

Grabher, G. (1993): The weakness of strong ties: The lock-in of regional development in the Ruhr area. In: G. Grabher (Eds.): The embedded firm: On the socioeconomics of industrial networks. London: Routledge, 255-277.

Henderson, J.V. (1997): Externalities and Industrial Development. Journal of Urban Economics 42(3), 449-470.

Henderson, J.V. (2003): Marshall's scale economies. Journal of Urban Economics 53, 1-28.

Hornych, C.; Schwartz, M. (2009): Industry Concentration and Regional Innovative Performance – Empirical Evidence for Eastern Germany. Post-Communist Economies 21 (4), 513-530.

Isard, W. (1956): Location and Space-economy; a General Theory Relating to Industrial Location, Market Areas, Land Use, Trade, and Urban Structure, Cambridge.

Jacobs, J. (1969): The economy of cities. Random House, New York.

Jaffe, A.B.; Trajtenberg, M.; Henderson, R. (1993): Geographic localization of knowledge spillovers as evidenced by patent citations. Quarterly Journal of Economics 63, 577-598.

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

Lobo, J.; Strumsky, D. (2008): Metropolitan patenting, inventor agglomeration and social networks: A tale of two effects. Journal of Urban Economics 63, 871-884.

Lösch, A. (1940): Die räumliche Ordnung der Wirtschaft – eine Untersuchung über Standort, Wirtschaftsgebiete und internationalen Handel. Fischer, Jena.

Malmberg, A.; Maskell, P. (1997): Towards an Explanation of Regional Specialization and Industry Agglomeration. European Planning Studies 5, 25-42.

Marshall, A. (1920): Principles of Economics. Eighth Edition, McMillan, London, reprinted 1962.

Neffke, F.; Svensson, H., M.; Boschma, R.; Lundquist, K.-J.; Olander, L.-O. (2008): Who Needs Agglomeration? Varying Agglomeration Externalities and the Industry Life Cycle. Papers in Evolutionary Geography 08/08, Utrecht University.

Porter, M.E. (1990): The Competitive Advantage of Nations. MacMillan, London.

Romer, P.M. (1986): Increasing Returns and Long Run Growth. Journal of Political Economy 94, 1002-1037.

Rosenfeld, M.T.W. (2006): Interregional Support Policy for East German Regions. German Annual of Spatial Research and Policy 1, 79-89.

Rosenfeld, M.T.W.; Franz, P.; Heimpold, G. (2007): Economic 'Clusters, in East Germany: Evidence on the Location and Characteristics of Spatially Concentrated Industries Post-Communist Economies 19 (1), 73-92.

Rosenthal, S.S.; Strange, W.C. (2004): Evidence on the nature and sources of agglomeration economies. In: V. Henderson, J. Thisse, (Ed.), Handbook of regional and urban economics: Cities and geography. Amsterdam: Elsevier, 2119-2171.

Saxenian, A. (1991): The origins and dynamics of production networks in Silicon Valley. Research Policy 20, 423-437.

Schwartz, M.; Hornych, C. (2008): Specialization as strategy for business incubators: An assessment of the Central German Multimedia Center, Technovation 28, 436-449.

Scott, A. J. (2000): The Cultural Economy of Cities. Sage: London.

Suedekum, J.; Blien, U. (2005): Local Economic Structure and Industry Development in Germany, 1993-2001. Economics Bulleting 15, 1-8.

Usai, S.; Paci, R. (2003): Externalities and local economic growth in manufacturing industries. In: B. Fingleton; hrsg. European regional growth. Springer, 293-323.

Viladecans-Marsal, E. (2004): Agglomeration economies and industrial location: city-level evidence. Journal of Economic Geography 4(5), 565-582.

Zucker, L.G.; Darby, M.R.; Brewer, M.B. (1998): Intellectual Human Capital and the Birth of U.S. Biotechnology Enterprises. American Economic Review 88 (1), 290-306.

Appendix

Appendix 1:
Dummy variables for the provinces

Abkürzung	Bundesland
d_sh	Schleswig-Holstein
d_ni	Lower Saxony
d_nrw	North Rhine-Westphalia
d_he	Hesse
d_rlp	Rhineland-Palatinate
d_sl	Saarland
d_bw	Baden-Württemberg
d_by	Bavaria
d_bb	Brandenburg
d_mv	Mecklenburg-Western Pomerania
d_sn	Saxony
d_sa	Saxoy-Anhalt
d_th	Thuringia
d_be	Berlin
d_hh	Hamburg
d_hb	Bremen

Source: Authors' illustration.

Appendix 2:
Descriptive statistics (Free cities)

Variable	Mean	Std. Dev.	Min.	Max.
$\hat{L}$	0.005	0.592	-5.589	5.712
LQ	-0.534	1.315	-7.976	4.914
LQ²	2.015	4.661	0.000	63.614
HHI	-0.325	0.317	-2.230	0.091
L_r	10.970	0.922	9.437	13.879
L_r^2	121.195	20.871	89.066	192.621
growth	-0.001	0.045	-0.254	0.290
competition	4.053	0.914	0.020	8.173
fsize	-0.538	1.089	-6.206	3.275
educ	-2.243	0.405	-3.117	-1.366
HQ	0.638	1.621	0.000	8.000
agglomeration	4.358	0.426	3.178	5.136
capital	0.121	0.326	0.000	1.000
L_{ir}	5.913	2.131	0.000	11.871
population	11.809	0.901	10.482	15.037
population²	140.265	21.968	109.878	226.105
density	6.234	0.591	4.686	7.683
LQ_35	-0.169	0.817	-6.236	4.914
LQ_90+	-0.160	0.720	-7.976	3.183
LQ²_35	0.695	2.832	0.000	38.894
LQ²_90+	0.543	2.597	0.000	63.614
HHI_35	-0.121	0.214	-1.395	0.000
HHI_90+	-0.076	0.242	-2.230	0.091

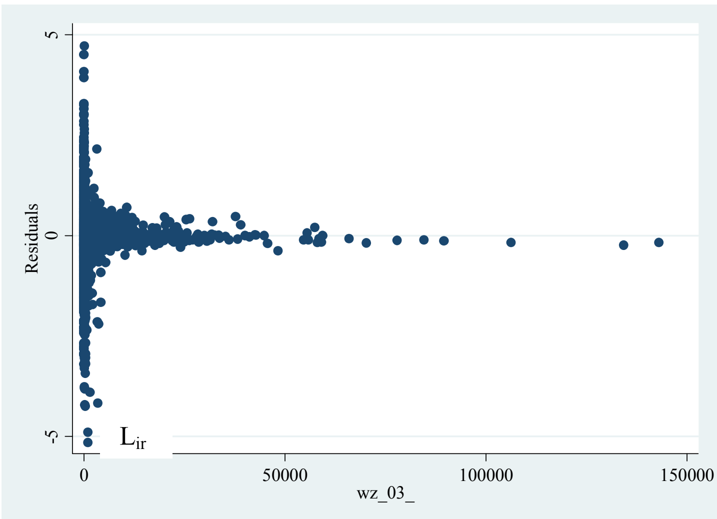
Source: Authors' calculations.

Counties				
Variable	Mean	Std. Dev.	Min.	Max.
$\hat{L}$	0.004	0.538	-5.601	5.703
LQ	-0.548	1.270	-7.831	4.542
LQ^2	1.914	4.301	0.000	61.318
HHI	-0.319	0.238	-2.262	0.129
L_r	10.701	0.696	9.379	13.879
L_r^2	114.986	15.440	87.961	192.621
growth	-0.002	0.043	-0.254	0.290
competition	5.102	0.902	0.262	8.912
fsize	-0.549	1.033	-5.577	3.665
educ	-2.608	0.444	-3.650	-1.366
HQ	0.230	0.918	0.000	8.000
agglomeration	4.551	0.382	3.178	5.429
capital	0.036	0.187	0.000	1.000
L_{ir}	5.696	1.980	0.000	11.871
population	11.897	0.633	10.482	15.037
population²	141.947	15.373	109.878	226.105
density	4.447	1.286	2.216	7.683
LQ_35	0.796	2.949	0.000	44.910
LQ_90+	0.293	1.747	0.000	61.318
LQ²_35	-0.221	0.865	-6.701	4.542
LQ²_90+	-0.087	0.534	-7.831	3.250
HHI_35	-0.144	0.207	-1.512	0.085
HHI_90+	-0.041	0.156	-2.262	0.129
density1	0.339	0.474	0.000	1.000
density2	0.428	0.495	0.000	1.000

Planning regions				
Variable	Mean	Std. Dev.	Min.	Max.
$\hat{L}$	0.012	0.341	-4.041	4.115
LQ	-0.378	1.039	-6.643	3.302
LQ^2	1.221	3.351	0.000	44.125
HHI	-0.169	0.130	-0.744	0.158
L_r	12.303	0.634	11.057	13.934
L_r^2	151.766	15.901	122.261	194.146
growth	0.002	0.024	-0.062	0.084
competition	4.531	0.530	2.479	6.229
fsize	-0.458	1.074	-6.917	2.930
educ	-2.483	0.351	-3.303	-1.619
HQ	1.041	2.329	0.000	12.000
L_{ir}	7.328	1.921	0.000	11.992
population	13.474	0.563	12.368	15.037
population²	181.866	15.408	152.958	226.105
density	4.227	0.867	2.794	7.086
LQ_150	-0.144	0.676	-6.643	3.302
LQ_300+	-0.083	0.506	-6.296	2.114
LQ²_150	0.478	2.199	0.000	44.125
LQ²_300+	0.263	1.601	0.000	39.634
HHI_150	-0.078	0.135	-0.709	0.051
HHI_300+	-0.028	0.075	-0.654	0.158
density1	0.309	0.462	0.000	1.000
density2	0.443	0.497	0.000	1.000

Source: Authors' calculations.

Appendix 3:
Residuals of the unweighted regression plotted against IRC employment



Appendix 4:
White test for homoscedasticity in regression I

H0:	homoscedasticity
H1:	heteroscedasticity
$\chi^2(2)$	299.282
p-value	0.000

Source: authors' calculations

Appendix 5:
Moran's I test for spatial autocorrelation in free cities and planning regions

	Cities (regression II)					Planning regions (regression IV)				
sector	N	I	z	p-value		N	I	z	p-value	
15	116	-0.009	-0.001	0.499		97	-0.105	-1.488	0.068	*
17	95	.	.	.		97	0.005	0.256	0.399	
18	102	.	.	.		97	0.052	0.984	0.163	
19	76	.	.	.		94	.	.	.	
20	109	.	.	.		97	0.038	0.768	0.221	
21	89	.	.	.		96	.	.	.	
22	116	0.136	1.036	0.150		97	-0.120	-1.750	0.040	**
24	108	.	.	.		97	0.117	2.285	0.011	**
25	113	.	.	.		97	0.064	1.206	0.114	
26	116	-0.081	-0.517	0.303		97	0.069	1.236	0.108	
27	98	.	.	.		97	-0.040	-0.468	0.320	
28	116	0.061	0.495	0.310		97	-0.117	-1.679	0.047	**
29	116	-0.308	-2.244	0.012	**	97	0.123	2.092	0.018	**
30	75	.	.	.		91	.	.	.	
31	114	.	.	.		97	0.023	0.551	0.291	
32	102	.	.	.		97	0.119	2.093	0.018	**
33	116	-0.045	-0.264	0.396		97	-0.031	-0.331	0.370	
34	103	.	.	.		97	0.126	2.187	0.014	**
35	83	.	.	.		96	.	.	.	
36	116	-0.097	-0.630	0.264		97	0.027	0.585	0.279	
37	104	.	.	.		97	-0.020	-0.155	0.438	
40	114	.	.	.		97	0.026	0.576	0.282	
41	52	.	.	.		93	.	.	.	
45	116	-0.011	-0.015	0.494		97	0.055	1.027	0.152	
50	116	-0.001	0.053	0.479		97	-0.002	0.146	0.442	
51	116	0.115	0.894	0.186		97	-0.080	-1.095	0.137	
52	116	0.321	2.346	0.009	***	97	-0.044	-0.531	0.298	
55	116	-0.083	-0.528	0.299		97	-0.003	0.109	0.457	
60	116	0.053	0.441	0.330		97	-0.007	0.058	0.477	
61	62	.	.	.		78	.	.	.	
63	116	-0.061	-0.377	0.353		97	-0.118	-1.724	0.042	**
64	116	0.270	2.072	0.019	**	97	0.013	0.366	0.357	
65	116	-0.009	-0.001	0.500		97	0.077	1.383	0.083	*
66	111	.	.	.		97	0.051	1.021	0.154	
67	116	0.016	0.178	0.429		97	0.147	2.484	0.006	***
70	116	0.024	0.232	0.408		97	-0.088	-1.217	0.112	
71	116	-0.096	-0.639	0.261		97	-0.031	-0.324	0.373	
72	116	-0.103	-0.678	0.249		97	0.076	1.355	0.088	*
73	108	.	.	.		97	0.057	1.081	0.140	
74	116	0.046	0.392	0.347		97	0.113	1.925	0.027	**
80	116	0.245	1.811	0.035	**	97	-0.065	-0.908	0.182	
85	116	0.143	1.071	0.142		97	-0.028	-0.275	0.392	
90	114	.	.	.		97	0.069	1.260	0.104	
91	116	-0.001	0.056	0.478		97	0.134	2.265	0.012	**
92	116	-0.072	-0.451	0.326		97	-0.083	-1.144	0.126	
93	116	-0.086	-0.560	0.288		97	0.026	0.584	0.280	

Source: Authors' calculations.

Appendix 6:
Complete regression results for regressions I and II

	(I) Cities			(II) Cities		
	Coeff.	p-value		Coeff.	p-value	
LQ	-0.0150	0.438		-0.0364	0.071	*
LQ²	0.0344	0.000	***	0.0224	0.005	***
HHI	0.0316	0.278		-0.0128	0.589	
L_r	-0.0675	0.784		0.2566	0.144	
L_r^2	0.0036	0.747		-0.0122	0.094	*
growth	-0.5910	0.005	***	-1.6707	0.000	***
competition	-0.0379	0.029	**	-0.0500	0.000	***
fsize	-0.0710	0.004	***	-0.0414	0.138	
educ	-0.0325	0.377		0.0525	0.214	
HQ	-0.0166	0.068	*	-0.0101	0.001	***
agglomeration	-0.0613	0.051	*	0.0081	0.770	
capital	0.0179	0.564		-0.0182	0.208	
constant	0.6767	0.629		-1.0753	0.338	
d_wz15	0.0193	0.792		-0.0106	0.807	
d_wz16	-0.1342	0.495		-0.1779	0.001	***
d_wz17	-0.1219	0.115		-0.2179	0.003	***
d_wz18	-0.2209	0.004	***	-0.0778	0.288	
d_wz19	0.0180	0.831		-0.5108	0.030	**
d_wz20	0.0187	0.803		-0.1867	0.065	*
d_wz21	-0.2523	0.001	***	-0.0184	0.791	
d_wz22	0.0012	0.987		0.0380	0.345	
d_wz23	-0.3090	0.006	***	-0.1743	0.082	*
d_wz24	-0.1970	0.009	***	-0.0525	0.466	
d_wz25	-0.0532	0.470		-0.0844	0.129	
d_wz26	-0.0546	0.462		-0.1339	0.044	**
d_wz27	-0.3176	0.000	***	0.0120	0.836	
d_wz28	-0.0095	0.896		-0.0924	0.078	*
d_wz30	0.0187	0.829		-0.9173	0.130	
d_wz31	-0.1757	0.018	**	-0.0472	0.607	
d_wz32	-0.3204	0.000	***	-0.0416	0.807	
d_wz33	-0.0526	0.475		0.0211	0.643	
d_wz34	-0.3482	0.000	***	0.0069	0.889	
d_wz35	-0.4550	0.000	***	0.0558	0.328	
d_wz36	-0.0600	0.418		-0.0523	0.463	
d_wz37	-0.0738	0.328		-0.1031	0.303	
d_wz40	-0.0434	0.554		-0.0538	0.338	
d_wz41	-0.2892	0.002	***	0.0983	0.790	
d_wz45	0.0621	0.398		0.0192	0.584	
d_wz50	0.0336	0.646		0.0186	0.621	
d_wz51	0.0105	0.886		0.0028	0.943	
d_wz52	0.0272	0.710		0.0309	0.378	
d_wz55	-0.0286	0.695		0.0574	0.151	
d_wz60	-0.0288	0.694		0.0588	0.145	
d_wz61	-0.4469	0.000	***	0.0515	0.548	
d_wz62	-1.1912	0.000	***	-0.3555	0.295	
d_wz63	-0.0158	0.831		-0.1315	0.176	
d_wz64	-0.0901	0.219		0.0487	0.440	
d_wz65	-0.0059	0.936		0.0395	0.305	
d_wz66	-0.3718	0.000	***	0.0455	0.263	
d_wz67	-0.0632	0.396		-0.0191	0.729	
d_wz70	-0.0264	0.719		-0.0486	0.242	
d_wz71	-0.0672	0.358		0.0226	0.618	
d_wz72	0.0143	0.845		-0.0384	0.390	
d_wz73	-0.1424	0.059	*	-0.0846	0.485	
d_wz74	0.0767	0.301		-0.0539	0.150	

Continuation Appendix 6

d_wz80	-0.0303	0.678		0.0601	0.220	
d_wz85	0.0583	0.433		-0.0045	0.899	
d_wz90	0.0088	0.906		-0.0217	0.740	
d_wz91	-0.0342	0.640		0.0446	0.296	
d_wz92	-0.0548	0.454		0.0125	0.732	
d_wz93	0.0300	0.682		-0.0385	0.310	
d_sh	-0.0879	0.107		0.0859	0.013	**
d_nrw	-0.0688	0.069	*	0.0041	0.894	
d_he	-0.0770	0.150		-0.0080	0.809	
d_rlp	-0.0146	0.731		0.0744	0.108	
d_bw	-0.0222	0.639		0.0237	0.481	
d_by	0.0086	0.817		0.1117	0.001	***
d_bb	0.0300	0.620		0.1509	0.024	**
d_mv	0.0149	0.786		0.0293	0.427	
d_sn	-0.0104	0.841		0.0561	0.119	
d_sa	-0.0566	0.358		-0.0416	0.319	
d_th	-0.0436	0.444		0.0144	0.723	
d_be	0.0003	0.998		0.0870	0.063	*
d_hh	0.1019	0.318		0.2264	0.000	***
d_hb	-0.0566	0.423		0.0286	0.459	
N	5,018			5,018		
F(74, 4943)	9.990	0.000		2.390	0.000	
R^2	0.130			0.321		
Adj R^2	0.117					

Source: Authors' calculations.

Appendix 7:
Regression results for independent cities with alternative operationalizations of specialization and city size

	(IIa) Cities			(IIb) Cities			(IIc) Cities		
	Coeff.	p-value		Coeff.	p-value		Coeff.	p-value	
LQ	-0.0349	0.054	*	-0.0434	0.020	**			
LQ^2	0.0211	0.010	**	0.0198	0.009	***			
L_{ir}							-0.0099	0.595	
HHI	-0.0359	0.144		0.0153	0.510		-0.0379	0.125	
density	-0.0705	0.005	***						
population				-0.2616	0.185				
population²				0.0076	0.337				
L_r							0.2705	0.121	
L_r^2							-0.0125	0.095	*
growth	-1.6644	0.000	***	-1.7666	0.000	***	-1.5274	0.000	***
competition	-0.0495	0.000	***	-0.0545	0.000	***	-0.0534	0.000	***
fsize	-0.0330	0.237		-0.0346	0.187		-0.0248	0.376	
educ	0.0530	0.147		0.0648	0.075	*	0.0487	0.281	
HQ	-0.0118	0.001	***	-0.0105	0.002	***	-0.0100	0.002	***
agglomeration	-0.0018	0.945		-0.0256	0.346		-0.0089	0.764	
capital	-0.0085	0.612		-0.0161	0.232		-0.0179	0.212	
constant	0.7400	0.004	***	2.5116	0.047	**	-0.9978	0.376	
d_wz15	-0.0207	0.639		-0.0054	0.895		-0.0214	0.635	
d_wz16	-0.1908	0.001	***	-0.1567	0.002	***	-0.1560	0.076	*
d_wz17	-0.2282	0.002	***	-0.2068	0.002	***	-0.1841	0.009	***
d_wz18	-0.0950	0.204		-0.0643	0.361		-0.1005	0.283	
d_wz19	-0.5386	0.025	**	-0.5040	0.031	**	-0.3004	0.236	
d_wz20	-0.2136	0.036	**	-0.1856	0.052	*	-0.2051	0.113	
d_wz21	-0.0262	0.709		-0.0093	0.890		-0.0491	0.533	
d_wz22	0.0291	0.476		0.0482	0.197		0.0235	0.563	
d_wz23	-0.1848	0.063	*	-0.1557	0.122		-0.1918	0.102	

Continuation Appendix 7

d_wz24	-0.0470	0.527		-0.0368	0.601		-0.0194	0.775	
d_wz25	-0.0993	0.078	*	-0.0819	0.129		-0.1093	0.093	*
d_wz26	-0.1436	0.031	**	-0.1245	0.043	**	-0.1399	0.058	*
d_wz27	-0.0057	0.922		0.0519	0.390		0.0379	0.558	
d_wz28	-0.1003	0.063	*	-0.0804	0.102		-0.0824	0.111	
d_wz30	-0.9316	0.127		-0.9011	0.140		-0.9401	0.132	
d_wz31	-0.0582	0.542		-0.0471	0.593		-0.0601	0.549	
d_wz32	-0.0522	0.757		-0.0348	0.839		-0.0619	0.718	
d_wz33	0.0098	0.831		0.0293	0.503		0.0050	0.916	
d_wz34	-0.0146	0.774		0.0130	0.783		0.0071	0.890	
d_wz35	0.0480	0.366		0.0683	0.223		0.0257	0.671	
d_wz36	-0.0657	0.379		-0.0443	0.522		-0.0669	0.350	
d_wz37	-0.0766	0.443		-0.0900	0.376		-0.1399	0.224	
d_wz40	-0.0597	0.296		-0.0441	0.415		-0.0697	0.222	
d_wz41	0.2173	0.482		0.1060	0.773		0.0498	0.893	
d_wz45	0.0106	0.768		0.0301	0.346		0.0193	0.618	
d_wz50	0.0106	0.782		0.0258	0.459		0.0149	0.700	
d_wz51	-0.0056	0.888		0.0108	0.761		-0.0006	0.989	
d_wz52	0.0218	0.544		0.0402	0.210		0.0357	0.395	
d_wz55	0.0472	0.250		0.0644	0.088	*	0.0473	0.238	
d_wz60	0.0489	0.221		0.0700	0.064	*	0.0465	0.235	
d_wz61	0.0428	0.624		0.0748	0.365		0.0349	0.694	
d_wz62	-0.3696	0.283		-0.3489	0.303		-0.3864	0.267	
d_wz63	-0.1431	0.156		-0.1198	0.197		-0.1499	0.137	
d_wz64	0.0475	0.452		0.0567	0.352		0.0363	0.573	
d_wz65	0.0306	0.438		0.0485	0.174		0.0311	0.430	
d_wz66	0.0268	0.515		0.0522	0.167		0.0200	0.630	
d_wz67	-0.0316	0.574		-0.0142	0.791		-0.0530	0.424	
d_wz70	-0.0573	0.174		-0.0397	0.305		-0.0669	0.116	
d_wz71	0.0113	0.809		0.0307	0.466		-0.0152	0.813	
d_wz72	-0.0482	0.296		-0.0298	0.473		-0.0538	0.246	
d_wz73	-0.0967	0.431		-0.0766	0.521		-0.1108	0.356	
d_wz74	-0.0611	0.107		-0.0489	0.159		-0.0428	0.384	
d_wz80	0.0548	0.269		0.0685	0.138		0.0595	0.244	
d_wz85	-0.0132	0.715		0.0036	0.912		0.0062	0.896	
d_wz90	-0.0329	0.616		-0.0111	0.861		-0.0473	0.502	
d_wz91	0.0357	0.406		0.0515	0.200		0.0333	0.426	
d_wz92	0.0004	0.990		0.0192	0.570		-0.0046	0.901	
d_wz93	-0.0479	0.221		-0.0317	0.371		-0.0564	0.193	
d_sh	0.1092	0.002	***	0.1052	0.002	***	0.0551	0.122	
d_nrw	0.0241	0.449		0.0177	0.567		-0.0333	0.308	
d_he	0.0178	0.596		-0.0237	0.469		-0.0552	0.133	
d_rlp	0.1047	0.015	**	0.0563	0.199		0.0608	0.205	
d_bw	0.0613	0.080	*	0.0084	0.800		-0.0200	0.583	
d_by	0.1436	0.000	***	0.1149	0.001	***	0.0824	0.026	**
d_bb	0.1146	0.089	*	0.1372	0.040	**	0.1013	0.137	
d_mv	0.0326	0.361		0.0226	0.563		-0.0001	0.997	
d_sn	0.0530	0.131		0.0763	0.030	**	0.0146	0.705	
d_sa				-0.0297	0.482		-0.0831	0.065	*
d_th	-0.0057	0.890		0.0092	0.825		-0.0164	0.709	
d_be	0.0306	0.415		0.0963	0.153		0.0501	0.302	
d_hh	0.1867	0.000	***	0.2319	0.000	***	0.1835	0.000	***
d_hb	0.0246	0.554		0.0328	0.404		-0.0126	0.751	
N	4,885			5,018			5,018		
F	2.310	0.000		2.540	0.000		2.080	0.000	
R^2	0.328			0.330			0.311		

Source: Authors' calculations.

Appendix 8:
Correlation coefficients (Free cities)

	$\hat{L}$	LQ	LQ²	HHI	L_r	L_r^2	Growth	Comp.	fsize
$\hat{L}$	1.000								
LQ	-0.234	1.000							
LQ²	0.248	-0.690	1.000						
HHI	-0.019	0.111	-0.070	1.000					
L_r	-0.023	0.019	-0.058	0.243	1.000				
L_r^2	-0.023	0.021	-0.059	0.245	0.998	1.000			
growth	-0.028	0.022	0.006	0.034	-0.070	-0.067	1.000		
competition	-0.028	0.042	-0.066	-0.229	-0.498	-0.501	0.014	1.000	
fsize	-0.233	0.873	-0.654	0.033	0.159	0.157	0.013	0.220	1.000
educ	-0.020	-0.031	-0.014	0.063	0.589	0.586	-0.018	-0.262	0.066
HQ	-0.026	0.025	-0.055	0.159	0.687	0.710	-0.093	-0.342	0.110
agglomeration	-0.008	-0.007	0.030	-0.129	-0.595	-0.592	0.165	0.285	-0.094
capital	-0.007	0.003	-0.023	0.187	0.500	0.512	0.070	-0.272	0.047
L_{ir}	-0.158	0.681	-0.555	0.150	0.432	0.432	-0.037	0.069	0.702
population	-0.020	0.035	-0.065	0.308	0.962	0.963	-0.181	-0.509	0.136
population²	-0.020	0.036	-0.067	0.308	0.961	0.964	-0.171	-0.510	0.135
density	-0.031	0.001	-0.036	0.121	0.753	0.746	-0.054	-0.334	0.147
LQ_35	-0.138	0.561	-0.348	0.030	0.206	0.198	-0.034	-0.079	0.539
LQ_90+	-0.124	0.479	-0.345	0.047	-0.224	-0.222	0.034	0.160	0.375
LQ²_35	0.126	-0.339	0.542	-0.031	-0.259	-0.249	0.048	0.076	-0.381
LQ²_90+	0.121	-0.356	0.468	-0.002	0.216	0.213	-0.028	-0.160	-0.283
HHI_35	-0.004	-0.003	-0.017	0.318	0.603	0.577	-0.117	-0.295	0.090
HHI_90+	-0.022	0.072	-0.023	0.504	-0.261	-0.255	0.099	0.054	-0.049

	educ	HQ	agglo.	Capital	L_{ir}	pop.	pop.²	density	LQ_35
educ	1.000								
HQ	0.380	1.000							
agglomeration	-0.274	-0.478	1.000						
capital	0.413	0.458	-0.210	1.000					
L_{ir}	0.228	0.306	-0.255	0.206	1.000				
population	0.523	0.673	-0.620	0.476	0.422	1.000			
population²	0.517	0.693	-0.612	0.487	0.423	0.999	1.000		
density	0.427	0.529	-0.500	0.299	0.319	0.662	0.657	1.000	
LQ_35	0.120	0.080	-0.128	0.072	0.431	0.196	0.189	0.190	1.000
LQ_90+	-0.164	-0.121	0.143	-0.123	0.273	-0.197	-0.194	-0.177	-0.041
LQ²_35	-0.176	-0.100	0.146	-0.090	-0.359	-0.243	-0.234	-0.228	-0.660
LQ²_90+	0.157	0.099	-0.143	0.115	-0.209	0.193	0.190	0.168	0.041
HHI_35	0.334	0.222	-0.413	0.202	0.244	0.575	0.553	0.561	0.232
HHI_90+	-0.161	-0.131	0.214	-0.062	-0.079	-0.199	-0.194	-0.204	-0.059

	LQ_90+	LQ²_35	LQ²_90+	HHI_35	HHI_90+
LQ_90+	1.000				
LQ²_35	0.052	1.000			
LQ²_90+	-0.771	-0.051	1.000		
HHI_35	-0.115	-0.280	0.114	1.000	
HHI_90+	0.288	0.073	-0.225	-0.164	1.000

Source: Authors' calculations.

Counties

	$\hat{L}$	LQ	LQ²	HHI	L_r	L_r^2	growth	comp.	fsize
$\hat{L}$	1.000								
LQ	-0.233	1.000							
LQ²	0.253	-0.723	1.000						
HHI	0.004	0.076	-0.057	1.000					
L_r	-0.011	0.012	-0.023	0.185	1.000				
L_r^2	-0.012	0.012	-0.023	0.184	0.999	1.000			
growth	-0.004	0.013	0.004	0.082	0.041	0.036	1.000		
competition	-0.011	0.031	-0.038	-0.189	-0.339	-0.338	-0.022	1.000	
fsize	-0.222	0.849	-0.650	-0.004	0.174	0.174	0.023	0.278	1.000
educ	-0.029	-0.008	0.007	-0.021	0.504	0.506	-0.070	-0.069	0.134
HQ	-0.021	0.005	-0.009	0.036	0.573	0.599	-0.016	-0.155	0.115
agglomeration	0.004	-0.008	0.024	-0.105	-0.557	-0.558	-0.010	0.144	-0.121
capital	-0.013	-0.005	0.010	0.074	0.436	0.455	0.029	-0.118	0.080
density1	-0.016	0.011	-0.023	0.085	0.400	0.402	-0.083	-0.148	0.051
density2	0.019	-0.007	0.007	0.013	-0.101	-0.109	0.032	0.042	-0.010
L_{ir}	-0.142	0.735	-0.597	0.094	0.352	0.352	0.017	0.153	0.734
population	-0.003	0.031	-0.044	0.305	0.906	0.904	-0.027	-0.398	0.101
population²	-0.003	0.031	-0.044	0.301	0.911	0.911	-0.026	-0.396	0.104
density	-0.031	-0.021	0.016	-0.100	0.559	0.563	0.037	-0.018	0.200
LQ_35	-0.149	0.597	-0.433	0.041	0.220	0.212	0.025	-0.060	0.550
LQ_90+	-0.081	0.369	-0.245	0.013	-0.257	-0.258	0.020	0.084	0.249
LQ²_35	0.150	-0.421	0.601	-0.044	-0.237	-0.229	-0.024	0.069	-0.424
LQ²_90+	0.091	-0.260	0.340	0.007	0.277	0.279	-0.007	-0.120	-0.169
HHI_35	0.012	0.008	-0.020	0.352	0.614	0.591	0.079	-0.250	0.081
HHI_90+	0.002	0.031	-0.014	0.337	-0.418	-0.420	0.086	0.077	-0.095

	educ	HQ	agglo.	Capital	dens1	dens2	L_{ir}	pop.	pop.²
educ	1.000								
HQ	0.366	1.000							
agglomeration	-0.355	-0.400	1.000						
capital	0.338	0.468	-0.218	1.000					
density1	0.385	0.275	-0.556	0.156	1.000				
density2	-0.154	-0.151	0.176	-0.089	-0.640	1.000			
L_{ir}	0.165	0.201	-0.198	0.143	0.142	-0.035	1.000		
population	0.306	0.499	-0.513	0.350	0.427	-0.103	0.326	1.000	
population²	0.313	0.521	-0.516	0.366	0.430	-0.112	0.328	0.999	1.000
density	0.609	0.400	-0.515	0.328	0.342	-0.110	0.190	0.260	0.276
LQ_35	0.104	0.058	-0.120	0.048	0.078	0.008	0.494	0.204	0.200
LQ_90+	-0.153	-0.148	0.153	-0.135	-0.095	0.024	0.201	-0.213	-0.215
LQ²_35	-0.116	-0.063	0.137	-0.052	-0.090	-0.009	-0.409	-0.222	-0.217
LQ²_90+	0.170	0.159	-0.168	0.157	0.099	-0.026	-0.144	0.229	0.231
HHI_35	0.235	0.150	-0.341	0.129	0.223	0.031	0.209	0.594	0.579
HHI_90+	-0.267	-0.261	0.275	-0.167	-0.166	0.045	-0.131	-0.313	-0.316

	density	LQ_35	LQ_90+	LQ²_35	LQ²_90+	HHI_35	HHI_90+
density	1.000						
LQ_35	0.103	1.000					
LQ_90+	-0.183	-0.039	1.000				
LQ²_35	-0.110	-0.741	0.042	1.000			
LQ²_90+	0.199	0.041	-0.753	-0.045	1.000		
HHI_35	0.241	0.266	-0.104	-0.287	0.111	1.000	
HHI_90+	-0.338	-0.066	0.301	0.071	-0.289	-0.178	1.000

Source: Authors' calculations.

Planning regions

	$\hat{L}$	LQ	LQ²	HHI	L_r	L_r²	growth	Comp.	fsize
$\hat{L}$	1.000								
LQ	-0.195	1.000							
LQ²	0.201	-0.714	1.000						
HHI	-0.007	0.034	-0.043	1.000					
L_r	-0.047	0.052	-0.063	0.361	1.000				
L_r²	-0.047	0.052	-0.062	0.356	1.000	1.000			
growth	0.010	0.027	-0.018	0.115	-0.111	-0.115	1.000		
competition	0.040	-0.022	-0.006	-0.400	-0.686	-0.689	0.176	1.000	
fsize	-0.191	0.984	-0.721	0.081	0.146	0.145	0.037	-0.010	1.000
educ	-0.022	0.030	-0.029	0.179	0.595	0.597	-0.290	-0.464	0.071
HQ	-0.039	0.038	-0.038	0.217	0.737	0.750	-0.105	-0.474	0.109
density1	-0.043	0.030	-0.043	0.192	0.654	0.655	-0.192	-0.473	0.083
density2	0.036	-0.013	0.017	0.045	-0.203	-0.213	0.069	0.260	-0.001
L_{ir}	-0.103	0.702	-0.608	0.136	0.358	0.358	-0.026	-0.187	0.743
population	-0.050	0.053	-0.066	0.321	0.983	0.983	-0.167	-0.729	0.131
population²	-0.050	0.053	-0.066	0.317	0.983	0.984	-0.170	-0.731	0.130
density	-0.060	0.047	-0.057	0.320	0.815	0.815	-0.102	-0.430	0.155
LQ_150	-0.143	0.598	-0.441	0.139	0.201	0.197	0.034	-0.128	0.606
LQ_300+	-0.035	0.454	-0.302	-0.068	-0.205	-0.205	0.040	0.157	0.425
LQ²_150	0.160	-0.425	0.615	-0.155	-0.211	-0.206	-0.027	0.117	-0.448
LQ²_300+	0.018	-0.317	0.428	0.067	0.223	0.223	-0.028	-0.193	-0.301
HHI_150	-0.011	0.051	-0.068	0.641	0.557	0.544	0.058	-0.379	0.123
HHI_300+	0.019	-0.017	0.017	0.185	-0.504	-0.506	0.217	0.304	-0.066

	educ	HQ	dens1	dens2	L_{ir}	pop.	pop.²	density	LQ_150
educ	1.000								
HQ	0.507	1.000							
density1	0.570	0.529	1.000						
density2	-0.161	-0.284	-0.618	1.000					
L_{ir}	0.204	0.264	0.227	-0.069	1.000				
population	0.564	0.713	0.673	-0.223	0.351	1.000			
population²	0.565	0.723	0.673	-0.229	0.351	1.000	1.000		
density	0.526	0.651	0.674	-0.186	0.300	0.782	0.784	1.000	
LQ_150	0.107	0.091	0.082	0.055	0.443	0.195	0.192	0.169	1.000
LQ_300+	-0.117	-0.135	-0.146	0.060	0.271	-0.204	-0.204	-0.160	-0.034
LQ²_150	-0.104	-0.095	-0.086	-0.056	-0.386	-0.204	-0.201	-0.181	-0.735
LQ²_300+	0.137	0.154	0.163	-0.071	-0.223	0.219	0.219	0.175	0.036
HHI_150	0.302	0.255	0.244	0.193	0.212	0.536	0.527	0.485	0.273
HHI_300+	-0.289	-0.348	-0.292	0.094	-0.178	-0.528	-0.530	-0.420	-0.080

	LQ_300+	LQ²_150	LQ²_300+	HHI_150	HHI_300+
LQ_300+	1.000				
LQ²_150	0.036	1.000			
LQ²_300+	-0.731	-0.038	1.000		
HHI_150	-0.094	-0.295	0.099	1.000	
HHI_300+	0.178	0.084	-0.197	-0.218	1.000

Source: Authors' calculations.

Appendix 9:
Variance inflation factors of regressions I to IV

	(I) Cities VIF	(II) Cities VIF	(III) Counties VIF	(IV) Planning regions VIF
Lr²	907.94	3955.48	3675.94	3495.89
Lr	855.91	3590.74	3382.62	3445.26
d_be	1.90	37.35	11.61	5.37
d_wz74	2.01	31.62	11.18	6.76
d_wz85	2.02	24.78	9.99	6.82
d_hh	1.63	19.14	5.30	2.78
fsize	10.61	16.14	12.90	166.48
LQ	9.74	15.26	11.08	152.62
d_wz52	1.96	12.74	5.46	4.09
d_by	3.74	12.70	4.81	5.31
d_nrw	3.82	12.46	4.74	5.46
HQ	3.86	11.99	11.63	4.42
LQ²	2.33	11.38	7.78	4.53
d_he	1.96	10.49	3.14	3.57
d_bw	2.67	7.44	3.02	3.79
d_wz34	1.99	7.42	4.42	2.95
agglomeration	2.91	7.28	4.64	
d_wz51	1.98	7.19	3.52	2.92
competition	4.10	6.49	6.09	22.79
educ	3.59	6.26	5.93	9.56
d_wz80	1.96	5.92	2.72	1.91
capital	1.76	5.90	5.65	
d_wz45	1.98	5.83	3.42	3.04
d_wz65	1.99	5.75	2.69	1.77
d_sn	2.46	4.24	1.84	2.62
d_wz63	2.00	4.03	2.07	1.56
d_wz24	1.93	3.93	2.31	1.52
d_wz55	1.96	3.81	1.96	1.54
d_hb	1.38	3.26	1.30	1.34
growth	1.40	3.09	1.97	3.06
d_wz60	1.96	3.01	1.63	1.28
d_wz91	1.96	2.85	1.59	1.25
d_rlp	2.63	2.79	1.59	1.85
d_wz66	1.95	2.76	1.63	1.19
d_wz92	1.96	2.59	1.51	1.19
d_wz31	2.00	2.55	1.61	1.30
HHI	1.34	2.34	1.88	3.10
d_wz72	1.97	2.33	1.51	1.26
d_wz70	1.97	1.95	1.30	1.11
d_wz22	1.97	1.84	1.28	1.15
d_wz50	1.96	1.83	1.39	1.33
d_sa	1.59	1.56	1.24	1.47
d_wz27	1.84	1.56	1.29	1.22
d_sh	1.63	1.46	1.23	1.39
d_th	2.46	1.45	1.29	1.73
d_wz28	1.95	1.42	1.65	1.57
d_wz33	1.98	1.41	1.21	1.16
d_wz35	1.79	1.41	1.16	1.07
d_wz15	1.96	1.39	1.33	1.31
d_wz64	1.96	1.38	1.14	1.07
d_bb	1.93	1.34	1.28	1.49
d_mv	2.27	1.32	1.26	1.53
d_wz32	1.89	1.31	1.12	1.05
d_wz73	1.94	1.31	1.12	1.05
d_wz93	1.96	1.26	1.10	1.06
d_wz40	1.94	1.21	1.09	1.05
d_wz67	2.03	1.12	1.04	1.02

Continuation Appendix 9

d_wz90	1.96	1.10	1.04	1.02
d_wz25	1.94	1.05	1.16	1.12
d_wz26	2.02	1.05	1.06	1.05
d_wz23	1.32	1.04	1.02	1.04
d_wz61	1.60	1.04	1.02	1.02
d_wz62	1.29	1.04	1.04	1.01
d_wz30	1.79	1.03	1.05	1.03
d_wz36	2.01	1.03	1.08	1.07
d_wz17	1.80	1.02	1.04	1.05
d_wz21	1.76	1.02	1.04	1.02
d_wz71	1.96	1.02	1.01	1.01
d_wz16	1.12	1.01	1.00	1.01
d_wz18	1.93	1.01	1.01	1.01
d_wz19	1.71	1.01	1.01	1.01
d_wz20	1.94	1.01	1.02	1.02
d_wz41	1.50	1.01	1.01	1.00
d_wz37	1.88	1.00	1.00	1.00
density1			9.62	14.36
density2			6.50	8.08
averge	26.05	106.98	95.81	100.62

Source: Authors' calculations.

Appendix 10:
F-test for joint significance of variables in regressions II, III and IV - Test for joint significance of the variables for regional employment

H_0: $\beta_{Lr} = 0$ $\beta_{Lr^2} = 0$ H_1: $\beta_{Lr} \neq 0$ and/or $\beta_{Lr^2} \neq 0$	Cities: F(2,4943) p-value Counties: F(2,19010) p-value Planning regions: F(2,4496) p-value	 2.590 0.075 2.500 0.082 4.310 0.014

Source: Authors' calculations.

Test for joint significance of the variables for specialization

H_0: $\beta_{LQ} = 0$, $\beta_{LQ^2} = 0$ H_1: $\beta_{LQ} \neq 0$ and/or $\beta_{LQ^2} \neq 0$	Cities: F(2,4943) 4.310 p-value 0.014 Counties: F(2,19010) 2.260 p-value 0.104 Planning regions: F(2,4496) 2.670 p-value 0.069

Source: Authors' calculations.

Appendix 11:
Complete results of regressions III and IV

	(III) Counties			(IV) Planning regions		
	Coeff.	p-value		Coeff.	p-value	
LQ	-0.0314	0.049	**	-0.0479	0.299	
LQ²	0.0081	0.156		0.0188	0.028	**
HHI	0.0042	0.816		0.0340	0.429	
L_r	0.3317	0.031	**	0.2874	0.073	*
L_r^2	-0.0146	0.027	**	-0.0131	0.040	**
growth	-1.0857	0.000	***	-0.7713	0.000	***
competition	-0.0366	0.000	***	-0.0381	0.042	**
fsize	-0.0073	0.744		0.0015	0.975	
educ	-0.0092	0.643		0.0169	0.382	
HQ	-0.0047	0.093	*	-0.0016	0.374	
agglomeration	-0.0233	0.202				
capital	-0.0068	0.559				
density1	-0.0487	0.007	***	-0.0058	0.764	
density2	0.0021	0.887		0.0070	0.610	
Constant	-1.6055	0.069	*	-1.3485	0.181	
d_wz15	0.0180	0.459		0.0232	0.224	
d_wz16	-0.0854	0.131		-0.0603	0.395	
d_wz17	-0.0590	0.159		-0.0235	0.507	
d_wz18	0.0045	0.942		0.0653	0.265	
d_wz19	0.0067	0.976		0.0041	0.978	
d_wz20	-0.0473	0.135		-0.0236	0.561	
d_wz21	-0.0372	0.309		-0.0033	0.903	
d_wz22	0.0347	0.197		0.0373	0.107	
d_wz23	-0.1843	0.043	**	-0.0958	0.285	
d_wz24	-0.0635	0.218		-0.0207	0.715	
d_wz25	-0.0146	0.522		0.0079	0.697	
d_wz26	-0.0523	0.118		-0.0034	0.888	
d_wz27	0.0229	0.481		0.0430	0.126	
d_wz28	-0.0168	0.437		0.0029	0.896	
d_wz30	-0.2920	0.243		-0.2175	0.015	**
d_wz31	-0.0591	0.449		-0.0004	0.995	
d_wz32	-0.1158	0.402		-0.0086	0.938	
d_wz33	0.0016	0.956		0.0032	0.916	
d_wz34	-0.0423	0.330		0.0055	0.816	
d_wz35	0.0468	0.330		0.0666	0.076	*
d_wz36	-0.0221	0.583		0.0322	0.277	
d_wz37	-0.2329	0.033	**	-0.0713	0.361	

Continuation Appendix 11

d_wz40	-0.0137	0.761		0.0037	0.907	
d_wz41	0.0380	0.898		-0.0365	0.854	
d_wz45	0.0246	0.176		0.0284	0.118	
d_wz50	0.0306	0.124		0.0256	0.160	
d_wz51	0.0077	0.708		0.0365	0.045	**
d_wz52	0.0344	0.055	*	0.0298	0.083	*
d_wz55	0.0896	0.002	***	0.0651	0.013	**
d_wz60	0.0463	0.053	*	0.0337	0.082	*
d_wz61	0.1458	0.113		0.1757	0.091	*
d_wz62	-0.2645	0.219		-0.1261	0.616	
d_wz63	-0.1273	0.179		-0.0746	0.328	
d_wz64	0.0912	0.062	*	0.0755	0.064	*
d_wz65	0.0698	0.024	**	0.0827	0.016	**
d_wz66	0.0188	0.503		0.0797	0.000	***
d_wz67	-0.0290	0.530		0.0488	0.234	
d_wz70	-0.0393	0.135		0.0262	0.537	
d_wz71	0.0051	0.886		0.0334	0.229	
d_wz72	-0.0358	0.347		0.0275	0.174	
d_wz73	-0.0872	0.354		0.0377	0.466	
d_wz74	-0.0233	0.268		-0.0011	0.950	
d_wz80	0.0641	0.097	*	0.0445	0.129	
d_wz85	0.0228	0.201		0.0243	0.139	
d_wz90	-0.0323	0.525		-0.0282	0.559	
d_wz91	0.0715	0.016	**	0.0685	0.013	**
d_wz92	0.0372	0.066	*	0.0599	0.002	***
d_wz93	-0.0014	0.946		0.0236	0.336	
d_sh	0.0169	0.276		0.0105	0.400	
d_nrw	-0.0113	0.380		0.0062	0.544	
d_he	-0.0335	0.052	*	-0.0218	0.086	*
d_rlp	0.0471	0.106		0.0249	0.077	*
d_bw	0.0035	0.805		0.0287	0.011	**
d_by	0.0810	0.000	***	0.0583	0.000	***
d_bb	0.0373	0.237		-0.0201	0.359	
d_mv	-0.0083	0.750		-0.0431	0.023	**
d_sn	0.0448	0.036	**	-0.0227	0.150	
d_sa	-0.0542	0.043	**	-0.0363	0.030	**
d_th	-0.0113	0.650		-0.0548	0.004	***
d_be	0.0583	0.025	**	0.0386	0.019	**
d_hh	0.1399	0.000	***	0.1008	0.000	***
d_hb	-0.0018	0.926		-0.0068	0.792	
N	19,087			4,571		
F	2.860	0.000		2.950	0.000	
R^2	0.208			0.248		

Source: Authors' calculations.

Appendix 12:
Complete results of regressions V, VI and VII

	(Va) Manufacturing Cities			(VIa) Manufacturing Counties			(VIIa) Manufacturing planning regions		
	Coeff.	p-value		Coeff.	p-value		Coeff.	p-value	
LQ	-0.0082	0.842		0.0010	0.971		-0.2300	0.072	*
LQ²	0.0309	0.005	***	0.0019	0.754		0.0230	0.037	**
HHI	-0.1386	0.158		-0.0526	0.367		-0.0753	0.531	
L_r	-0.0058	0.992		0.5838	0.072	*	0.8626	0.018	**
L_r^2	0.0020	0.933		-0.0246	0.084	*	-0.0398	0.007	***
growth	-2.4584	0.000	***	-1.9446	0.000	***	-1.1165	0.023	**
competition	0.0255	0.477		-0.0204	0.400		-0.1525	0.000	***
fsize	-0.0528	0.220		0.0001	0.998		0.1880	0.137	
educ	-0.0017	0.989		-0.0677	0.315		-0.0069	0.891	
HQ	-0.0164	0.337		-0.0042	0.727		0.0001	0.983	
agglomeration	0.0761	0.363		-0.0315	0.620				
capital	0.0045	0.953		0.0000	1.000				
density1				0.0679	0.086	*	0.0610	0.210	
density2				0.0435	0.260		0.0784	0.052	*
constant	-0.7698	0.824		-3.4316	0.076	*	-4.0196	0.078	*
city				-0.0053	0.863				
d_wz15	-0.0083	0.858		0.0064	0.816		0.0210	0.219	
d_wz16	-0.1652	0.047	**	-0.0916	0.307		-0.0191	0.875	
d_wz17	-0.1920	0.033	**	-0.0712	0.177		-0.0516	0.210	
d_wz18	-0.0447	0.612		-0.0291	0.679		0.0327	0.554	
d_wz19	-0.5583	0.027	**	-0.0240	0.914		-0.0384	0.796	
d_wz20	-0.1829	0.088	*	-0.0618	0.062	*	-0.0411	0.294	
d_wz21	0.0169	0.810		-0.0471	0.298		-0.0013	0.961	
d_wz22	0.0234	0.618		0.0113	0.758		0.0492	0.025	**
d_wz23	-0.0852	0.462		-0.1854	0.119		-0.0674	0.554	
d_wz24	0.0479	0.373		-0.0426	0.353		0.0132	0.789	
d_wz25	-0.0443	0.473		-0.0337	0.224		0.0088	0.676	
d_wz26	-0.1016	0.166		-0.0991	0.018	**	-0.0374	0.114	
d_wz27	0.0520	0.407		0.0100	0.837		0.0514	0.104	
d_wz28	-0.0569	0.256		-0.0229	0.355		0.0072	0.640	
d_wz30	-0.9190	0.130		-0.3325	0.208		-0.2319	0.008	***
d_wz31	-0.1099	0.285		-0.1118	0.175		-0.0202	0.682	
d_wz32	-0.0545	0.755		-0.1590	0.249		-0.0078	0.940	
d_wz33	0.0167	0.727		-0.0149	0.634		-0.0017	0.953	
d_wz34	-0.0099	0.853		-0.0887	0.178		0.0223	0.307	
d_wz35	0.0437	0.449		-0.0018	0.978		0.0639	0.096	*
d_wz36	-0.0553	0.485		-0.0505	0.413		0.0130	0.700	
d_sh	-0.0090	0.915		-0.0137	0.762		-0.0084	0.802	
d_nrw	-0.0067	0.921		-0.0652	0.062	*	-0.0276	0.330	
d_he	0.0609	0.465		-0.0509	0.124		-0.0190	0.533	
d_rlp	0.0341	0.715		0.0290	0.661		0.0935	0.010	**
d_bw	0.1883	0.014	**	-0.0011	0.977		0.0816	0.009	***
d_by	0.2632	0.000	***	0.1647	0.000	***	0.1633	0.000	***
d_bb	0.2179	0.026	**	0.0972	0.133		0.0586	0.213	
d_mv	0.0725	0.455		0.1357	0.026	**	0.1031	0.082	*
d_sn	0.1974	0.139		0.1417	0.039	**	0.0574	0.186	
d_sa	-0.2637	0.368		0.0454	0.521		0.0705	0.069	*
d_th	-0.0495	0.803		0.0675	0.380		0.0153	0.744	
d_be	0.1453	0.327		0.1030	0.306		0.0677	0.179	
d_hh	0.3584	0.005	***	0.1947	0.030	**	0.1261	0.009	***
d_hb	0.0876	0.448		-0.0715	0.184		-0.0751	0.071	*
N	2,120			8,139			2,016		
F	4.500	0.000		6.600	0.000		7.190	0.000	
R²	0.323			0.171			0.222		

	(Vb) services cities			(VIb) services counties			(VIIb) services planning regions		
	Coeff.	p-value		Coeff.	p-value		Coeff.	p-value	
LQ	0.018	0.522		-0.0228	0.170		-0.0019	0.966	
LQ²	-0.068	0.021	**	-0.0129	0.340		0.0156	0.594	
HHI	-0.032	0.246		0.0148	0.404		0.0723	0.103	
L_r	0.098	0.538		0.2180	0.073	*	0.2596	0.113	
L_r^2	-0.005	0.407		-0.0099	0.062	*	-0.0103	0.113	
growth	-1.215	0.000	***	-0.5285	0.001	***	-0.5944	0.004	***
competition	-0.054	0.000	***	-0.0394	0.000	***	0.0039	0.834	
fsize	-0.094	0.015	**	-0.0348	0.221		-0.0643	0.164	
educ	0.064	0.067	*	0.0141	0.437		0.0138	0.467	
HQ	-0.012	0.000	***	-0.0064	0.007	***	-0.0016	0.404	
agglomeration	0.000	0.994		-0.0029	0.802				
capital	-0.021	0.080	*	-0.0381	0.007	***			
density1				-0.0134	0.247		-0.0274	0.132	
density2				-0.0109	0.253		-0.0131	0.288	
constant	0.187	0.862		-1.1170	0.101		-1.6254	0.125	
city				0.0141	0.269				
d_wz37	-0.242	0.498					-0.0378	0.857	
d_wz40	-0.237	0.501		0.2175	0.057	*	0.0288	0.885	
d_wz41				0.3081	0.327				
d_wz45	-0.221	0.526		0.2185	0.040	**	0.0486	0.805	
d_wz50	-0.209	0.548		0.2298	0.031	**	0.0460	0.815	
d_wz51	-0.237	0.496		0.1963	0.067	*	0.0602	0.760	
d_wz52	-0.204	0.557		0.2298	0.031	**	0.0504	0.798	
d_wz55	-0.176	0.613		0.2921	0.007	***	0.0884	0.655	
d_wz60	-0.166	0.633		0.2540	0.018	**	0.0584	0.766	
d_wz61	0.024	0.945		0.4539	0.001	***	0.2516	0.317	
d_wz62	-0.462	0.322		0.0909	0.725		-0.0807	0.801	
d_wz63	-0.312	0.375		0.0798	0.565		-0.0467	0.825	
d_wz64	-0.182	0.605		0.2992	0.010	**	0.0982	0.624	
d_wz65	-0.161	0.641		0.2924	0.007	***	0.1129	0.572	
d_wz66	-0.141	0.683		0.2545	0.018	**	0.1183	0.547	
d_wz67	-0.209	0.547		0.1975	0.077	*	0.0828	0.678	
d_wz70	-0.280	0.422		0.1658	0.123		0.0585	0.769	
d_wz71	-0.196	0.572		0.2117	0.053	*	0.0606	0.759	
d_wz72	-0.272	0.434		0.1704	0.128		0.0629	0.749	
d_wz73	-0.286	0.434		0.1363	0.324		0.0741	0.714	
d_wz74	-0.286	0.411		0.1823	0.089	*	0.0244	0.901	
d_wz80	-0.159	0.647		0.2735	0.013	**	0.0690	0.727	
d_wz85	-0.240	0.491		0.2187	0.040	**	0.0474	0.810	
d_wz90	-0.239	0.496		0.1869	0.105		-0.0044	0.982	
d_wz91	-0.182	0.601		0.2755	0.011	**	0.0933	0.637	
d_wz92	-0.214	0.538		0.2498	0.018	**	0.0908	0.643	
d_wz93	-0.269	0.439		0.1942	0.070	*	0.0446	0.822	
d_sh	0.070	0.008	***	0.0092	0.535		0.0119	0.343	
d_nrw	-0.012	0.598		-0.0050	0.634		0.0062	0.505	
d_he	-0.022	0.349		-0.0320	0.031	**	-0.0303	0.008	***
d_rlp	0.040	0.134		0.0241	0.037	**	0.0011	0.933	
d_bw	0.004	0.909		0.0069	0.605		0.0015	0.894	
d_by	0.049	0.07	*	0.0389	0.007	***	0.0210	0.087	*
d_bb	0.100	0.073	*	0.0022	0.928		-0.0185	0.405	
d_mv	-0.012	0.726		-0.0330	0.122		-0.0423	0.034	**
d_sn	-0.003	0.921		-0.0027	0.879		-0.0265	0.106	
d_sa	-0.054	0.141		-0.0506	0.062	*	-0.0414	0.017	**
d_th	-0.015	0.695		-0.0322	0.147		-0.0532	0.008	***
d_be	0.001	0.973		0.0226	0.364		0.0191	0.230	
d_hh	0.153	0	***	0.1069	0.000	***	0.0843	0.001	***
d_hb	0.013	0.693		0.0049	0.822		0.0073	0.788	
N	2,898			10,948			2,555		
F	2.910	0.000		3.100	0.000		2.960	0.000	
R²	0.421			0.296			0.327		

Source: Authors' calculations.

Appendix 13:
Variance inflation factors of regressions V, VI and VII

	Cities		Counties		Planning regions	
	Va	Vb	VIa	VIb	VIIa	VIIb
	VIF	VIF	VIF	VIF	VIF	VIF
L_r^2	4313.22	3761.96	2841.40	3717.44	3254.35	3680.06
Lr	3905.20	3419.04	2591.88	3455.15	3191.54	3630.66
LQ^2	37.45	5.88	16.52	6.69	333.07	74.36
fsize	23.54	7.09	15.66	8.70	358.05	81.25
LQ^2	23.02	4.55	10.87	3.94	6.55	3.07
HQ	21.02	11.16	12.17	11.65	5.85	4.33
agglomeration	11.60	6.95	5.02	5.62		
capital	11.10	5.42	6.38	5.50		
d_bw	9.45	9.25	4.53	2.94	5.95	3.60
educ	8.46	6.29	6.24	7.22	8.81	9.97
d_be	7.65	60.18	3.73	16.23	1.70	6.20
d_rlp	6.90	1.95	2.58	1.30	2.69	1.76
d_nrw	6.61	21.06	4.53	6.36	5.49	5.70
d_by	6.54	21.51	3.79	6.53	4.64	5.89
HHI	6.36	2.13	3.09	1.91	3.07	3.35
d_wz34	6.18		4.37		2.91	
d_hh	4.94	31.37	2.46	7.74	1.67	3.14
d_wz24	4.85		2.72		1.75	
d_hb	4.75	3.79	1.57	1.42	1.34	1.36
competition	4.17	7.90	3.24	7.59	23.06	23.18
d_wz31	3.11		1.84		1.40	
Growth	2.80	3.61	1.67	2.19	2.49	3.35
d_he	2.73	16.20	1.75	3.93	1.94	4.15
d_wz27	2.15		1.40		1.37	
d_sn	2.05	5.93	1.39	2.28	1.78	2.88
d_wz22	2.00		1.51		1.19	
d_wz35	1.92		1.58		1.30	
d_wz28	1.55		1.66		1.51	
d_wz33	1.48		1.25		1.16	
d_wz32	1.47		1.22		1.07	
d_wz15	1.43		1.34		1.29	
d_sh	1.22	1.80	1.14	1.40	1.28	1.42
d_th	1.21	1.73	1.23	1.36	1.42	1.87
d_wz23	1.11		1.07		1.13	
d_wz26	1.09		1.08		1.07	
d_mv	1.07	1.55	1.06	1.36	1.11	1.65
d_sa	1.06	2.01	1.09	1.33	1.15	1.58
d_wz25	1.06		1.17		1.11	
d_wz30	1.06		1.13		1.04	
d_bb	1.04	1.54	1.09	1.39	1.15	1.57
d_wz17	1.04		1.08		1.09	
d_wz19	1.04		1.03		1.01	
d_wz16	1.03		1.01		1.05	
d_wz36	1.03		1.12		1.09	
d_wz20	1.02		1.03		1.02	
d_wz21	1.02		1.04		1.03	
d_wz18	1.01		1.02		1.03	
d_wz74		2961.83		5050.10		3559.01
d_wz85		2470.74		4695.88		3793.84
d_wz52		1250.62		2443.00		2095.78
d_wz51		663.15		1414.23		1361.24
d_wz80		528.41		903.49		616.57
d_wz45		519.04		1326.96		1360.79
d_wz65		494.26		790.92		526.59
d_wz63		321.61		571.38		383.81
d_wz55		300.28		535.80		375.35

Continuation Appendix 13

d_wz60		210.48		342.78		196.39
d_wz91		200.10		317.68		178.41
d_wz66		182.78		280.92		115.99
d_wz92		170.97		264.72		128.35
d_wz72		142.69		268.39		179.16
d_wz70		99.57		149.72		73.73
d_wz50		90.60		214.94		228.74
d_wz64		41.24		73.22		51.69
d_wz73		33.26		59.46		32.84
d_wz93		29.02		54.50		44.09
d_wz40		23.21		42.25		33.26
d_wz67		13.07		19.66		13.11
d_wz90		11.77		22.07		16.31
d_wz61		4.37		6.89		3.25
d_wz62		4.36		10.01		4.28
d_wz71		3.58		6.12		5.02
d_wz37		1.40				1.79
density1			11.37	9.55	15.56	14.49
density2			6.82	6.34	8.92	7.96
d_wz41				2.82		
city			4.98	4.47		
average	180.06	349.89	112.00	494.14	154.71	441.50

Source: Authors' calculations.

Appendix 14:
Complete results of regressions VIII, IX and X

	(VIII) Cities			(IX) Counties			(X) Planning regions		
	Coeff.	p-value		Coeff.	p-value		Coeff.	p-value	
LQ	-0.0245	0.624		-0.0210	0.540		-0.1030	0.034	**
LQ_35/LQ_150	-0.0354	0.617		-0.0267	0.432		0.0079	0.779	
LQ_90+/LQ_300+	-0.0085	0.865		-0.0122	0.722		0.0173	0.406	
LQ²	0.0230	0.295		0.0053	0.711		0.0337	0.002	***
LQ²_35/LQ²_150	0.0329	0.257		0.0126	0.429		-0.0180	0.261	
LQ_90+/LQ²_300 +	-0.0011	0.963		0.0033	0.832		-0.0193	0.171	
HHI	-0.0508	0.177		-0.0174	0.444		-0.0448	0.235	
HHI_35/HHI_150	-0.1311	0.070	*	-0.0081	0.788		0.0070	0.828	
HHI_90+/HHI_30 0+	0.0514	0.238		0.0318	0.233		0.1105	0.018	**
L_r	0.6035	0.021	**	0.4076	0.027	**	0.4862	0.014	**
L_r^2	-0.0260	0.016	**	-0.0175	0.026	**	-0.0211	0.006	***
growth	-1.6948	0.000	***	-1.0926	0.000	***	-0.8353	0.000	***
competition	-0.0482	0.000	***	-0.0366	0.000	***	-0.0512	0.002	***
fsize	-0.0484	0.089	*	-0.0078	0.720		0.0420	0.368	
educ	0.0487	0.230		-0.0103	0.601		0.0227	0.230	
HQ	-0.0090	0.003	***	-0.0044	0.099	*	-0.0012	0.501	
agglomeration	0.0177	0.516		-0.0223	0.216				
capital	-0.0211	0.134		-0.0083	0.440				
density1				-0.0498	0.009	***	-0.0185	0.336	
density2				0.0014	0.927		0.0003	0.978	
constant	-3.2899	0.046	**	-2.0947	0.049	**	-2.5121	0.052	*
d_wz15	-0.0081	0.854		0.0183	0.457		0.0221	0.245	
d_wz16	-0.1878	0.010	**	-0.0823	0.274		-0.0334	0.660	
d_wz17	-0.2762	0.001	***	-0.0667	0.128		-0.0353	0.349	
d_wz18	-0.0905	0.217		0.0025	0.970		0.0552	0.256	
d_wz19	-0.9454	0.002	***	-0.0662	0.752		0.0259	0.859	
d_wz20	-0.2226	0.003	***	-0.0473	0.134		-0.0229	0.574	

Continuation Appendix 14

d_wz21	-0.0196	0.779		-0.0402	0.289		-0.0005	0.986	
d_wz22	0.0382	0.342		0.0362	0.178		0.0356	0.121	
d_wz23	-0.1760	0.076	*	-0.1831	0.047	**	-0.1118	0.268	
d_wz24	-0.0472	0.522		-0.0632	0.223		-0.0286	0.626	
d_wz25	-0.0924	0.103		-0.0159	0.488		0.0071	0.729	
d_wz26	-0.1449	0.023	**	-0.0582	0.101		-0.0072	0.778	
d_wz27	0.0153	0.801		0.0233	0.481		0.0465	0.103	
d_wz28	-0.0925	0.080	*	-0.0165	0.443		0.0025	0.907	
d_wz30	-0.9071	0.134		-0.2871	0.254		-0.2107	0.021	**
d_wz31	-0.0455	0.614		-0.0594	0.444		-0.0002	0.997	
d_wz32	-0.0451	0.793		-0.1150	0.406		-0.0092	0.934	
d_wz33	0.0227	0.619		0.0000	0.999		0.0001	0.997	
d_wz34	0.0105	0.832		-0.0398	0.382		0.0069	0.780	
d_wz35	0.0577	0.331		0.0473	0.350		0.0683	0.084	*
d_wz36	-0.0571	0.429		-0.0276	0.504		0.0322	0.289	
d_wz37	-0.1026	0.308		-0.2332	0.034	**	-0.0727	0.360	
d_wz40	-0.0559	0.316		-0.0143	0.749		0.0024	0.938	
d_wz41	0.1038	0.780		0.0387	0.896		-0.0381	0.847	
d_wz45	0.0194	0.576		0.0258	0.155		0.0289	0.108	
d_wz50	0.0193	0.606		0.0312	0.116		0.0244	0.178	
d_wz51	0.0031	0.936		0.0086	0.670		0.0344	0.053	*
d_wz52	0.0319	0.360		0.0355	0.048	**	0.0289	0.088	*
d_wz55	0.0588	0.139		0.0906	0.002	***	0.0637	0.014	**
d_wz60	0.0594	0.139		0.0479	0.057	*	0.0326	0.088	*
d_wz61	0.0478	0.588		0.1473	0.120		0.1938	0.064	*
d_wz62	-0.3535	0.296		-0.2606	0.245		-0.1178	0.639	
d_wz63	-0.1283	0.182		-0.1249	0.178		-0.0752	0.314	
d_wz64	0.0495	0.436		0.0923	0.061	*	0.0738	0.071	*
d_wz65	0.0408	0.292		0.0722	0.031	**	0.0818	0.018	**
d_wz66	0.0494	0.235		0.0211	0.475		0.0800	0.001	***
d_wz67	-0.0152	0.784		-0.0268	0.572		0.0484	0.240	
d_wz70	-0.0479	0.244		-0.0373	0.161		0.0256	0.543	
d_wz71	0.0248	0.586		0.0066	0.855		0.0318	0.246	
d_wz72	-0.0374	0.398		-0.0336	0.380		0.0264	0.194	
d_wz73	-0.0831	0.491		-0.0860	0.361		0.0381	0.462	
d_wz74	-0.0546	0.132		-0.0230	0.280		-0.0068	0.704	
d_wz80	0.0614	0.211		0.0651	0.096	*	0.0439	0.132	
d_wz85	-0.0034	0.924		0.0239	0.171		0.0240	0.139	
d_wz90	-0.0205	0.753		-0.0310	0.547		-0.0296	0.537	
d_wz91	0.0467	0.279		0.0734	0.016	**	0.0663	0.016	**
d_wz92	0.0136	0.707		0.0390	0.073	*	0.0588	0.002	***
d_wz93	-0.0368	0.331		-0.0004	0.985		0.0226	0.358	
d_sh	0.0771	0.016	**	0.0140	0.381		0.0019	0.873	
d_nrw	-0.0127	0.669		-0.0119	0.277		-0.0003	0.978	
d_he	-0.0156	0.655		-0.0330	0.062	*	-0.0263	0.046	**
d_rlp	0.0823	0.073	*	0.0533	0.049	**	0.0172	0.197	
d_bw	0.0107	0.759		0.0028	0.846		0.0211	0.079	*
d_by	0.0958	0.003	***	0.0792	0.000	***	0.0538	0.000	***
d_bb	0.1382	0.035	**	0.0359	0.264		-0.0276	0.197	
d_mv	0.0141	0.691		-0.0089	0.740		-0.0620	0.001	***
d_sn	0.0437	0.252		0.0473	0.034	**	-0.0227	0.161	
d_sa	-0.0455	0.302		-0.0480	0.077	*	-0.0576	0.001	***
d_th	0.0106	0.794		-0.0065	0.789		-0.0690	0.000	***
d_be	0.0907	0.049	**	0.0612	0.028	**	0.0468	0.009	***
d_hh	0.2185	0.000	***	0.1393	0.000	***	0.0968	0.000	***
d_hb	0.0152	0.704		-0.0021	0.915		-0.0221	0.403	
N	5,018			19,087			4,571		
F	2.610	0.000		2.930	0.000		3.520	0.000	
R^2	0.325			0.209			0.252		

Source: Authors' calculations.

Appendix 15:
F-test for joint significance of the location quotients in regression VIII

H_0:	$\beta_{LQ} = 0$ $\beta_{LQ\_35} = 0$ $\beta_{LQ\_90+} = 0$ $\beta_{LQ^2} = 0$ $\beta_{LQ^2\_35} = 0$ $\beta_{LQ^2\_90+} = 0$
H_1:	at least one $\beta \neq 0$
F(6,4937)	3.890
p-value	0.001

Source: Authors' calculations.

Appendix 16:
F-test for joint significance of the location quotients, Herfindahl indexes and the variables for regional employment in regressions VIII, IX and X

H_0:	$\beta_{LQ} = 0$ $\beta_{LQ\_35} = 0$ $\beta_{LQ\_90+} = 0$ $\beta_{LQ^2} = 0$ $\beta_{LQ^2\_35} = 0$ $\beta_{LQ^2\_90+} = 0$ $\beta_{HHI} = 0$ $\beta_{HHI\_35} = 0$ $\beta_{HHI\_90+} = 0$ $\beta_{Lr} = 0$ $\beta_{Lr^2} = 0$	Cities: F(11,4937) p-value Counties: F(11,19004) p-value Planning regions F(11,4490) p-value	 2.750 0.002 1.650 0.079 3.020 0.001
H_1:	at least one $\beta \neq 0$		

Source: Authors' calculations.

Appendix 17:
Variance inflation factors for regressions VIII, IX and X

	(VIII) Cities VIF	(IX) Counties VIF	(X) Planning regions VIF
Lr	7609.38	6081.55	5332.92
Lr	7228.61	5810.80	5249.35
LQ²	95.55	33.52	6.79
LQ	95.29	36.60	186.94
LQ²_90+/LQ²_300+	82.17	29.38	14.33
LQ_90+/LQ_300+	77.91	31.21	21.93
d_be	45.83	13.45	5.99
d_wz74	32.19	11.59	7.04
d_wz85	25.00	10.14	6.86
d_hh	22.36	5.45	2.83
fsize	16.85	13.12	184.02
d_by	16.21	5.14	5.47
d_nrw	15.54	5.11	5.94
d_wz52	12.86	5.54	4.10
HQ	12.40	12.16	4.54
d_he	11.68	3.31	3.75
LQ_35/LQ_150	10.47	7.64	16.67
LQ²_35/LQ²_150	10.19	7.07	6.39
d_bw	8.09	3.13	4.11
agglomeration	7.94	4.68	
d_wz34	7.47	4.52	3.20
d_wz51	7.26	3.57	2.97
competition	6.72	6.23	24.98
educ	6.68	5.99	9.94
HHI_90+/HHI_300+	6.42	4.81	8.90
capital	5.98	5.85	
d_wz80	5.96	2.75	1.91
d_wz45	5.88	3.44	3.06
d_wz65	5.83	2.75	1.80
HHI	5.77	3.96	8.57
d_sn	4.46	1.90	2.71
d_wz63	4.09	2.12	1.58
d_wz24	3.96	2.33	1.60
d_wz55	3.86	1.98	1.54
d_hb	3.47	1.31	1.41
growth	3.47	2.01	3.23
d_wz60	3.04	1.65	1.29
d_wz91	2.87	1.61	1.26
d_rlp	2.86	1.66	1.91
d_wz66	2.80	1.66	1.21
d_wz92	2.61	1.53	1.20
d_wz31	2.58	1.63	1.31
d_wz72	2.35	1.53	1.28
d_wz70	1.97	1.32	1.11
HHI_35/HHI_150	1.97	2.34	2.55
d_wz22	1.85	1.29	1.16
d_wz50	1.84	1.39	1.33
d_sa	1.68	1.28	1.77
d_wz27	1.58	1.29	1.24
d_sh	1.53	1.24	1.45
d_th	1.47	1.31	1.84
d_wz28	1.43	1.66	1.57
d_wz35	1.42	1.17	1.08
d_wz33	1.41	1.22	1.16
d_bb	1.39	1.29	1.52
d_wz15	1.39	1.33	1.32
d_wz64	1.38	1.14	1.07
d_mv	1.37	1.29	1.64

Continuation Appendix 17

d_wz32	1.32	1.12	1.05
d_wz73	1.31	1.12	1.05
d_wz93	1.26	1.10	1.06
d_wz19	1.22	1.13	1.02
d_wz40	1.21	1.09	1.05
d_wz67	1.12	1.04	1.02
d_wz90	1.10	1.04	1.02
d_wz25	1.05	1.16	1.12
d_wz26	1.05	1.09	1.06
d_wz17	1.04	1.06	1.05
d_wz23	1.04	1.02	1.04
d_wz61	1.04	1.03	1.03
d_wz62	1.04	1.07	1.01
d_wz30	1.03	1.06	1.03
d_wz36	1.03	1.10	1.07
d_wz16	1.02	1.01	1.01
d_wz21	1.02	1.04	1.02
d_wz71	1.02	1.01	1.01
d_wz18	1.01	1.01	1.02
d_wz20	1.01	1.03	1.02
d_wz41	1.01	1.01	1.00
d_wz37	1.00	1.00	1.00
Density1		9.70	15.69
Density2		6.59	8.87
average	194.88	149.48	140.32

Source: Authors' calculations.