SUMMARY BOOKLET OF THE PHD DISSERTATION
DOCTORAL SCHOOL OF EARTH SCIENCES

Development of inequalities in the European Union between 2004 and 2020

- Experiences and possibilities of catching up in the Visegrád countries at the national and regional level

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1. Introduction

Growing regional inequalities have a negative impact on the position, competitiveness and development of the European Union, which is one of the world's largest economic blocs and a key geopolitical and geoeconomic actor in the international system, in the economic, political and social fields.

In the EU, regional disparities are not decreasing or are slowly decreasing, catching up is slow, and shows very different trends from country to country and region to region. Inequalities are analyzed in the dissertation at the national and regional level (the NUTS2 and NUTS3 levels).

In order to distribute the subsidies necessary to catch up with the growing inequalities, the cohesion policy also applies increasingly specific groupings to the regions, and with the current 2021-2027 budget cycle, another change has taken place, instead of the previous conditional convergence (with development exceeding 90 percent of the average, it was considered catching up) absolute convergence came to the fore. This also creates a new framework for the examination of catching up, which also appears in the dissertation.

The actuality of the choice of topic is shown by the fact that in Hungary, as in other neighboring countries, more than 30 years have passed since the system change and more than 15 years since joining the EU, so the 2004-2020 time horizon is on the one hand connected to the European budget cycle, on the other hand during the 17 years examined many changes have also taken place in the trajectory of the countries. In addition to all this, the examined time interval also includes three major crises: the economic and financial world crisis of 2008-2009, the sovereign debt crisis of 2012-2013 and the crisis caused by the covid19 pandemic in 2020. The time horizon is long enough to allow certain conclusions to be drawn about the changes in regional inequalities in the EU, which can provide a basis for the possible directions of regional development programs. Both the choice of the time interval, the set of crises that can be analyzed during that time, and the use of extensive, complex investigation methods show a novel approach to the topic. The analysis of the development of convergence processes can shed light on different trends, development paths, successful examples and challenges, and can provide support for targeted development strategies.

2. Objectives

On the one hand, the dissertation examines, based on a complex methodology, the fact that territorial inequalities in the European Union are decreasing in the period since the accession of Hungary and the largest expansion of the EU to date, and on the other hand, it analyzes during the period that the major economic downturns (the 2008-2009 and global financial and economic crisis, the sovereign debt crisis of 2012-2013, and the recession caused by covid19 in 2020) have an impact on macro-level territorial inequalities. The preliminary assumption of the analysis of inequalities is that development in the European Union is balanced between regions, and convergence is broken only by external shocks and economic crises.

Based on these, the 1st objective is to analyze whether

- during periods of economic and financial crises, regional inequalities in the EU increase.

For all of this, three sub-goals are analyzed – based on the different territorial levels examined and the corresponding available data:

- EU member states have been converging on each other in terms of development since 2004, the convergence is broken only by major economic downturns in 2009, 2012 and 2020;
- EU NUTS2 level regions have been converging on each other in terms of development since 2004, the convergence is broken only by major economic downturns in 2009, 2012 and 2020;
- EU NUTS3 level regions have been converging on each other in terms of development since 2004, the convergence is broken only by major economic downturns in 2009 and 2012.

In the 2nd objective, territorial inequalities are investigated by looking at the tendencies of countries with a below-average level of development as they catch up with regard to inequalities within the country. The basic assumption is that a high degree of development, catching up, is associated with a separation and divergence between regions, since the most significant development is shown by the most developed regions. Based on these, the second main goal is to investigate whether

- within the European Union, the catching up of individual member countries to the EU average increases regional inequalities within the country.

For all of this, two sub-goals are analyzed - based on the different territorial levels examined and the corresponding available data:

- within the European Union, the catch-up of individual member states to the EU average increases regional inequalities at the NUTS2 level within the country, taking into account the period between 2004 and 2020, and
- within the European Union, the catch-up of individual member states to the EU average increases regional inequalities at the NUTS3 level within the country, taking into account the period between 2004 and 2019.

The third major research area of the dissertation is the situation of the Visegrad countries in the European Union: the examination of their previous catch-up experiences and their further catch-up opportunities. All four countries joined the Union in 2004, so their catch-up journeys are relatively comparable. Can absolute convergence be achieved in their case (or are they only able to catch up to a certain level), and if so, when can this happen. When examining the impact of catch-up on territorial inequalities within the country, the question is where the inequalities that existed in 2004 (the main differences between the capital and rural regions, as well as between the more developed regions in the west and the more backward regions in the east) are moving, and whether they are able to change in the direction of equalization in the near future. Related to this, the 3rd main objective is to investigate whether

- the Visegrad countries are able to catch up with the average of the European Union, which causes regional divergence within the country.

All this is developed on the basis of two sub-goals, which are the analysis of whether:

- the Visegrad countries are able to catch up to the average of the European Union within the next 25 years, as well as
- the catching up of the Visegrad countries leads to regional divergence within the country: center-periphery and west-east dimensions.

3. RESEARCH METHODS

The use of **secondary sources** provides the theoretical background of the dissertation. The second chapter of the dissertation includes an overview of *the main domestic and international literature* related to the research, based on a logical approach on the one hand, and a historical approach on the other. In addition to clarifying the use of terms, geoscience-regional science and economic theories, as well as the European Union's integration efforts (steps, as well as the cohesion policy and tools that help to reduce inequalities and catch up) and documents, were given a special role.

In relation to the subject of the dissertation, the research relied on official data and analyzes for the appropriate *statistical data analysis*. The data were collected primarily from the database of the Statistical Office of the European Union, Eurostat, and the database of the International Monetary Fund (IMF).

During the research, the analyzes were made at *national and regional levels* in the European Union, including *NUTS2 and NUTS3*. The EU real convergence indicator related to development is the *gross domestic product per capita*. The GDP, as the most scientifically accepted measure of the level of development, is suitable for carrying out the analyses, within which the per capita values are decisive in order to filter out distorting effects on a regional scale. The different price levels and exchange rates of different countries can be eliminated with values calculated on the basis of purchasing power standards (PPS).

The *time horizon* of the research is the period between 2004-2020, but to examine the effects of the global crisis caused by covid19 in 2020, the latest data available in the summer of 2022 will also be published, at the national level until 2021, at the NUTS2 level until 2020 and at the NUTS3 level until 2019. The base year is 2004.

In the course of most researches, the *relative standard deviation* is the basis of the tests, therefore, in the thesis, several other regional statistical methods and indicators were used during the examination of the hypotheses:

- The *σ-convergence* is a deviation-based measure, based on which inequalities decrease over time if the deviation calculated from the logarithmic data of GDP per capita (by which the distorting effect of outliers can be significantly reduced) shows a decreasing trend (Sala-i-Martin, 1996).
- *β-convergence* (Sala-i-Martin, 1996) predicts the catch-up time, which includes the assumption of absolute convergence (Halmai, 2014).
- To test the Williamson (1965) hypothesis, *territorial polarization* is defined as the ratio of the GDP/capita values of the highest and lowest developed region based on Nemes Nagy (2005).
- The *20/20 rate*, or the income quintile rate, which compares the average of the richest 20 percent of the population with the average of the poorest 20 percent.
- The *Palma ratio* – applied to GDP in research – is the share of the top 10 percent compared to the bottom 40 percent (Palma, 2006).
- The great advantage of the *Theil index*, an entropy-type method derived from information theory for examining inequalities, is that it allows inequalities to be broken down into inequalities between and within groups within the sample.
- In the case of examining GDP and population, the index showing the difference in territorial distribution is the *Robin Hood index*, which can be interpreted as the

proportion of income that must be transferred from the above-average to the below-average in order to achieve equal distribution (Nemes Nagy, 2005).

- A *concentration* (Hirschman–Herfindahl) *index* was also calculated for the concentration of income shares, which shows the absolute concentration.
- The *histogram* (and the image of the density function estimated based on it) shows the proximity of the territorial units to each other, if we compare functions made at different times. Drawing it also helps to understand that average and standard deviation type metrics can be extremely influenced by abnormally low or high values, so their use is advisable if the data is close to the normal distribution (Sitthiyot–Holasut, 2020).
- Testing whether the development of the countries depends on the initial level of development is done by *estimating the regression equation* drawn for the levels of development measured at the beginning and end of the examined period between the countries. Based on the drawing of the best-fitting lines during the testing, in addition to the linear trend line, the exponential also explains the co-movement of the examined data to a similar extent, so both regression estimates were analyzed.

The indicators and indices reviewed above were calculated using the Excel program. To illustrate the data and results, the maps were created using the Gisco (Geographical information system of the Commission) online program.

The **primary source** of the dissertation is a *professional questionnaire* on inequalities within the European Union and the catch-up of the Visegrad countries. The survey was conducted online between November 18, 2022 and December 8, 2022 using the Google Forms program.

One half of the questionnaire was aimed at all the countries of the European Union together; and examined whether absolute convergence can be achieved both nationally and at the NUTS2 and NUTS3 regional level, what causes led to divergence within the EU in the period 2004-2020, and how many differences would be acceptable between territorial units. The questions also focused on which groups of countries will be most strongly affected by the current crisis (caused by rising energy prices and war), and within how many years it will be possible for another state to join the European Union, or whether there is a chance that some states will secede from the from the Union. In addition, the respondents also answered a methodological question regarding the relevance of indicators for measuring territorial inequalities.

The other half of the questionnaire focused on the situation and catch-up of the Visegrad countries; and examined whether they are capable of catching up, when they can reach the EU average, what they should do in order to (faster) catch up, whether they are in the trap of the "medium developed", what reasons they consider to be the most important that hold them back in development, which areas represent the potential for development (NUTS3 level), which areas are capable of a high degree of development in the coming years, and whether the role of the countryside can be strengthened due to more periods similar to the covid19 virus expected in the future. The questions also focused on whether the development differences of the east-west dimension could move significantly toward equalization within 25 years, and whether the development differences of the center-periphery could significantly move toward equalization within 25 years.

The data (102 fillings) were evaluated on the one hand by combining them based on the built-in evaluator of Google forms, on the other hand by editing the Excel database created from the data and own diagrams from it.

4. SUMMARY OF RESULTS

The first objective of the dissertation focused on territorial inequalities within the European Union, examining the fact that the defined territorial units have been converging to each other since 2004, the convergence being broken by major economic downturns.

It can be determined at the member state level:

- Most of the examined inequality indicators showed convergence between countries in the period between 2004-2020 (or 2004-2021). Only the standard deviation (the relative standard deviation also examined until 2021) and the histogram analysis indicated divergence.
- In the highlighted year of 2009, divergence occurred based on only two indicators – sigma convergence and the ratio of income fives – the other indicators all showed convergence between the countries. As a result, the financial and economic crisis of 2008-2009 did not break the convergence of the member countries.
- In 2012, there was also divergence based on only two indicators – although unlike the 2009 results, here the standard deviation and the relative standard deviation – the other seven indicators indicated convergence between the countries. Thus, the sovereign debt crisis of 2012-2013 did not break the convergence of the member countries.
- In the year 2020 – with the exception of the concentration index – divergence can be established based on all the examined indicators. In this way, the global crisis caused by covid19 in 2020 clearly deepened the inequalities between the areas and broke the convergence of the member countries.

It can be determined at NUTS2 regional level:

- Most of the investigated inequality indicators showed convergence between NUTS2 level regions in the period between 2004-2020. Only the standard deviation and the histogram analysis indicated divergence.
- In the highlighted year 2009 – with the exception of the concentration index – all analyzed indices showed a convergence between the regions. In this way, the financial and economic crisis of 2008-2009 strengthened the convergence of the regions.
- In 2012, divergence appeared based on several indicators. Convergence was based on only four indicators – the sigma convergence, the 20/20 ratio, the Robin Hood index and the concentration index. Thus, the sovereign debt crisis of 2012-2013 broke the convergence of the regions.
- In 2020, with the exception of standard deviation and the concentration index, divergence can be established on the basis of all examined indicators. In this way, the global crisis caused by covid19 in 2020 clearly deepened the inequalities between the areas and broke the convergence of the regions.

It can be determined at NUTS3 regional level:

- Most of the analyzed inequality indicators showed convergence between NUTS3 level regions in the period between 2004-2019. Only the standard deviation, regional polarization, concentration index and histogram analysis indicated divergence.
- In the highlighted year 2009, with the exception of territorial polarization and the concentration index, all analyzed indices showed a convergence between the regions.

As a result, the financial and economic crisis of 2008-2009 did not break the convergence of the regions.

- In 2012, the regions also converged based on most indicators. Divergence was only based on the standard deviation and the Theil index. Thus, the sovereign debt crisis of 2012-2013 strengthened the convergence of the regions at the NUTS3 level.

In general, it can be determined at the level of all investigated areas:

- In addition to the highlighted crisis years, the convergence of the member countries and regions was not continuous, several years can be found when inequalities increased, that is, divergence can not only occur in the years of recession.
- The opinion of the experts about what caused the divergence within the European Union mostly supported the proposed hypothesis, most of them answered the three major crises that occurred during the period.
- Convergence between regions is primarily caused by the catching up of the regions of the countries that joined in 2004 and after.
- The development of countries and regions largely depends on their initial (2004) position.
- Overall, there was a disproportionate shift in the direction of poorer member countries and regions.
- At the beginning of the examined time interval, most of the inequalities in the European Union were caused by differences between countries, while by the end of the examined time interval, most of them came from inequalities within the country.
- In relation to catching up, based on the expectations of the respondents of the expert questionnaire, absolute convergence of neither the member countries nor the regions within the European Union is likely.

Overall, the 1st hypothesis – *that EU territorial inequalities increase during periods of economic and financial crises* – was partially confirmed, the economic crisis caused by covid19 caused divergence in 2020, while in 2009 and 2012 there was more convergence in most of the examined indicators appeared, that is, inequalities have decreased.

The second objective of the dissertation focused on the catch-up of the countries performing below the average to the EU average, examining the fact that the catch-up of the member countries increases the regional inequalities within the country, in connection with this:

- It was found that in the case of countries performing above the average, regional convergence within the country occurs to a greater extent than in the case of countries performing below the average.
- In the case of member countries with an above-average level of development, in countries with outstanding performance – which were able to relatively increase their development during the period (Denmark and Ireland) – there was a divergence between the regions.
- It appeared that in most countries the capital region increases the coverage and thus improves the average.
- At the NUTS2 level – as can be seen in Figure 1 – the process of divergence between the regions can be observed in most of the member countries with a below-average

level of development (13 analyzable countries), convergence can be highlighted in only three countries: Portugal, Hungary and Slovenia, however in the case of Portugal the disparities between regions have decreased so that the increase in national performance does not reach the EU average, and even gradually lags behind the average.

- At the NUTS3 level – as can be seen in Figure 2 – the process of divergence between the regions can be observed in most of the member countries with a development level below the average (16 analyzable countries), convergence can be highlighted in only five countries based on most of the analyzed indicators: Estonia, Latvia, Malta, Portugal and Spain, however, in the case of Portugal and Spain, the disparities between regions have decreased so that the increase in national performance does not reach the EU average, and even gradually lags behind the average.

Figure No. 1: The existence of regional convergence/divergence at the NUTS2 level within the EU27 member states based on the analyzed indicators, based on the period 2004-2020*

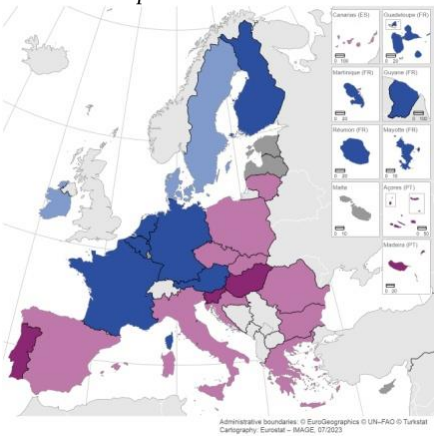
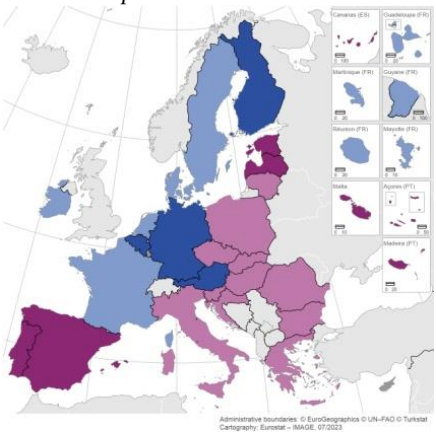


Figure No. 2: The existence of regional convergence/divergence at the NUTS3 level within the EU27 member states based on the analyzed indicators, based on the period 2004-2019*



Member countries with an above-average level of development with regional convergence
Member countries with an above-average level of development with regional divergence
Member countries with a below-average level of development with regional divergence
Member countries with a below-average level of development with regional convergence
Not applicable

Source: based on the Eurostat database (2022), own calculation and editing with the Gisco program

**Note: convergence designation for countries where convergence occurred in at least three of the five indicators examined (deviation, relative deviation, sigma convergence, beta convergence, Williamson hypothesis)*

- The respondents of the expert questionnaire are quite optimistic about when the regional divergence within the country can turn into convergence. The majority of

experts expect the next trend reversal within 15 years at the NUTS2 level and 20 years at the NUTS3 level.

Overall, **hypothesis 2 – *within the European Union, the catching up of individual member states to the EU average increases regional inequalities within the country* – was partially confirmed**. The catch-up of countries at both NUTS2 and NUTS3 levels (and even among countries performing below average and gradually lagging behind) led to regional divergence within the country in most cases.

The third major research area of the dissertation focused on the situation of the Visegrad countries in the European Union: the examination of the catching-up experience so far and the further catching-up opportunities, looking for answers to the questions of whether the Visegrad countries are able to catch up to the EU average within the next 25 years, and whether the catch-up of these countries leads to regional (center-periphery and west-east) divergence within the country. It can be established in connection with this:

- Based on the growth forecasts for the Visegrad countries and the summation of the expert questionnaire – which can be seen in figure 3 – as well as the expectations that events that move the EU average downwards (admission of a new member state or withdrawal of a member state with an above-average level of development) may take place, it is expected that the four countries will catch up to the EU average within 25 years.

Figure No. 3: Catch-up time (years) of the Visegrad countries to the EU (based on GDP per capita measured at PPS)

	Czech Republic	Poland	Hungary	Slovakia*
based on beta convergence (2004-2021)	7	9	26	33
based on average growth (2004-2021)	9	9	25	35
Based on the IMF (2023-2027) estimate	8	19	21	32
based on the summary of the expert questionnaire	Within 10 years	Within 15 years	Within 20 years	Within 15 years

Source: Own calculation and editing based on Eurostat and IMF database (2022).
**Note: In the case of Slovakia, catch-up may be faster due to the distorting effect of the significant drop in GDP/capita measured at PPS between 2015-2017, the reason for which is methodological, there is no question of backwardness in development (Oblath, 2021)*

- The primary research pointed out that in order for the Visegrad countries to catch up at a faster pace, a paradigm shift in economic policy, a complete reform of healthcare and education, more efficient and productivity-enhancing investments, the provision of more resources in the field of research, development and innovation, and the highlighting of knowledge-intensive and higher value-added sectors, less reliance on the manufacturing industry, increasing competitiveness, supporting domestic industry, and performance-oriented development policy are necessary. Transparency, the reduction of bureaucracy, the eradication of corruption, and a crisis-resistant and resilient economic policy are also important. It is emphasized how fast and effective crisis management the countries are able to implement during the crisis ahead of us and the next ones.

- In the case of the V4 countries – based on figures 4 and 5 – since 2004, the regions of Poland have shown the most significant development. Out of the four countries, only the Czech Republic shows a tendency towards an east-west balance (it should be noted that its eastern regions also border EU member states). In Poland, the center regions with a larger catchment area developed the most in the interior areas. In Slovakia, at the NUTS2 level, a relatively territorially balanced growth was typical during the examined period, at the NUTS3 level, the north and the capital region and regions close to them developed more. In the case of Hungary, the picture was varied, the highest annual average growth during the period was achieved by the region of Northern Hungary at the NUTS2 level, and by Bács-Kiskun county at the NUTS3 level. At the NUTS3 level, two western regions achieved growth below the EU average; Vas and Zala counties and a northern region; Nograd county.

Figure 4: Average growth (percentage) of the NUTS2 level regions of the Visegrad countries between 2004-2020 (GDP per capita measured at PPS, based on euros)

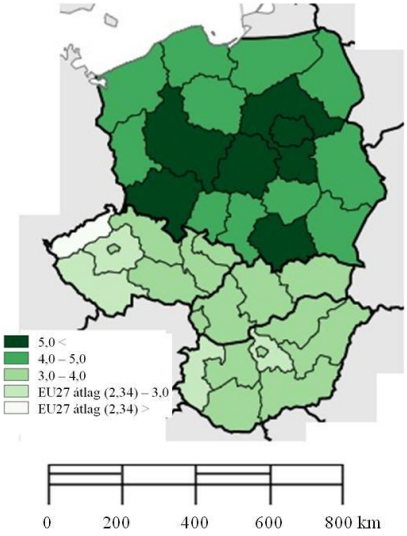
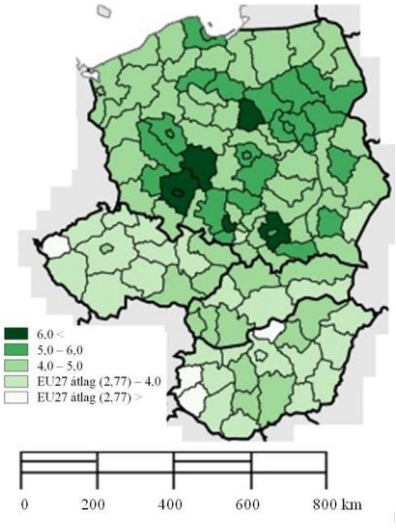


Figure 5: Average growth (percentage) of the NUTS3 level regions of the Visegrad countries between 2004-2019 (GDP per capita measured at PPS, based on euros)



Source: own calculations based on the Eurostat database (2022), own editing with the Gisco program

- The primary research showed that the majority of experts believe; in the Visegrad countries, the center regions still have a prominent role, they see the path of development primarily in the extension and expansion of the capital city center area, and secondly in the strengthening of the catchment area of the current developed regions. Within the framework of the East-West dimension, in all four countries, the western regions have a higher development potential.

Based on all of this, the **3rd hypothesis – *that the Visegrad countries are able to catch up to the European Union average, which causes regional divergence within the country* – was confirmed**. Based on most of the prognoses and expectations presented, there is a realistic chance of catching up within 25 years, and the western border edges, the metropolitan and rural metropolitan center regions together provide the catch-up potential for the Visegrad countries, which leads to further growth of inequalities within the country.

LIST OF OWN PUBLICATIONS ON THE TOPIC

1. SCIMAGO Q3: Gergics, Tünde (2023): The impact of convergence of inequalities in the European Union since 2004. Public Finance Quarterly, 69(2), pp. 30–50.
2. Gergics, Tünde (2023): A felzárkózás hatása az egyenlőtlenségekre az Európai Unióban 2004 óta. Pénzügyi Szemle, 69(2), pp. 32–52.
3. Category „A", national scientific journal: Gergics, Tünde (2020): A visegrádi országok gazdasági konvergenciája. GEOPOLITIKAI SZEMLE 2 : 1 pp. 47-68. Paper: No.4.
4. Category „A", national scientific journal: Gergics, Tünde (2020): A magyar régiók fejlődése és kapcsolódása az európai geodesign modellhez. GEOPOLITIKAI SZEMLE 2 : 2 pp. 43-64.
5. Ferkelt, Balázs – Gergics, Tünde (2019): Introduction of Euro in Visegrad Countries. In: Vuk, BEVANDA (szerk.) SELECTED PAPERS published by the Association of Economists and Managers of the Balkans, Belgrád, Szerbia: Association of Economists and Managers of the Balkans (2019) pp. 15-22.
6. Category „B", national scientific journal: Gergics Tünde – Huszti Réka – Schwertner Marcell (2019): A V4 országok versenyképességének alakulása, kitekintéssel a Kínával való gazdasági kapcsolatokra. KÖZÉP-EURÓPAI KÖZLEMÉNYEK 12 : 4 (47) pp. 175-193.
7. Gergics, Tünde (2019): Economic catching up in the European Union from 2004 to the present. In: Bálint, Horváth; András, Borbély; Eszter, Fodor-Borsos; Péter, Földi; Amelita, Kata Gódor; Zsombor, Kápolnai (szerk.) V. Winter Conference Of Economics PhD Students And Researchers: Book of Abstracts, Gödöllő, Magyarország: Doktoranduszok Országos Szövetsége (DOSZ) (2019) 138 p. pp. 50-50.
8. Gergics, Tünde (2018): A visegrádi országok felzárkózási állapota az EU csatlakozása óta. In: Korcsmáros, Enikő (szerk.) A Selye János Egyetem 2018-as X. Nemzetközi Tudományos Konferenciájának tanulmánykötete = Zborník X. medzinárodnej vedeckej konferencie Univerzity J. Selyeho – 2018 Komárno, Szlovákia: Selye János Egyetem (2018) 380 p. pp. 91-107.
9. Gergics, Tünde (2018): A Kárpát-medence régióinak gazdasági helyzete, a technológiai fejlődés, mint a felzárkózás egyik eszköze. In: Antalík, Imrich; Horbulák, Zsolt (szerk.) Kárpát medence, mint gazdasági tér : Tanulmányok az I. Szlovákiai Magyar Közgazdász Találkozó előadásaiból, Komárno, Szlovákia: Selye János Egyetem, Gazdaságtudományi Kar (2018) 208 p. pp. 164-181.