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Analysing spatial distribution of economic activity in case of Hungarian sub-regions

PhD Dissertation Theses

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Table of Contents

1. Topic justification

1.1. The starting point of the subject and the research

It is a basic feature of economics, income and population that they are spatially unevenly distributed. It would be surprising if it was not. There are many reasons why this distribution isn't balanced. It is certainly influenced by natural advantages, but the spatial concentration of population doesn't originate in these factors in all cases. In my dissertation I am dealing with the spatial concentration of economic activity. This phenomenon now increasingly gains ground in the literature as many researchers deal with not only the explanation of the unequal spatial distribution of economic activities, but also with the measurement accuracy and the quantification of affecting factors are as well.

My first comprehension understanding of the concentration of economic activity roots back to Paul Krugman's Centrum-Periphery model, while had background knowledge about the concentration as a statistical concept. I came across more analysis using the Ellison-Glaeser γ index, and I started to deal with spatial econometrics. In Hungary this indicator was used in analyses only few times, so I made the choice to apply it on Hungarian data. In addition or mostly by laying the foundations of this analysis I reviewed the international empirical studies on spatial concentration and agglomeration of economic activities and the applicable indicators, on which my methodological overview was based.

During my research of the spatial distribution of economic activities I wanted to get my evaluation done in Hungary at sub-regional level. I think these tests are important because they provide further analysis and practical utilization of the results. The test results can be used to - specifically or generally - highlight the causes and consequences of spatial concentration, for example through regression tests. It provides an opportunity for further analysis of Hungarian economic development level and of the spatial structure of economy. As a snapshot it can point out economic development opportunities and play a role in background analyses of economic strategy development, and also in economic development tenders on the EU and domestic levels.

1.2. Literature overview

The unequal spatial distribution of economic activities drew attention of theoretical economists' early on. At the beginning their goal was to investigate especially the cause: here we can mention Thünen's, Weber's, Marshall's and Lösch' work. Krugman (1995) lists five

traditional directions, which formed an integral part of the space-related economic ideas. However the toolbar allowing more in-depth analysis of the spatial economy, was absent for a long time.

In the last 20 years - exceeding the traditional concept of regional economics – the notion of territoriality found its way into more directions of theoretical economics due to the development of computer technology and economics. We can highlight the work of Paul Krugman, who has set up a theoretical macro-model (Centrum-Periphery model, CP-model) in order to study and better understand this phenomenon. The emphasis on the measure and quantification of spatial differentiation increased in parallel with the understanding and modelling of the mechanisms of centripetal and centrifugal forces attracting and distracting companies to and from each other's neighbourhood (Krugman 1995, 2000, Ellison-Glaeser 1997). In 2008 Paul Krugman got the Nobel Prize for analysing international trade movements and spatial context of economic activities.

After Krugman's CP model, several other new economic geography models were established, whose novelty was in their assumption of spatial concentration caused by decreasing unit transportation costs and increasing return to scale (observed in global sector) driven by monopolistic competition and positive local spillover effects (Combes–Mayer–Thisse 2008, Fujita-Krugman-Venables 1999, Fujita–Thisse 2002, Henderson–Thisse 2004).

2. Research aim and definitions

After studying the literature I intended to do an empirical analysis to assess the spatial aspects of economic activities in Hungary, using multiple indicators based on the available existing international literature.

It is not an easy task to reveal the causes of the localization of the economic activities in space. Therefore, in my dissertation I seek to examine the main concepts of spatial distribution of economic activities, indices related to these concepts and their interpretation to find ways to detect the spatial inequalities. My thesis adds value in the methodological development aspects. The tools to be presented with the Hungarian data provide methodological challenges to the application. That is why it is an important part of my job to describe results and edification from the special Hungarian investigations.

Methods presented in my dissertation are not able to identify the causes which are or were leading to uneven spatial distribution of the economic activities, but they presume the presence or absence of the causes, and so they may represent a starting point of further

investigations. My goal, while writing this work wasn't set development proposals to economic policy, but I wanted to achieve a thorough overview of the methodology and explore opportunities of the methodology application and the resulting conclusions for Hungary.

2.1. Conceptual framework

Concepts aiming to grasp the core of the uneven spatial distribution of economic activities and the localization of enterprises – concentration, agglomeration and specialization – can be found in many fields of science related to my subject area.

The concept of *agglomeration* appears in regional economics in the form of *external economics of agglomeration*, or in other word of *agglomeration economies of scale.* Due to the social-geographical approach, the concept of *agglomeration* is designated to the urban area of localized band of settlements, usually in form of a big city and its vicinity (Lengyel-Rechnitzer 2004, Pearce 1993). The previously mentioned external effect is an important concept of neoclassical economics, by contrast, 'the term of *agglomeration* is used mostly by *practitioners of regional economics* and *business (management) sciences*' (Lengyel 2010, pp. 23).

In statistics, the concept of concentration means that the major part of the total is centralized on a few numbers of units of the population (Hunyadi et al. 1996). Applying this definition in our case, the total can be taken the *number of employees*, or the *total value added* in the industry. The population is formed by the territorial units of current spatial subdivision level. Thus we get the concept of spatial concentration.

The concept of *specialization* is examining the localization of economic activities clearly from the viewpoint of an area or territorial unit. The concept means *'activities concentrated on the areas in which companies or individuals have natural or acquired advantages'* (Pearce 1993, 516.). This also means that '*the economy of the current region is characterized by different structure as the whole industrial economy*' (Pearce 1993, 516.). The concept of specialization reflects a different perspective. A *specific region* can be specialized on one or more specific industries, while an *industry* or *group of industries* can be agglomerated or concentrated in area.

Agglomeration and concentration: the international literature investigating spatial distribution of economic activities tends to use these two concepts mostly as synonyms However several attempts have been made to separate the two concepts, two of which I want to highlight. The first was formulated by Brakman Garretsen and Marrewijk (2009), I use the

abbreviation BGM for it, and the second is to found in Lafourcade and Mion's (2007) study, further I use abbreviation LM.

The studied range of economic activities (BGM)

The two concepts are different from one another in Brakman Garretsen and Marrewijk (2009) conception of the fact that while the *spatial concentration* focuses on smaller groups (one or a few well-defined sectors), the *agglomeration* of economic activities investigates a broader group - even the whole industry. According to this approach, depending on your choice on the range of economic activities examined, you determine a priori whether concentration or agglomeration is tested.

Independent territorial units vs. spatial autocorrelation (LM)

We can see in the international literature also that double system tests are made. From surveying the spatial concentration it is not yet possible to deduce the structure of the distribution (Breschi 1998). Lafourcade and Mion (2007) use both of the concepts of spatial concentration and agglomeration on any group of economic activities, but they distinguish them based on their measuring indices. Lafourcade and Mion suggest that:

- An industry is concentrated in space, if enterprises of the industry are localized in few territorial units, while these units can be adjacent or isolated as well;
- An industry is agglomerated, if the enterprises of the industry are localized in territorial units while these units are spatially near to each other, so there is positive spatial autocorrelation.

Figure 1. Agglomeration and/or spatial concentration in LM approach

Source: own construction on the basis of Lafourcade–Mion (2007) pp. 49

We can see the relationship between the two concepts in LM approach on Figure 1, which shows two different distributions of 12 enterprises in 9 territorial units. In both cases we can talk about the same level of spatial concentration, because the 12 enterprises are in

both cases equally distributed in 4-4 territorial units. However while in the first case (left side) we see agglomeration – the adjacent territorial units are similar –, in the second case (right side) we cannot register any agglomeration, because the adjacent territorial units are systematically different from each other.

- If the spatial distribution corresponds to the left image, it can be concluded that the forces, which can be called cause of localization of economic activities, have larger radius than the radius of units of chosen level of spatial division.
- If the location of the four equally high concentrated units is random, which means, the realized distribution is one of the transition distribution between the two cases, then the above mentioned range is smaller or equal, than the size of territorial units.
- However, if the spatial distribution corresponds to the right image, then the forces which are attracting companies near to each other have a radius smaller or equal, than the size of territorial units, or even the systematic dispersion raises the probability of presence of forces are rather a repulsive which have a range beyond boundary of the territorial units.

After reviewing the relevant literature and measuring indices *the best match corresponding my goals is the latter distinction - the LM approach -, so I chose to refer in my dissertation to spatial concentration and agglomeration of economic activities limit to this concept.*

3. Structure of the dissertation, methodology

The dissertation is divided into five chapters. In the first chapter I consider the concepts of the literature to describe the unequal spatial distribution of economic activities. In this context, I introduce the two approaches mentioned above, which distinguish the concepts of concentration and agglomeration. In the second chapter I describe the test methodology based on indicators used in the literature. The third chapter reviews the previously mentioned indicators appearances in the international literature. In the fourth chapter I investigate and evaluate the territorial distribution of the Hungarian manufacturing sub-sectors and knowledge-intensive sectors on sub-regional spatial level based on four indicators. Finally, in the summary of the dissertation I present my methodological results, methodological comments and my theses.

Studies and tests which are made on economic development and job creation purposes, measure the extent of spatial localization of economic activity usually *by employment data.* So I took in my analyses data on the number of employees of enterprises, and I introduce the reviewed indicators in this way.

The indicators can be classified by two aspects. As previously mentioned, the development of analysing tools can be determined in two different directions as well. Among the indicators of the LM approach' *spatial concentration* are the Location Quotient (LQ), the spatial Herfindahl index (Herfindahl 1950, Hirschman 1958, Ellison–Glaeser 1997), the Ellison-Glaeser γ (EG γ) index (Ellison – Glaeser 1997), Maurel and Sedillot's γ_A index (Maurel – Sédillot 1999) and Krugman's spatial Gini index (Krugman 1991). Among the indicators of the LM approach' *agglomeration* indicators we find the Moran index (Moran 1950, Dusek 2004, Varga 1998), the Geary's C (Geary 1954, Dusek 2004), the local Moran index (Anselin 1995) and the G_i^* index (Getis - Ord 1992).

During my investigations I used the EG γ, the LQ index, the Moran's index and the local Moran index out of the above listed indicators. I was motivated to choose the EG γ index by the several application and interpretation examples in the literature. I believe that the EG γ as correlation index is well interpretable. I think it is important to apply local indicators as well, so it seems obvious to use the LQ index. Out of the agglomeration indicators I choose the Moran index and the local Moran index, as they are to be reported and interpreted together. In their applications in the international literature we found many more examples than the other indices.

3.1. Hypotheses

I investigated the topic along the following ideas and hypotheses by partly complementing and partly applying the above-described methodological framework.

In Hungary we can observe the separation of sub-regions characterized by urbanization and localization economies. Budapest, as a special sub-region in Hungary is in a particularly striking position. This city plays an important role economically, culturally, and in many other aspects as well. It does not have the largest territory, but the largest population, population density and importance in the country. While Budapest plays undoubtedly a decisive role in both social and economic point of view, statistically it distorts fact that that the big part of the institutions concentrates there (i.e. institutions of national importance). It is displayed only in statistical data of Budapest, even though they serve the whole country as well (Lukovics 2008). The other distortion factor is that whether the spatial distribution is on municipality-,

sub-regional or county-level. Budapest is taken as a single entity in each case, although the population of Budapest is about 17% of Hungary's population, while its vicinity takes approximately the value of 30% (KSH 2010).

Other European countries also have poles around which a large proportion of the population and the economy is located. Although, 20% of Austria's population live in Vienna, and 12% of Czech Republic's population live in Prague (Eurostat 2012), but it is a rare phenomenon. In some countries, there are more poles, but the literature does not deal with this issue.

Based on these findings I decided to examine the values of indicators with taking the data of Budapest into account and also without them. My first hypothesis:

I. *hypothesis: Considering the Hungarian economic activities at sub-regional level, there are significant differences are to be expect between the values calculated with the data of Budapest, and without taking it into account*
    a. *in the values of the spatial concentration indicator;*
    b. *in the values of the agglomeration indicator.*

Through measuring the appearing differences in the values of indicators we can draw conclusions to the situation of Budapest in the individual sector.

In in each of the indicators used (EG γ, Moran's index, LQ, LISA index) appear the to every individual territorial unit belonging s_i and x_i values. Depending on that x_i is the fraction of the

a. *employees in the whole national economy*

b/1. *employees in manufacturing and constructing*

b/2. *employees in the service sector*

belonging to the territorial unit i, there are different index values to observe. In case **a**, we take into account both the sectorial and the industry-specific effects of centripetal and centrifugal forces, the indicators reflect the resultant of these. In case **b.** - when the x_i values are based on the specific sector (narrower than the entire national economy), in which the studied industry belongs – then we measure only the industry-specific consequences of the concentration forces within the sector. These two calculation methods can relate to the paired concepts of agglomeration and spatial concentration of economic activities based on the BGM approach (Brakman et al. pp. 2009). According to that, my second hypothesis is the following:

II. *hypothesis: Considering the Hungarian economic activities at sub-regional level, there is a significant difference*

   a. *in the values of the spatial concentration indicator,*
   b. *in the values of the agglomeration indicator*

   dependent on the fact whether the baseline employment data represents the whole national economy or only the manufacturing and construction sectors.

In the literature and theoretical models, knowledge spillover is an extremely important factor in the localization of economic activities. Therefore, several empirical analyses focused on examining whether those (sub-) sectors, which produce more knowledge – so called knowledge-intensive industries – have greater expected spatial concentration compared to the non-knowledge-intensive sectors. That is the base of my third hypothesis:

III. *hypothesis: Considering the Hungarian economic activities at sub-regional level, we expect higher values*

   a. *for the spatial concentration indicator,*
   b. *for the agglomeration indicator*

   in the knowledge-*intensive industries compared to the non-knowledge-intensive industries.*

Based on the empirical results of the international literature I conclude that it is worth to analyse industries by measurement indicators both of spatial concentration and agglomeration, which are two, different measurable phenomena. The two indicators can show co-movement and reverse movement compared to each other. It drives my fourth hypothesis:

IV. *hypothesis*: *Considering the Hungarian economic activities at sub-regional level, the distinction between spatial concentration and agglomeration - formulated by Lafourcade and Mion – is methodologically well founded. The two dimensions established based on two types of indicators are independent.*

My empirical studies on the Hungarian economy tested these hypotheses while I sought possibly wide application of the international methodology in Hungary.

3.2. An analysis of manufacturing sub-industries and knowledge intensive industries

I used the previously mentioned local and global indicators on the Hungarian economic activities. In addition, it was important to take into consideration that the Hungarian spatial structure is special. Therefore I not only applied previously known indicators drawn from the literature, but used own illustrations and presentation tools.

The empirical analysis of manufacturing sub-industries in Hungary (based on the classification NACE rev 1.1, 3-digits) was made based on sub-regional level data on the main activity of the relevant enterprises and the number of their employees. The sub-regional employment data was extracted from two databases: (1) CSO Regional Statistical Yearbook 2007 publication, (2) the 2001 census data from the CSO website (www.ksh.hu). The data of individual companies are from the CSO repository of company information (company-code-register) 2007/2 publication. I had to take into account 168 sub-regions (historical division till 2007), because the recent change of switching to 174 sub-regions has not been fully implemented in the database.

I assigned the data of the individual corporations for employment number and sub-industrial codes (NACE rev 1.1. pp. 4-digits) to the corresponding sub-region. The sub-regional level employment data (based on number-category of employees) were collected for 43 manufacturing sub-industries. The NACE was modified also (it was published the NACE rev 2), but at the time of the study (summer 2008) enterprises have not been fully reclassified yet, so I stayed with the older classification.

The selection of 43 sub-industries was made out of 103 manufacturing sub-industries. Selection criterion was the number of employees. At the time of testing 60% of manufacturing employees worked in these sub-sectors. To all indicator calculations the exact number of employees on enterprise level would have been needed, which was not available, therefore it had to be estimated. The international practice is to assume that the company sizes are evenly distributed in the number categories of employees (Ellison-Glaeser 1997). In the Herfindahl index and EG γ calculations I substituted it with the arithmetic mean of number category. By the EG γ index calculations I used Excel 2003 software.

At the calculations of Moran's index I used sub-regional proximity matrix based on the location of 168 sub-regions by 'rook' contiguity, that is, if the i-th and j-th territorial units have common boundary, then the value of w_{ij} is $\frac{1}{n_i}$ (here n_i represents the number of neighbours of the i-th sub-region), 0 otherwise, and w_{ii} also was 0. Calculation of the Moran's

index, p-values and the LISA index values were made with the help of Geode 0.9.5-i software, and by the mapping I used the ArcView 3.2 software. I tested my hypotheses on these data by *paired* and *independent t-tests*, *linear correlation tests* and *nonlinear regression models*.

In developed countries the knowledge-intensive industries are the fastest growing industries of the economy - thanks to the spread of information technologies and the strengthening knowledge based economy. In these sectors, the most innovation takes place, so examining their structure and operation could be interesting today.

Accordingly, I calculated EG γ, Moran's index; LQ and LISA index values (the same indices as in the previous study) in seven knowledge-intensive manufacturing and 18 knowledge-intensive service sector. Each industry was presented on a map showing each sub-regions in nine possible categories classified based on the indicators (Table 1).

Table 1: Classification of sub-regions by values of local indicators and their interpretation

LQ value	According to the LISA index and p-value	Meaning
1,5 < LQ	High – High	The sub-region is highly specialized on the industry's activities and the industry is also present above average in the surrounding area.
1,5 < LQ	Not significant	The sub-region is highly specialized on the industry's activities, but neither the presence of the industry nor the lack of the industry in the surrounding area is significant.
1,5 < LQ	High – Low	The sub-region is highly specialized on the industry's activities, but the lack of the industry in the surrounding area is significant.
1 < LQ < 1,5	High – High	The sub-region is weakly specialized on the industry's activities and the industry is also present above average in the surrounding area.
1 < LQ < 1,5	Not significant	The sub-region is weakly specialized on the industry's activities, but neither the presence of the industry nor the lack of the industry in the surrounding area is significant.
1 < LQ < 1,5	High – Low	The sub-region is weakly specialized on the industry's activities but the lack of the industry in the surrounding area is significant.
LQ < 1	Low – High	The industry in the sub-region is present at a lower fraction than expected, meanwhile the industry is present above average in the surrounding area.
LQ < 1	Not significant	The industry is present in the sub-region at a lower fraction than expected, and neither the presence of the industry nor the lack of the industry in the surrounding area is significant.
LQ < 1	Low – Low	The industry is present in the sub-region at a lower fraction than expected, and the lack of the industry in the surrounding area is significant.

Source: own construction.

The empirical analysis of knowledge intensive industries in Hungary (based on the classification NACE rev 2, 2-digits) was made based on sub-regional level data taken into account the main activity of the relevant enterprises and the number of their employees. The

sub-regional employment data was extracted from two databases: (1) CSO Regional Statistical Yearbook 2007 publication, (2) the 2001 census data from the CSO website (www.ksh.hu) . The data of individual companies are from the CSO repository of company information (company-code-register) 2007/2 publication. At the calculations of Moran's index I used sub-regional proximity matrix $W = (w_{ij})$, (following the now amended territorial classification) based on the location of 174 sub-regions by 'rook' contiguity.

4. Summary of the results

4.1. Methodological results and notifications

I performed the analysis of global (EG γ and Moran index) and local (LQ index and LISA) indicators of spatial concentration and agglomeration for two different range of economic activities (manufacturing sub-industries and knowledge-intensive manufacturing and services industries). During my research I came to the following methodological results:

1. Along the two different approaches of uneven distribution of economic activities i.e. the spatial concentration and agglomeration, two-dimensional global classes (twenty classes) can be created into which the individual economic industries can be categorized. On the basis of this, one can determine the average radius of resultant of forces attracting and distracting enterprises to and from each other's neighbourhood. I created these tables to analyse the manufacturing sub-industries and knowledge-intensive industries as well.
2. Along the two different approaches of uneven distribution of economic activities i.e. the spatial concentration and agglomeration, local classes (nine classes) can be created into which the individual territorial units can be categorized (defined by values of local indicators. On the basis of this, one can determine the local radius of resultant of forces attracting and distracting enterprises to and from each other's neighbourhood (Table 1).
3. In Hungary the sub-regional level seems to be appropriate level to analyse and compare the spatial distribution of certain economic industries in the sense that the values of certain indicators are scattered across a wide spectrum separating economic activities of different nature. Although the research was made on sub-regional level so we can detect the existence and radius of forces only, which appear at this level of

territorial division. It would be useful to do the research at county and municipal level too.

While analysing the empirical data I detected some phenomena that affected the interpretation of test results, which are summarized in the following methodological notes:

1. *Absolut or relative deviation*. The LQ value denotes the $\frac{s_i}{x_i}$ ratio, meanwhile local and global Moran inidicies and also the Ellison–Glaeser γ index are based on the $s_i - x_i$ values. The first one measures the concentration in the sub-region compared to its own employment level, so measuring specific deviation. Contrary to that, the second one measures the absolute (in or out-) flowing part of the country's employment. Therefore, it is worth to apply both measures and the results should be interpreted accordingly.
2. *Distortion of indicators.* By the lack of accurate employment data (there were given only the belonging of companies to the number category of employees) I had to estimate them. This fact can even substantially distort values of indicators, since if there are more firms which have higher employee number within the their number category, then the estimate can decrease the value of Herfindahl index significantly, up to half of the real, thus leading to significant increasing in EG γ value.

4. *Agglomeration – is it?* Behind the high value of Moran's index it is not certain that there is true agglomeration. This occurs in cases, when there is no detectable spatial concentration, but we detect positive spatial autocorrelation. A possible reason is that there are many sub-regions with low industry employment, or they are even 'empty', so causing an increase in Moran's index value. To solve this problem after using the global index it is worth to apply more (local) indicators. On the other hand, when the given industry is spatially concentrated, but it is not agglomerated, our applied index, the Moran's index, usually shows no false agglomeration due to the calculation method, which is based on the $d_i = s_i - x_i$ absolute indicator values - as opposed to the by Arbia et al (2006) used $LQ_i = \frac{s_i}{x_i}$ values.
5. *Boundary and number of neighbours.* If a sub-region is a hot-spot based on the high value of local Moran index, than it is the High-High category, which basically means that the activity is more dense in average in the given sub-region and the surrounding neighbours. This may be misleading for sub-regions located near to the country's borders, since we cannot take into account cross-border neighbours of the sub-region, so there is low number of neighbours, which distorts the results. The border-territorial

units cause problems are not only in case of the autocorrelation, but in case of other spatial econometric methods (Dusek 2001).

6. *Reasons of spatial localization.* In case of an industry if the investigation results in high values, it indicates some causes of the localization, so justifies its existence. However, since this localizing factor can be economical, social, geographical or other reasons, we have to investigate each individual case. This means a differentiated application of the indicators or involvement of other methods.

4.2. Theses

In my dissertation I have studied the concepts of spatial distribution of economic activities and new economic geographical explanations of the uneven distribution. Then, I reviewed concepts differentiating spatial concentration and agglomeration. I presented the Lafourcade and Mion's (2007) categorization of indicators to measure the uneven spatial distribution. After the international literature review I used the EG γ index and Moran's index, as global indicators, and the LQ and LISA indices as local indicators applying them for a certain range of the Hungarian manufacturing sub-industries, and for the knowledge-intensive manufacturing and services industries on sub-regional level. Then I made conclusions on both methodological and economic interpretation levels.

My results can be summarized in the following theses based on the hypotheses testing:

Thesis 1. For Hungarian sub-industries at sub-regional level, the indicator of spatial concentration of economic activities shows a significant difference considering data for Budapest being in or excluded, while measuring agglomeration calculated with or without these data, does not show significant discrepancy.

In the manufacturing sub-industries and the knowledge-intensive industries as well, tests are often showing significant differences in the indicators when the values of the Budapest data are in- or excluded from their calculations. The change direction of the indices is not evident, but we can clearly show the drop in scattering driven by inter-industry differences mostly in Budapest. The correlation analysis of spatial concentration index (EG γ) showed significant difference when observed with data of Budapest. Without the data from the capital, the agglomeration index (Moran index) values showed no difference at 5 % significance level based on either the correlation analysis or the t-test.

Thesis 2. For Hungarian sub-industries at sub-regional level there is no relevant difference caused when measuring either the spatial concentration or agglomeration based on the employment data reflecting the entire national economy or only on a relevant slice of it: manufacturing and construction sectors.

The investigation has not revealed a difference on a 5% significance level between the two different calculation methods for the γ values of EG, however, there are sectors in which a significant difference. Measuring the agglomeration (Moran's index) including Budapest, there was a difference at 2.14% level of significance when comparing the indices of employment in industry and construction versus the nation's overall economy.

Thesis 3. For Hungarian sub-industries at sub-regional level higher value of spatial concentration appears in the knowledge-intensive sectors compared to the non-knowledge-intensive ones, therefore, we can expect a higher level of spatial concentration with the growth of the knowledge-intensity, while the agglomeration index shows no significant difference.

The study of knowledge-intensive manufacturing sub-sectors indicated a higher spatial concentration compared to non-knowledge-intensive ones at a 9% significance level.

Thesis 4. For Hungarian sub-industries at sub-regional level the distinction between spatial concentration and agglomeration - formulated by Lafourcade and Mion – is methodologically well founded. The two dimensions established on base of two types of indicators are independent.

Indicators presented in the second part of the dissertation can be categorized into two distinct groups. Ones are those that measure the localisation economic activities in space, while the spatial relations of individual geographical units are irrelevant. The others are those that are specifically trying to structure based on spatial relationship for the distribution of economic activities. The results from the correlation analysis suggest that there is no connection between the EG γ index and the Moran index values, which means that from the values of the one we cannot predict the values of the other.

5. Publication in the subject of the dissertation

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