Észak-magyarországi Stratégiai Füzetek
Gazdaság-Régió-Társadalom

Strategic Issues of Northern Hungary
Economy-Region-Society

Térgazdaságtani és az üzleti kutatások lektorált tudományos folyóirata.
A peer-reviewed academic journal of spatial economics and business research.

Megjelenik évente négyszer a Miskolci Egyetem Gazdaságtudományi Kara és a Nemzetstratégiai Kutatóintézet támogatásával.
It is published four times a year with the support of the Faculty of Economics of the University of Miskolc and the Research Institute for National Strategy.

A folyóiratban megjelenő tanulmányokat két független szakértő lektorálta és ajánlotta közlésre.
The papers published in the journal have been edited and recommended for publication by two independent experts.

Magyar Tudományos Akadémia IX. Gazdaság- és Jogtudományok Osztály, Regionális Tudományok Bizottsága: B

A folyóiratot indexeli: EBSCO, REPEC, Magyar Tudományos Művek Tára (MTMT)
The journal is indexed by: EBSCO, REPEC, MTMT

Kiadó / *Publisher:*
Miskolci Egyetem Gazdaságtudományi Kar
University of Miskolc, Faculty of Econoics

Szerkesztőség / *Editorial Office:*
Miskolci Egyetem Gazdaságtudományi Kar
University of Miskolc, Faculty of Econoics
E-mail: strategiaifuzetek@uni-miskolc.hu

Felelős kiadó / *Responsible publisher:*
Veresné Dr. Somosi Mariann

Főszerkesztő / *Editor-in-Chief:*
Dr. Kocziszky György
Felelős szerkesztő / *Editor:*
Dr. Lipták Katalin

Nyomdai munkák / *Printing:*
MAXIMA CS-A Nyomdai és Kereskedelmi Szolgáltató Kft

ISSN 1786-1594 (Nyomtatott)
ISSN 2560-2926 (Online)

Tartalomjegyzék / Contents

TANULMÁNYOK / STUDIES

Editorial preface

Citizens of the Central and Eastern European countries, in expressing – either explicitly or implicitly – their intention to join the European Union, harbored the hope of rapidly converging with the EU average in terms of development and income levels. Based on the geopolitical shift that occurred in 1990, the majority of analysts considered this aspiration achievable. Differences of opinion existed primarily regarding the pace and time horizon of convergence.

However, the achievements of the past three decades present a mixed picture. While the performance and development level of capital city regions have reached or even surpassed the EU average, the situation of peripheral regions has improved only slowly and with high volatility. These regions appear to have fallen into a development trap. In these areas, the added value of the economy is increasing only moderately, total factor productivity shows minimal improvement, R&D&I expenditures remain modest, and the proportion of investments supporting Industry 4.0 remains limited. The population of disadvantaged regions is declining, and the dependency ratio is increasing.

The role of foreign direct investment (FDI) in stimulating local economies is contradictory. Although national governments have consistently supported such investments through both direct and indirect means, their societal perception has been negatively affected by the ecological risks occasionally associated with their implementation.

The second issue of our journal in 2025 provides an assessment of the Hungarian economy, highlighting regional disparities and offering economic policy recommendations. While interpreting the findings, it is important to recognize that the second decade of the 21st century posed unique challenges to the Hungarian economy. The Russian–Ukrainian war and the crisis in the Middle East have weakened the country's export performance, which, in turn, has dampened investment activity and reduced the growth potential of small and medium-sized enterprises. One can only hope that rationality will soon prevail over hedonistic perspectives, paving the way for resolving ongoing geopolitical crises.

Miskolc, June 2025

Dr. György Kocziszky Dr. Katalin Lipták

TANULMÁNYOK / STUDIES

Barna Szabó[1] – Magdolna Csath [2] – Lóránt Dénes Dávid[3]

Statistical analysis of the long-run relationship between regional integration and convergence, the European Union and integration theories

Since the mid-twentieth century, the development of the world economy has been driven by integration processes in several dimensions. According to some integration theories, the intensive and free flow of goods, services, capital and labour creates conditions similar to those of domestic economic relations, ultimately leading to convergence. European Union (EU) policy makers are trying to increase convergence and reduce divergence within the framework of a predefined regional policy. The objective of this paper, on the other hand, is not to analyse the policy of reducing regional disparities, but to statistically examine the relationship between regional integration and convergence across EU Member States within the longest time frame allowed by the methodology used. In our research, we have used a novel indicator (ITLS and CEW) to measure each of these two variables.
Keywords: integration theories, regional integration, EU, ITLS, CEW, convergence, European Union (EU)
JEL code: B41, C22, C43, E01, F63, O11, P17

https://doi.org/10.32976/stratfuz.2025.15

Introduction

Theories explaining the processes of regional integration seek to answer the question of the laws underlying the phenomena that lead to coalescence (Bóka, 2001 In: Pintér 2017, p. 342). Puchala (1972, p. 267) illustrated this with the simile in which the fairy-tale king gave the blind wise men the task of characterizing the appearance of an elephant. The wise men tried to do this by touching one of its parts, but those who touched its feet described the animal as an iron pillar, those who touched its back as a huge barrel, and those who touched its ears as a thin, flexible sheet. Needless to say, all of these wise men were right, and none of them were right at the same time.
According to Szabó (2021b, pp. 103-104), among the theories of integration based on economic foundations - if we focus on convergence - the following two dominant but opposing trends are worth highlighting:

- the *liberal school*, which argues that the intensive and free flow of goods, services, capital and labour creates conditions similar to domestic economic relations between countries participating in regional cooperation, ultimately leading to convergence (Palánkai et al., 2011, p. 137); and
- the *regular school*, according to which the assumptions of the liberal schools do not correspond to reality, since there is no perfectly free competition and free trade anywhere in the world, and according to the observed practice of free competition always favours the stronger party, which ultimately causes divergence (Losoncz, 2011, p. 9).

It is important to note that, in practice, EU policy makers seek to increase convergence and reduce divergence within the framework of a pre-defined regional policy.

[1] PhD, Investigator, National Tax and Customs Administration of Hungary; email: szabo.barna@nav.gov.hu
[2] DSc, Research Professor, National University of Public Service; email: leadership@magdacsath.t-online.hu
[3] PhD, Professor, Hungarian University of Agriculture and Life Sciences; email: david.lorant.denes@nje.hu

However, for a meaningful state influence on economic and social processes, statistical data, facts and other knowledge are needed, especially in terms of how much economic performance a country has in terms of specific indicators (Bod, 2020, p. 76, p. 73). Measuring economic performance is important, among other things, because some fast-growing economies often reach a medium level - typically a GDP level of around USD 10,000 per capita - from which they cannot move on and become high-income countries. This phenomenon is also referred to as the middle-income trap, the avoidance of which can be a major challenge, especially for economies that for some reason (e.g. high share of low value-added assembly plants of foreign firms, or lack of knowledge-based labour, effective use of domestic resources and innovation) cannot move up the so-called value chain from product invention to market sale (Csath, 2022, p. 31, p. 34).
Another important economic policy issue is the question of how economic performance should be compared with what we have done in the past, with our own performance, with that of the countries around us, or with that of a larger community - regional integration, such as the EU. Csath (2021, p. 18) and Matolcsy (2020, p. 14) also argue that economic policy should retain the tried and tested elements that have worked well in the past, break with approaches that have failed in the past, and recognise and benefit from international trends, taking into account domestic specificities.
Contrary to the above problem, the objective of our paper is not to analyse policies affecting the reduction of regional disparities, to statistically examine the relationship between regional integration (as independent variable) and convergence (as dependent variable) across EU Member States, within the longest time interval allowed by the methodology used. In our research, we have used a novel indicator, ITLS and CEW, to measure these two variables.

Literature review

The concept and forms of regional integration

According to Csath (2023, pp. 9-10), globalisation is generally speaking an economic, social and political phenomenon, but it is not based on regularity, it is essentially nothing more than a consciously created "product". Szabó (2021a, p. 22) uses a similar conceptual framework to define regional integration, arguing that it is nothing other than a structure of global integration that is geographically defined, transnational, voluntarily created, economic and other dimensions, made possible by technological - primarily information technology - progress.
The forms of regional integration, which basically differ in the degree of the so-called four freedoms (goods, services, capital, labour), were first put together in a unified model by Béla Balassa in his book "The Theory of Economic Integration" published in 1961 (Balassa, 1961, p. 2). In practice, many transitional and mixed formations may emerge. The development of the EU and other regional integrations has not exactly followed Balassa's model (Simai, 2003, p. 56).
Regional integration in all its forms - as a free trade agreement - can also be understood as part of a larger structure, the international trade policy regime (Palánkai et al., 2011, pp. 157-160).
The evolutionary development of the international trade policy regime, which also encompasses the stages of regional integration - Balassa (1961, p. 2), Benczes (2011, pp. 174-175), Constantinovits (2014, 2.1), Esze et al. (2009, pp. 19-20), Kutasi (2011, pp. 201-203), Mészáros (2007, p. 251), Palánkai (2002, p. 357), Palánkai et al. (2011, pp 157-160), Simai (2003, p. 56), Tóth ed. (2010, 7.6.3) - Szabó (2021a, p. 62, p. 91) summarizes in Table 1.

Table 1: The evolution of the international trade policy regime, including the stages of regional integration, as a function of the liberalisation of the "four freedoms"

Stepping stones (ITLS)	International trade policy regime	Regional integration	Liberalised freedoms
0.	Discriminatory system	-	-
1.	Equal treatment	-	Application of a single tariff to the states concerned
2.	Preferential trade	-	Unilateral tariff preferences granted in addition to equal treatment
	Free Trade Agreement	Preferential zone	Reducing customs duties between countries
3.		Free trade area	Abolition of customs duties between Member States
4.		Customs union	Application of uniform duties against a third country
5.		Common market	Liberalisation of further freedoms (capital, labour) across borders
6.		Single market	Removal of non-tariff barriers
7.		Economic Union	Harmonisation of national economic policies
8.		Monetary union	Exchange rate stability and the introduction of a single currency
9.		Political union	Further harmonisation of policies and the creation of supranational authorities
10.	Universal free trade (theoretical category)		Global General Trade

Source: Szabó (2021a, 62, 91)

As can be seen, the two extremes of the integration steps identified in Table 1 are the discriminatory system (step 0) and universal free trade (step 10). Both concepts are more theoretical than practical. Discrimination was a feature of the relationship between the Soviet Union (and other former socialist states) and capitalist countries, and today, with the exception of the few most isolated states of the world economy, it is typically applied on an ad hoc basis, driven by economic-political objectives. Universal free trade, on the other hand, is not yet a reality, and is unlikely to become one in the near future, given the lack of a so-called 'global identity'.

Equality of treatment (Step 1) became a general principle of world trade under the General Agreement on Tariffs and Trade, and was reaffirmed in the 1974 UN Charter of Economic Rights and Duties of States. However, it is easy to see that, from time to time, economic difficulties may make it impossible to ensure equal treatment, and that unilateral preferential trade (Step 2) may also be justified for less developed countries (WTO, 2025).

Alongside equal treatment and preferential trade, the emergence of free trade agreements became a feature of the second half of the 20th century. Today, their number is estimated at 150-200. With a few exceptions, all countries in the world are involved in some level of regional integration, and some even more than others (Halmai, 2020, p. 21).

Classifying regional cooperation in the current sense, which is voluntary, is not a simple task, since, as discussed earlier, it does not develop in exactly the same stages as those described in Table 1. The regional integrations of today and of the past are classified from stage 2 to stage 8. With the exception of the historically federal countries, no political union has yet been achieved (stage 9), and there is no realistic prospect of this in the case of the EU, which is at the highest level of integration. The main reasons for this are the lack of common European traditions, identity and language; the diversity of economic and social expectations; and the large number of potential member.
In the following, alongside the EU's integration development, we consider it important to highlight the Southern African Customs Union (SACU), given that it was used as a control country group to test the reliability of our research results.

The integration evolution of SACU

It was founded in 1969 by the Republic of South Africa, Botswana, and two other small countries within the borders of South Africa, Lesotho and Swaziland. In 1990, Namibia, another state that had seceded from the Republic of South Africa, joined the community. Its integration objective was to create a customs union between the countries that had become independent during decolonisation. In fact, the initial (then involuntary) form of the customs union already existed in the colonial era, with roots going back to 1889. The SACU now also functions as a quasi-currency union, since the currency of the Republic of South Africa, the South African rand (with the exception of Botswana), is the common currency between the SACU countries, without the establishment of a central bank and without fixing national currencies, while maintaining national currencies, on the basis of bilateral agreements. It is also important to note that the SACU economy is clearly dominated by the Republic of South Africa, which has a developed economy. For the Republic of South Africa, the other member states of the community - Botswana, Lesotho, Namibia and Swaziland - are important sources of raw materials and labour. In return, South Africa provides a market and a capital base SACU, 2025).

EU integration developments

Of all regional integrations, the EU is currently the most dominant, model community.
As it is well known, the "six" - France, Germany, Italy and the Benelux countries - began closer economic cooperation between the member states within the framework of the community created by the Treaty of Rome, signed on *25 March 1957, and* known today as the EU *The customs union* and *common market* set out in the objective were achieved virtually in parallel by *1 July 1968.* The crises of the early 1970s, however, highlighted the shortcomings of integration, as governments often sought to deal with their internal difficulties by non-tariff means at the expense of their integration partners. To address this, the *single market was* completed by *31 December 1992*, but this still posed further problems in a number of areas, mainly due to the absence of a common economic policy and a common currency. In order to remedy the shortcomings of the single market, a group of Member States agreed to monetary cooperation - *Economic and Monetary* Union (EMU). Within the framework of EMU, a single currency in the form of banknotes and coins was introduced on *1 January 1999* and cash on *1 January 2002*, under the name of the euro. The EU's integration process is not yet complete, and further developments are needed, in particular to improve crisis management and resilience. However, the final form of the Community, the level of integration, which is accepted by all, has not yet emerged.
The community of six was joined in 1973 by Denmark, the United Kingdom and Ireland; in 1981 by Greece; in 1986 by Portugal and Spain; in 1995 by Austria, Finland and Sweden; in 2004 by Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia; in 2007 by Bulgaria and Romania; and finally in 2013 by Croatia. The United Kingdom left in 2020 (brexit).

The EMU was founded in 1999 by Austria, Benelux, Finland, France, Germany, Ireland, Italy, Portugal, Spain and Portugal; joined by Greece in 2001; Slovenia in 2007; Cyprus and Malta in 2008; Slovakia in 2009; Estonia in 2011; Latvia in 2014; Lithuania in 2015; and finally Croatia in 2023.

The EU's drive for convergence

As discussed above, while the market automatisms assumed by liberal integration theory lead to convergence, the regularist school of thought believes that these self-operating processes do not work properly in reality, ultimately causing divergence. However, EU policy makers are trying to increase convergence and reduce divergence within the framework of a predefined regional policy. The Treaty of Rome, which established the Community, already mentions the importance of reducing regional disparities, but the common level of development of the six founding Member States meant that this was of marginal importance. In 1972, however, in preparation for the enlargement of the Community, the Member States decided to establish a common regional policy combined with financial support (Kaszalik, 2023, p. 126). The primary objective of the policy, which was institutionalised in 1988, was to create economic and social cohesion and ensure convergence. After the turn of the millennium, in order to achieve the goals of the Lisbon Strategy and the Europe 2020 Strategy, cohesion policy also prioritised the increase of competitiveness, and, based on the experience of the 2004 enlargement of Central and Eastern Europe, territorial cohesion - both economic and social aspects - also became important. Nowadays, in response to the new global challenges of our time, the set of objectives has been complemented by additional areas of intervention, such as combating climate change, promoting digitalisation or managing migration, which pose additional adaptation challenges and questions for policy mechanisms (Kiss, 2021, p. 8).

Measuring convergence

The literature on measuring convergence has become very extensive, with sources such as. Kuruczleki et al. (2017, p. 45), Hussain (2022, pp. 132-141), Szabó and Dávid (2023, pp. 35-37), Varga (2016 In: Kiss, 2021, p. 30) - distinguish between different mathematical-statistical methods based on different distributions, regression models, stochastic time series analyses and club convergence (country group analysis), some of which operate with complex variables in addition to the traditional econometric indicators.
The two basic statistical methods for measuring convergence are called sigma and beta convergence.

1. *The sigma convergence* expresses the trend of the deviation of the indicators under study from their mean, expressed as a percentage. In the case of a decreasing trend, we speak of convergence, in the case of an increasing trend, of divergence.
2. *The beta convergence* is a hypothesis test based on the assumption that developing countries grow faster than developed countries. If this assumption is true, we see catching up, otherwise we see lagging behind (Anjani & Prasetyo, 2024, pp. 1863-1864).

According to Palánkai et al. (2011, p. 99), *GDP per capita* can be used as a basic indicator for convergence analysis, although in agreement with other authors, e.g. Cheng and Ke (2023, pp. 1-14), Csath (2001, pp. 189-195), Deaton and Schreyer (2022, pp. 1-15), Feldstein (2017, pp. 145-164), Mink (2022, pp. 275-292), Ross (2019) - also draw attention to the distorting effects of GDP on the true value, which, if taken into account, may lead to the need to consider a number of other indicators (Nguyen & Paczos, 2020, p. 2, pp. 24-30; Hamilton, 2021, pp. 295-297). GDP expresses only the value of the total final consumption goods produced in a given area over a given period of time (Botos, 2013, p. 77), ignoring a number of relevant factors, among which Csath (2001, pp. 189-195) highlights the following:

- GDP counts all financial movements as activities that boost the national economy, regardless of whether they are beneficial or harmful.
- Despite the fact that the location of GDP production and consumption is usually different, this indicator takes into account the results of all activities within a given economy, whether they come from domestic or foreign-owned firms.
- No account is taken of inequalities in income distribution.
- Even with a steady increase in this indicator, the population may feel that their living standards are stagnating or deteriorating.

Economic output as measured by GDP is therefore only a slice of the wealth of national economies, i.e. *national wealth* (Dynan & Louise, 2018, p. 5; Quiros-Romero & Marshall, 2020). In a country's wealth, in addition to the economic result, *human* and *natural* wealth elements also play a decisive role, since economic wealth cannot be increased in the long term by damaging the labour force and nature, and the main driver and shaper of economic development is no other than a highly knowledgeable, motivated and, last but not least, healthy human being (Csath, 2022, pp. 26-27). It is also worth noting here that the stock of knowledge typical of advanced industrialised countries can also be interpreted as a factor of production that can be developed at very high cost (Dőry & Ponácz, 2003, pp. 155-166). Although there is no generally accepted definition of national wealth, there is broad agreement that it is not the same as GDP and consists of the three dimensions mentioned above - economic, human and natural wealth (Csath, 2023, p. 109).
In view of the above, we have also sought to shift the focus from a one-sided examination of the dispersion of GDP per capita levels to a focus on potential indicators of national wealth in the research presented in the following chapters.
In view of the above, we have also sought to shift the focus from a one-sided examination of GDP per capita to a focus on potential indicators of national wealth in our research presented in the following chapters.

Material and method

Hypothesis

To the extent that short-term market imbalances - imperfect free competition and free trade, power imbalances - are levelled out in the long run through regional cooperation, the convergence assumed by liberal integration theory and targeted by regional policy can be measured in the long run among EU Member States.

Regional integration indicator (independent variable, x)

In our research, we used an estimation-based international trade liberalisation scale (ITLS) to measure regional integration, the values of which are defined by Szabó (2021a, 70) as follows:

1. The two endpoints of the ITLS, as shown in the first column of Table 1, are the discriminatory system (ITLS=0) and universal free trade (ITLS=10). Accordingly, the intermediate values of the scale are: equal treatment (ITLS=1), preferential trade regime/zone (ITLS=2), free trade area (ITLS=3), customs union (ITLS=4), common market (ITLS=5), single market (ITLS=6), economic union (ITLS=7), monetary union (ITLS=8), and political union (ITLS=9).
2. The ITLS value for a given free trade agreement for a given date - event - can be estimated using the above scale, taking into account the available data. For the EU, the initial ITLS was estimated at 2 in 1958 (preferential trade), 5 in 1968 (common market) and 6 in 1992 (single market). From 1999 onwards, fractional numbers (ITLS=6 and ITLS=8) became necessary, as the single market Member States entered EMU in partial and successive waves and the UK left the Community in 2020.

3. By linear interpolation of the ITLS event points, a continuous data series can be constructed, from 1958 to 2020 for the EU (Figure 1).

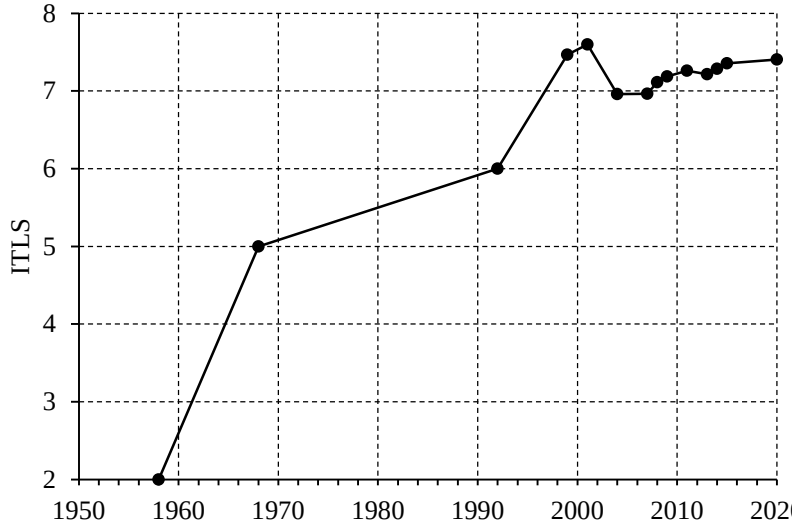


Figure 1: The evolution of EU integration, in the light of interpolated ITLS event points, from 1958 to 2020.
Source: Szabó (2021a, 92)

Convergence index (dependent variable, y)

As we have seen above, GDP per capita can be used as a basic indicator to measure convergence. GDP, however, is a one-sided and imprecise measure of economic performance, while national wealth is more than that, it includes natural and human elements. Although we do not yet know the exact indicator system for national wealth, we have used a variable proposed by Szabó (2021a, pp. 119-122), which we believe refines the measurement range of GDP, shifting the focus from unilateral measures of economic performance to national wealth. This variable is the complex economic well-being indicator (CEW), which can be formed by aggregating the following measures without weighting:

1. *GNI* as a share of GDP measures incomes received from abroad and outflows from within the country;
2. *the agricultural sector as a share of GDP*, measures the structural relationships of the sectors of the economy relative to GDP;
3. *GINI index*, a measure of income inequality;
4. *HDI index*, sub-indicators are: life expectancy index, education index, GNI.

The different measures used to construct the CEW have been normalised with relative extreme values between 0 and 1 (0 for unfavourable and 1 for favourable) to make them comparable.
Although the four basic indicators were given equal importance (25%) to avoid subjective elements, the final result is a weighted average, since the HDI index used is also composed of three additional indicators. Therefore, if the HDI index is broken down into further sub-indicators, the components of the PPSM can be refined and weighted as follows:

1. 33,33% stake: GINI;
2. 25.00% share: agricultural sector in GDP;
3. 25.00% share: GINI index;
4. 08.33% share: life expectancy index;
5. 08.33% share: education index.

We believe that the CEW takes into account economic wealth more accurately than the GDP index, since it corrects for it if income production and consumption would take place in other countries (GNI), takes into account the structural relations of the sectors of the economy (agricultural sector share in GDP), and certain human wealth elements, in particular inequality of income distribution (GINI index), and, in addition to GNI, life expectancy and education level (HDI index).

Databases used and period covered

The databases used in our research - World Bank, United Nations Development Program - contain the indicators from 1990 onwards from which the CEW can be determined. The ITLS estimate can be applied within the framework of the extreme values of the event points, i.e. 1958-2020. However, given that from 2020 onwards we may witness major global crises and geopolitical realignments beyond the scope of this study, the year 2020 has been excluded.
Based on the bottleneck of the CEW and ITLS datasets available to us as described above, our period of analysis is from 1990 to 2019.

Statistical methods used

Hypothesis testing was performed using bivariate regression analysis and correlation calculations. The strength of the relationship between the variables included in the study - ITLS (as independent variable) and CEW (as dependent variable) - was measured using a coefficient of determination (R^2).
The value of the CEW is given in the form of sigma convergence (CV), taking into account the objective of our study.
In order to smooth out the divergence jumps resulting from the accession of new Member States with different economic performances, in particular from the 2004 enlargement, a time series correction has been applied, dividing the EU's development into two sub-periods up to 2003 and from 2004 onwards. For each subperiod, we have taken into account the dependent variables of all the countries that were members of the Community in that subperiod, irrespective of their accession year (15 Member States up to 2003, 28 Member States from 2004). The curve of the two subperiods was fitted by a function transformation, which resulted in a correction of the numerical values of the variables along the axes.

Results

Hypothesis testing results

The relationship between the ITLS, an indicator of the estimated degree of regional integration, and the CEW (CV), a measure of convergence, is regression-analysed and correlation-calculated to show that the two variables are negatively linearly related over the period under study. The R^2 describing the relationship between the two variables is 0.9495, indicating a strong correlation. Considering that the relative error of the regression function exceeded 15%, the years 1990-1992, 1997-2001, 2004, and 2010 were standardized as extreme values, so that the relative error was reduced to below 15%. *Thus, if we accept the data processed and the methodology used, the results suggest that in the long run - 1990-2019 - regional cooperation between EU Member States has had a measurable - strongly deterministic effect on convergence, in line with the predictions of liberal integration theory and the objectives of regional policy* (Figure 2).

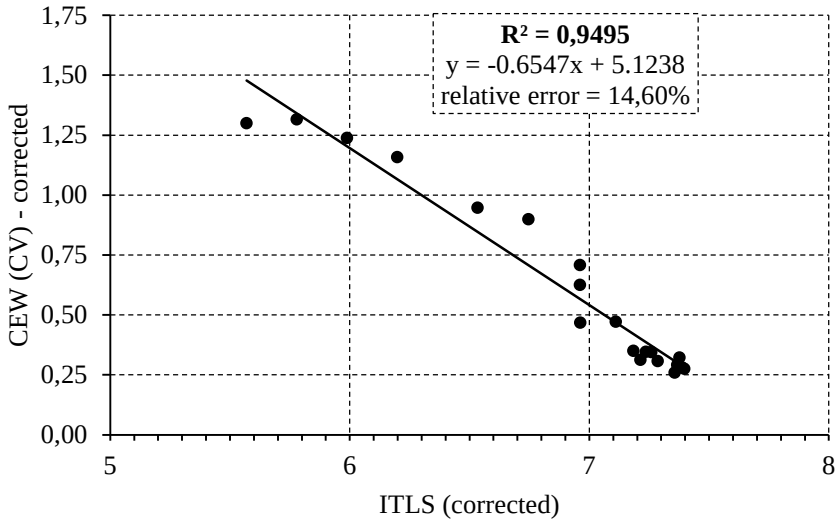


Figure 2: Relationship between ITLS and the dispersion of the CEW (CV), across EU Member States, 1990 to 2019.
Source: based on World Bank (2020, 2022), United Nations Development Program (2020, 2022), Szabó

If we also accept that the short-run market inequalities, suggested by the scatter of data points next to the regression function illustrated in Figure 2, arise from imperfect free competition and free trade and from different power relations, *our hypothesis* holds, i.e. the predictions of the convergence of the regular school in the short run and the liberal school in the long run.

Reliability assessment of CEW

In addition to the hypothesis testing, we also consider it necessary to analyse the reliability of the CEW, in particular the impact of attempts to reduce autocorrelation factors and GDP bias factors on the research results

The following steps were used to test the CEW:

1. The EU was compared to a regional integration in which the location of GDP production and consumption differs much more markedly than in the EU. Our choice was the SACU mentioned above. Indeed, the SACU economy is clearly dominated by the advanced economy of South Africa. For South Africa, the other member states of the Community - Botswana, Lesotho, Namibia and Swaziland - are important sources of raw materials and labour. In return, South Africa provides a market and a capital base.
2. Correlation calculations were performed for both regional integration using the following variables:

- Given that the ITLS estimation did not yield results for SACU due to the lack of a sufficient number of event points, the time series was used as a quasi-independent variable. By introducing a restrictive condition, we assumed that the time series and the degree of integration could be described by a positive linear relationship. As a consequence, the rules of the correlation calculus can be applied.
- As a dependent variable, GDP per capita and per year at purchasing power parity and fixed exchange rates were also examined in addition to the CEW.

The results of the correlation calculation show that for the EU there is no significant difference between convergence measured by the CEW and convergence measured by GDP. However, for

the SACU, while the CEW measures a strong divergence, GDP shows a weak convergence (Table 2).

Table 2: Convergence/divergence in PPS and GDP between EU and SACU Member States

Regional integration	Available data	R^2 CEW	R^2 GDP	R^2 difference
EU	1990-2019	0,9495 *strong convergence*	0,9501 *strong convergence*	0,0006
SACU	1990-2015	0,9198 *strong divergence*	0,4579 *weak convergence*	1,3777

Source: Maddison[4] (2003:62-65,68-69), World Bank (2020, 2022), United Nations Development Program (2020, 2022), Szabó

Thus, if we accept the data processed and the method used, the similarity in magnitude of the R^2 values for the EU leads us to conclude that the CEW did not contain significant autocorrelation factors in our hypothesis testing. This similarity in magnitude, and the significant difference in R^2 values observed for SACU, in turn, strengthens the criticisms of GDP. Sceptics argue that the bias of GDP is significant in cases where GDP is produced and consumed at different locations. This phenomenon is more pronounced among SACU Member States than in the EU economy.

Conclusions

The relationship between short-term divergence and long-term convergence

However, examining the causal link between regional policy and short-term market imbalances is beyond the scope of our study. Nevertheless, the logical conclusion *that can be* drawn from our research *is that regional policy can be an instrument that, in the long run, "bridges" the empirical experience of the regular school and the convergence theory of the liberal school.* In other words, to the extent that we accept the data processed and the methodology used, both the regular and the liberal school predictions are correct, but the former can be interpreted in the short term, the latter in the long term, and it is reasonable to assume that regional policy is an important factor in the smoothing effect between the two time periods (Figure 3).

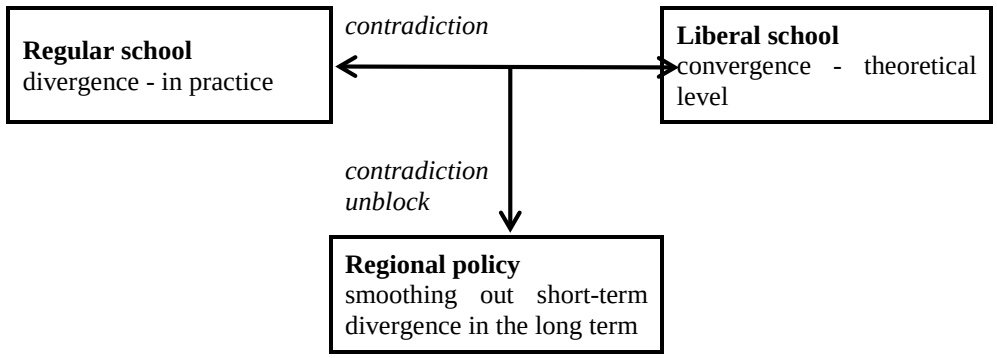


Figure 3: The link between regional policy and regional integration theories.
Source: own edited

[4] GDP for the EU1990-2003 is extracted from the statistical publication Maddisson (2003:62-65,68-69), which covers a wider time series.

Methodological boundaries

The regression analysis and correlation calculations used in the hypothesis testing were carried out with two novel variables (ITLS, CEW), as described in the material and methods section. Given that the statistical calculations with these indicators have supported the predictions of widely accepted theoretical trends, we believe that, given their methodological characteristics, they can be effectively applied to the investigation of the bivariate relationship between regional integration and convergence. In addition, we also consider it worth mentioning the main factors that limit their measurement range and suggest further research directions.
Szabó (2021a, pp. 94-95) suggests that the ITLS curve expressing the degree of regional integration is:

- It can only be used effectively in communities where several (at least two or three) ITLS event points can be identified during the integration evolution and the measurement range is narrowed down to the two extreme ITLS event points.
- It is necessarily based on an estimate with subjective elements.
- In practice, there may be transitional and mixed forms of regional cooperation in relation to the pre-defined categories of the ITLS, and in the long term there may be a need to create additional stages.
- Linear interpolation of ITLS event points can lead to estimated levels of integration that do not exist in reality (e.g. EU 1958-1968), and the trend of regional integration development is not necessarily linear.

The CEW used in the convergence analysis is believed to be:

- While it does mitigate the distorting effects of GDP - as it takes into account incomes received from abroad and income flows from the rest of the country, the structural distribution of economic sectors, and other human elements (income distribution, life expectancy, education) - it cannot be considered a national wealth indicator, it only accounts for some characteristic elements of economic wealth and human wealth, and does not measure natural wealth.
- Given that the CEW is an aggregate indicator, it can be argued that the four variables under consideration are not equally relevant when measuring the convergence effect of regional integration.
-

Further research directions

The results of the hypothesis testing presented above and the novel statistical indicators used may open up a number of further research avenues, of which the following two areas are considered key to the objective of our study:

1. *Exploring the causal link between regional policy and short-term market imbalances.* A precise identification of the link could help to formulate appropriate economic policy recommendations and to prepare and implement policy measures in order to achieve long-term convergence.
2. *Review and weighting of the indicators of the CEW.* The creation of a system of indicators of national wealth could not only clarify the results of the convergence research, but could also help decision-makers to identify and forecast the emergence of a middle-income trap, and help to determine its causes, avoid the "trap", or, in the case of an already existing crisis, to leave it.

References

ANJANI, I. R., & PRASETYO, P. E. (2024). Beta and sigma convergence analysis of inclusive economic growth on national and regional economic growth in Indonesia. *International Journal of Multidisciplinary: Applied Business and Education Research*, *5*(5), 1858–1871. http://dx.doi.org/10.11594/ijmaber.05.05.29

BALASSA, B. (1961). *The Theory of Economic Integration*. Homewood. Illinois: Richard D. Irwin.

BENCZES, I. (2011). A regionális moetáris integráció néhány elméleti kérdése. In: Palánkai, T. et al. (Eds), *A globális és regionális integráció gazdaságtana*. (pp. 174-200). Budapest: Akadémiai Kiadó.

BOD, P. Á. (2020). *Bevezetés a gazdaságpolitikába*. Budapest: Akadémiai Kiadó. https://doi.org/10.1556/9789634546016

BÓKA, É. (2001). *Az európai egységgondolat fejlődéstörténete.* Budapest: Napvilág Kiadó

BOTOS, K. (2013). Fizetési mérleg: a gazdaságpolitika mostohagyereke. *Közép-európai közlemények*, 6(1-2). 77-88. https://www.analecta.hu/index.php/vikekkek/article/view/12150/12009

CHENG, H., & KE, W. (2023). Multi-factor productivity growth with natural capital and undesirable output: A measurement for OECD and G20 countries. *Innovation and Green Development*, *2*(2), 1–14. https://www.sciencedirect.com/science/article/pii/S2949753123000073

CONSTANTINOVITS, M., & SIPOS, Z. (2014). *Nemzetközi üzleti technikák.* Budapest: Akadémiai Kiadó.

CSATH, M. (2001). *Kiút a globalizációs zsákutcából.* Budapest: Kairosz Kiadó.

CSATH, M. (2021). *Fejlődési csapdaveszély a pandémia után.* Budapest: Kairosz Kiadó.

CSATH, M. (2022). A versenyképesség fogalma és szerepének mérése. In M. Csath (Ed.), *Versenyképességi mozaik* (pp. 16–54). Budapest: Akadémiai Kiadó. https://doi.org/10.1556/9789634547587

CSATH, M. (2023). *Közgazdaságról közérthetően.* Budapest: Kairosz Kiadó.

DEATON, A., & SCHREYER, P. (2022). GDP, wellbeing, and health: Thoughts on the 2017 round of the International Comparison Program. *Review of Income and Wealth*, *68*(1), 1–15. https://doi.org/10.1111/roiw.12520

DŐRY, T., & PONÁCZ, GY. M. (2003). Az infokommunikációs ágazatok szerepe és súlya a magyar városhálózatban. *Tér és társadalom*, *17*(3), 165–181. https://ponacz-gyorgy-mark.weebly.com/uploads/1/2/0/6/12064579/2003t%C3%A9t-tanulm%C3%A1ny.pdf https://doi.org/10.17649/TET.17.3.906

DYNAN, K., & LOUISE, S. (2018). GDP as a measure of economic well-being. *Hutchins Center Working Papers*, *43*(1), 1–52. https://www.brookings.edu/wp-content/uploads/2018/08/WP43-8.23.18.pdf

ESZE, M. et al. (2009). *Integrálódó Európa.* Budapest: Perfekt Gazdasági Tanácsadó, Oktató és Kiadó.

FELDSTEIN, M. (2017). Underestimating the real growth of GDP, personal income, and productivity. *Journal of Economic Perspectives*, *31*(2), 145–164. https://doi.org/10.1257/jep.31.2.145

HALMAI, P. (2020). *Európai gazdasági integráció.* Budapest: Dialóg Campus.

HAMILTON, J. D. (2021). Measuring global economic activity. *Journal of Applied Econometrics*, *36*(3), 293–303. https://doi.org/10.1002/jae.2740

HUSSAIN, M. R. (2022). Measuring the impact of globalization on countries using composite indexes. *Cross-Curtular Management Journal*, *24*(2), 121–142. https://seaopenresearch.eu/Journals/articles/CMJ2022_I2_5.pdf

KASZALIK, Z. (2023). Az Európai Unió kohéziós törekvései – az oktatás, képzés mint beavatkozási altényezők. In Kecskés, P., Tompos, A., & Szőke, J. (Eds.), *Kultúra, kommunikáció, nemzetközi kapcsolatok* (pp. 125–132). Győr: Széchenyi István Egyetem. https://ntk.sze.hu/images/Kutat%C3%A1s/NTKT_2023_Kult%C3%BAra_kommunik%C3%A1ci%C3%B3_nemzetk%C3%B6zikapcsolatok.pdf

KISS, G. F. (2021). *Regionalitás az Európia Unió kohéziós politikájában. Forrásallokációs dilemmák a fővárosi régiók speciális helyzetének tükrében.* (PhD dissertation) Budapesti

Corvinus Egyetem, Budapest. https://doi.org/10.32559/et.2021.4.4 http://phd.lib.uni-corvinus.hu/1202/1/Kiss_Gabor_Ferenc_dhu.pdf

KURUCZLEKI, É., LONDON, A., & PELLE, A. (2017). Klubjavak, konvergencia és komplexitás az Európai Unióban. In Homoki-Nagy, M. (Ed.), *Katona Tamás ünnepi kötet* (pp. 42–60). Szeged: Szegedi Tudományegyetem. http://acta.bibl.u-szeged.hu/73590/1/juridpol_082_041-060.pdf

KUTASI, G. (2011). Monetáris uniók elemei a regionális integrációkban. In Palánkai, T. et al. (Eds.), *A globális és regionális integráció gazdaságtana* (pp. 201–216). Budapest: Akadémiai Kiadó.

LOSONCZ, M. (2011). *Az Európai Unió Rómától Budapestig.* Tatabánya: Tri-Mester.

MADDISON, A. (2003). *The world economy: Historical statistics.* Paris: OECD. https://doi.org/10.1787/9789264104143-en

MATOLCSY, GY. (2020). Quo vadis Hungária? – Arccal egy új világ felé. *Polgári Szemle, 16*(1–3), 13–35. https://doi.org/10.24307/psz.2020.0703

MÉSZÁROS, Á. (2007). Regionális integrációk a világgazdaságban. In BLAHÓ, A. et al. (Eds.), *Világgazdaságtan* (pp. 251–279). Budapest: Akadémiai Kiadó.

MINK, R. (2022). Happiness and happiness researchers. In MINK, R. (Ed.), *Official statistics – A plaything of politics?* (pp. 275–292). Cham: Springer. https://doi.org/10.1007/978-3-031-04624-7_11

NGUYEN, D., & PACZOS, M. (2020). Measuring the economic value of data and cross-border data flows: A business perspective. *OECD Digital Economy Papers, (297)*, 1–47. https://doi.org/10.1787/6345995e-en

PALÁNKAI, T. (2002). Vámunió-elméletek. In Blahó, A. (Ed.), *Világgazdaságtan II.* (pp. 357–359). Budapest: Aula Kiadó.

PALÁNKAI, T. et al. (2011). *A globális és regionális integráció gazdaságtana.* Budapest: Akadémiai Kiadó.

PINTÉR, T. (2017). Az európai integráció – gazdasági és politikai alapú elméleti megközelítések. *Polgári Szemle, 13*(4–6), 341–364. https://doi.org/10.24307/psz.2017.1225

PUCHALA, D. J. (1972). Of blind men, elephants and European integration. *Journal of Common Market Studies, 10*(3), 267–286.

QUIROS-ROMERO, G., & MARSHALL, B. R. (2020). *Measuring economic welfare: What and how?* Washington, D.C.: International Monetary Fund. https://dspace.ceid.org.tr/xmlui/bitstream/handle/1/992/MEASURING%20ECONOMIC%20WELFARE.pdf?sequence=1

ROSS, S. (2019). What are the best measurements of economic growth. https://www.investopedia.com/ask/answers/032515/what-are-best-measurements-economic-growth.asp (downloaded: March 2025)

SIMAI, M. (2003). Globalizáció és regionális együttműködés a XXI. század elején. In Blahó, A. (Ed.), *Európai integrációs alapismeretek* (pp. 41–66). Budapest: Aula Kiadó.

SOUTHERN AFRICAN CUSTOMS UNION (2025). https://www.sacu.int/ (downloaded: April 2025)

SZABÓ, B., & DÁVID, L. D. (2023). A gazdasági teljesítmény mérése a konvergencia-vizsgálat során GDP-től a nemzeti vagyonig. *Polgári Szemle, 19*(1–3), 31–47. https://doi.org/10.24307/psz.2023.0904

SZABÓ, B. (2021a). A regionális integrációk fejlődésének elmélete és konvergencia hatásuk mérésének gyakorlata. (PhD dissertation) Magyar Agrár- és Élettudományi Egyetem, Gödöllő https://uni-mate.hu/documents/20123/336900/Szabo_Barna_ertekezes.pdf/6247655e-4d2e-80dc-0575-73c9e30b4d85?t=1645785925286

SZABÓ, B. (2021b). Liberális-, vs. regulációs integrációelméletek, azaz konvergencia, vagy divergencia. *Multidiszciplináris kihívások, sokszínű válaszok – Gazdálkodás- és Szervezéstudományi folyóirat, (2)*, 95–123. https://doi.org/10.33565/MKSV.2021.02.05

TÓTH, J. (Ed.). (2010). *Világföldrajz.* Budapest: Akadémiai Kiadó.

UNITED NATIONS DEVELOPMENT PROGRAM. (2020, 2022). *Human Development Reports.* https://hdr.undp.org/data-center/documentation-and-downloads (downloaded: June 2024)

VARGA, A. (2016). *Regionális fejlesztéspolitikai hatáselemzés.* Budapest: Akadémiai Kiadó. https://doi.org/10.1556/9789634540151

WORLD BANK. (2020, 2022). *Data Bank – World Development Indicators.* https://databank.worldbank.org/source/world-development-indicators# (downloaded: October 2020, Juli 2022)

WORLD TRADE ORGANIZATION. (2025). https://www.wto.org/index.htm (downloaded: April 2025)

Máté Zöldy[5] - Pál Péter Kolozsi[6]

Modeling the Impact of Economic Interventions on Mobility Sustainability: A Multidimensional Approach

Economic instruments provide an opportunity to influence the sustainability of mobility positively. It is important to understand the distribution of mobility forms in terms of functional space use and individual and social utility to understand the effects of applying economic instruments. Economic instruments affect social utility by influencing individual decisions based on the technical characteristics of functional space use. This paper explores these relationships, which can help determine where and to what extent currently preferred economic instruments have an impact. The model allows for identifying areas where the use of financial instruments is expected to have significant utility. This article presents the details and internal connections of the developed four-dimensional model. The created model is a suitable tool for more accurately assessing the effects of economic instruments in the future.
Keywords: Economic Instruments, Sustainable Mobility, Personal Utility, Social Utility, Functional space use
JEL code: R11, R41, R48

https://doi.org/10.32976/stratfuz.2025.16

Introduction

Mobility development is one of the cornerstones of human development, shaping societies and economies. At the beginning of the third millennium, mobility transformation is driven by technological innovations, sustainability demands, and changing social expectations. Key aspects of this transformation include cognitive mobility, functional space use of mobility, various forms of mobility, sustainability demands, and economic instruments influencing mobility. Understanding these aspects and their internal connections can help achieve maximum results with economic instruments (Kocziszky, 2022).

Cognitive mobility integrates artificial intelligence (AI) and cognitive technologies into transportation systems (Horváth et al., 2024). This concept includes using AI to improve vehicle automation, traffic management, and user experience and developing and researching elements of the mobility system. Cognitive mobility aims to create seamless interaction between humans and machines, optimize routes, reduce congestion, and improve safety. For example, AI-equipped autonomous vehicles can make real-time decisions based on traffic conditions, increasing efficiency and reducing accident likelihood (Heinike et al., 2023). The advancement of cognitive mobility is crucial because it significantly increases our real-time knowledge related to mobility, allowing for more precise quantification of the effects of economic instruments (Zöldy & Baranyi, 2023).

The changes in society and mobility require us to examine and, if necessary, redefine our understanding of mobility. The classic urban-rural-highway mobility has changed with increasing urbanization, creating a new form of mobility space use: downtown mobility (Zöldy, 2024). This new approach more accurately describes reality and is crucial for evaluating the sustainability of road mobility tools and understanding the effects of related economic measures. Mobility needs and patterns vary significantly in different spatial contexts:

[5] PhD, Budapest Metropolitan University, Research Centre for Financial Innovation; e-mail: mzoldy@metropolitan.hu
[6] PhD, Budapest Metropolitan University, Research Centre for Financial Innovation; email: ppkolozsi@metropolitan.hu

Downtown mobility appears in densely populated city centres with many office workplaces, walking and micromobility (e.g., e-scooters, bicycles) are common due to short distances and high traffic congestion. Many areas have traffic-calmed or even car-free zones. Parking is scarce and expensive (Zamprogno & Esztergár-Kiss 2024). Public transportation systems such as buses and subways are essential for efficiently handling large numbers of commuters (Lang et al., 2024). Urban mobility is common in broader urban areas. Personal vehicles, public transportation, and micromobility options are used for the transportation, walking is less common compared to downtown. The availability of various transportation modes helps reduce congestion and provides flexibility for different travel needs (Crivellari & Retsch, 2022). In rural areas, personal vehicles dominate due to the lack of extensive public transportation infrastructure. Distances between destinations are generally greater, making walking and micromobility less practical (Infrastructure USA, 2017). Personal vehicles and freight transport primarily use highways for long-distance travel. Here, speed and efficiency are emphasized, with less focus on public transportation (Alessandretti et al., 2017).

Sustainability is a critical aspect in developing modern mobility systems (Zöldy et al., 2023; Zöldy et al., 2024). The transportation sector significantly contributes to greenhouse gas emissions, accounting for approximately 25% of global CO_2 emissions (Crivellari & Resch, 2022). To address this issue, there is increasing emphasis on developing sustainable mobility solutions such as electric vehicles (EVs) (Wengritzky, 2023), public transportation powered by renewable energy, and infrastructure for active transportation modes like cycling and walking. Policies promoting low-emission vehicle use (Lucyszyn, 2024), investment in public transportation infrastructure, and urban planning encouraging sustainable mobility are essential for reducing transportation's environmental footprint (Ghanbari et al., 2024; Attard & Ison, 2010).

Economic instruments play a vital role in shaping mobility patterns and promoting sustainable practices (Szalmáné et al., 2024; Zöldy & Kolozsi, 2025). These instruments can be categorized into two main groups related to pollution reduction (Hörcher & Tirachini, 2021). The first group includes "command and control" measures, while the second group encompasses "incentives," which cover a wide range of tools. Generally, incentive-based tools are more advantageous as they pay greater attention to economic efficiency. Additionally, implementation costs are typically higher for "command and control" policies (Rothengatter, 1994).

In summary, the development and transformation of mobility are driven by technological advancements, sustainability goals, and economic strategies. By integrating cognitive technologies, optimizing space use, promoting diverse forms of mobility, and utilizing economic instruments, a more efficient, sustainable, and inclusive transportation system can be created for the future.

Methodology

Main logic of the carried out research is presented in Figure 1. According to this hypothesis, economic measures primarily affect individual utility and functional space use of mobility. An example of a measure affecting individual utility is increasing the maximum allowed speed (reducing travel time by car), which increases the likelihood of choosing a personal car or supporting the use of shared electric scooters, which may increase their usage. A decision affecting functional space use includes supporting suburban rail passes or banning internal combustion engine vehicles from city centers. Economic measures rearrange individual decision preferences; through these choices, they affect the performance share of transportation modes influencing social utility and CO_2 emissions.

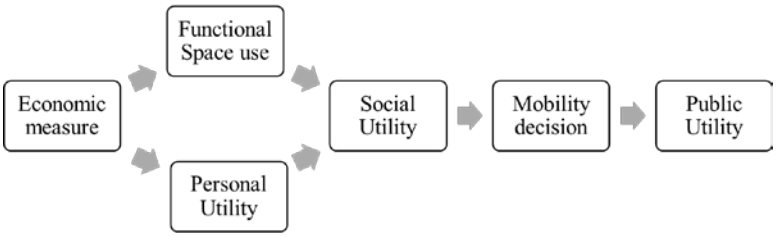


Figure 1: Mechanism of economic measures' impact on mobility
Source: Own compilation

Economic measures affecting mobility was summarised based on literature (Zöldy & Kolozsi, 2025). The paper analyzes economic policy tools aimed at promoting sustainable mobility. The study presents various economic tools used in the transport sector, such as regulatory and incentive-based tools. It reviews the European emission standards, technological standards, performance standards, as well as taxes and subsidies' role in promoting sustainable transport. The paper highlights the importance of economic tools in managing mobility sustainability and suggests ways to increase different tools' effectiveness.

During model creation, functional space use was examined based on a previously presented four-level model (Zöldy, 2024), distinguishing between downtown, urban, rural, and highway mobilities. The article examines changes in space use during the cognitive mobility era. The study presents urbanization's impact on transport forms and sustainability, analyzing current urban, rural, and highway categories, proposing a new category focusing on downtown areas, considering low speed, pedestrian interactions, and limited parking. It emphasizes the importance of adapting transport systems for sustainable mobility and highlights the need for further research in this area.

Individual utility means individuals choose transport options providing the greatest benefit or utility, comprising factors like travel cost, duration, comfort, safety, and environmental impact. Differing preferences result in varying utilities; for example, some prioritize speed, while others prefer cost-effectiveness or eco-friendly solutions. Thus, individual utility means selecting the best transport option matching preferences and needs. Literature shows travel time importance alongside cost equivalence. Travel time and cost equivalence, with travel cost usually being a flat rate, led us to choose average speed as the model basis.

Mobility decisions and alternatives, or modal split, represent the performance share of different transport modes in a given area or system. The modal split has four main elements: walking, micromobility, public transport, and car usage. Walking is the most sustainable mode, requiring no fossil fuel and having minimal environmental impact. It is influenced by sidewalk quality, pedestrian-friendly infrastructure, safety, and urban density. Cycling is also an eco-friendly mode, improving air quality and promoting a healthy lifestyle. It is influenced by the bike lane network, bike storage availability, safety, and comfort. Public transport, including buses, trams, metro, and trains, effectively reduces congestion and emissions. Its share is influenced by service frequency, reliability, comfort, cost, integrated ticketing, transfer options, and traveler information. Car usage is a convenient and flexible mode but has significant environmental impacts, including air pollution and congestion. Its share is influenced by fuel cost, parking availability and fees, tolls, and infrastructure quality.

Mobility decisions and alternatives, or modal split, represent the performance share of different transport modes in a given area or system. The modal split has four main elements: walking, micromobility, public transport, and car usage. Walking is the most sustainable mode, requiring no fossil fuel and having minimal environmental impact. It is influenced by sidewalk quality, pedestrian-friendly infrastructure, safety, and urban density. Cycling is also an eco-friendly mode, improving air quality and promoting a healthy lifestyle. It is influenced by the bike lane network, bike storage availability, safety, and comfort. Public transport, including buses, trams, metro, and trains, effectively reduces congestion and emissions (Surmanova et al., 2025). Its share is

influenced by service frequency, reliability, comfort, cost, integrated ticketing, transfer options, and traveler information. Car usage is a convenient and flexible mode but has significant environmental impacts, including air pollution and congestion. Its share is influenced by fuel cost, parking availability and fees, tolls, and infrastructure quality.
The social utility of mobility decisions is significant in many aspects, as it affects not only individuals but also the well-being of society as a whole. The impact of economic measures on social utility appears in four major areas of mobility: environmental benefits, economic benefits, social benefits, and health benefits. Presented research focuses on examining the impact of economic instruments on sustainable mobility, equating social utility with this in our work. Among environmental benefits, we focus on CO_2 emissions, which drive current economic decisions.

Results

The dimensions presented in the methodology section form the framework of our model:

Dimensions

Based on the methodology section, the dimensions of the model were identified. These are shown in Table 1.

Table 1: Dimensions of the Mobility Sustainability Model

Dimension	Unit / Value Set
Functional space use	Downtown, Urban, Rural, Highway
Individual utility	Average speed, [m/s]
Mobility alternatives	Personal car use, Public transport, Micromobility, Walking
Social utility	Environmental impact, [CO_2/passangerkm]

Source: Own compilation

Simplification for Model Construction

During model construction, the relationships between dimensions were simplified to examine whether the model can be used to demonstrate and evaluate the effects of economic instruments. The simplification allows for demonstrating the operation, but higher resolution relationships will likely be needed in future model development.

Dimension Relationships

The relationships between dimensions were taken from international literature. When using the model, it is possible to specify unique dimension relationships, making the results more specific. At this stage of model creation, average relationships were applied to demonstrate the operation.

Table 2: Dimension Relationships in Mobility for Demonstrating the Impact of Economic Instruments

		distribution %	individual utility (average speed) (m/s)	social utility (CO_2 emission) (gCO_2/pkm)
Downtown	Public transport	34	5.5	80
	Personal car	25	8.4	160
	Micromobility	23	4	20

	Walking	18	1.42	40
Urban	Public transport	23	8.3	60
	Personal car	48	10	140
	Micromobility	16	6	20
	Walking	14	1.42	40
Rural	Public transport	7.65	13.9	60
	Personal car	77.5	19.4	115
	Micromobility	2.1	5.5	20
	Walking	13.1	0	0
Motorway	Public transport	5	7.7	76
	Personal car	95	30.5	140
	Micromobility	0	0	0
	Walking	0	0	0

Source: Own compilation

In Table 2, the dimension relationships were quantified based on international literature, the details are follows:

Functional Space Use Distribution

The distribution of passenger transport volume in passenger kilometers (passenger km) across different areas such as downtown, urban, rural, and highway can vary significantly by region and the data of the given year. As a starting point, the average mobility distribution of Europe was taken. The aggregated data in Table 3 were collected from multiple sources (ERF, 2024; Transportation Statistics, 2023; EEA, 2024; Eurostat, 2024; ITF, 2023).

Table 3: Distribution of Personal Mobility by Space Use (own collection)

Space Use	EU
Downtown	20%
City	40%
Rural	15%
Highway	25%

Source: Own compilation

Mobility Form Distribution

The distribution within each functional space was also determined based on international literature. For urban personal transport performance distribution, we used McKinsey's 2023 study (Heineke et al., 2023). The distribution of mobility in downtown traffic-calmed zones was determined based on sources (Oeschger et al., 2023; Schwinger et al., 2022). The rural usage distribution was based on (Purcher & Renne, 2005). For highway usage estimation, we used (Aparicio, 2016).

Determining Individual and Social Utilities

To determine the social utility of different mobility forms, we used (NAVIT, 2024) as a source for highways.

Diagram and Evaluation

The relationship between the examined dimensions is visualized in Figure 1. The x-axis represents individual utility, shown as average travel speed [m/s]. The higher the value on this scale, the greater the utility for the individual. The y-axis shows social utility represented by CO_2 emissions per passenger kilometer [gCO_2/passangerkm]. For society, greater utility means lower values on this scale: lower CO_2 emissions per passenger kilometer. The vertical z-axis represents functional space use: downtown, city, rural, and highway. In this space, personal transport mobility forms (walking, micromobility, public transport, personal car use) are illustrated. The sum of the shares in each functional space is 100%. The values of mobility forms are connected for easier visual understanding, indicating that they are of the same type, but their connection is not mathematically justified as they are not continuous.

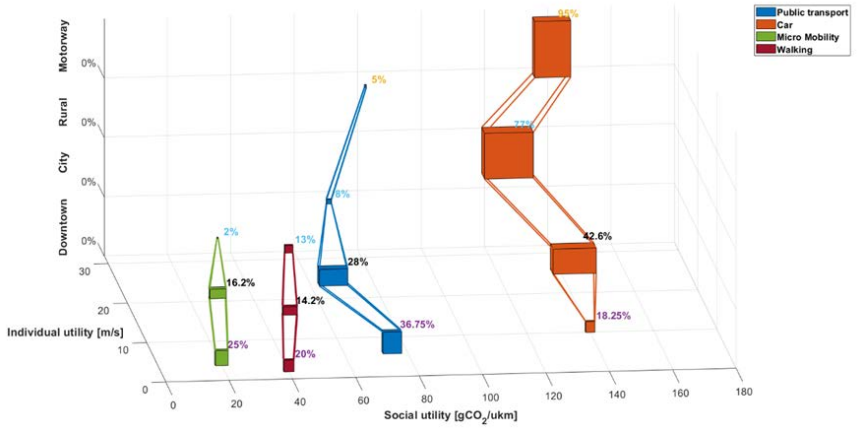


Figure 1: Visualization of the Relationship Between Examined Dimensions
Source: Own compilation

The initial state was developed using average values typical for a mid-European country. These values are suitable for demonstrating the relationships.

Demonstrating an Impact

With the completed model, the goal is to demonstrate, model, evaluate, and plan economic instruments that aim to influence mobility sustainability. For this demonstration, the introduction of the London Congestion Charge (LCC) in 2011 was chosen. According to (Tang, 2021), the charge boundary is drawn around the city center to alleviate congestion on London's busiest roads. The charge for entering the zone was initially £5 on weekdays between 7:00 and 18:30, which has since increased to £15. This Pigouvian tax forces drivers to internalize the externalities imposed on others by congestion. By closing the gap between the marginal cost of driving and the social marginal cost, the LCC reduces equilibrium traffic volume, bringing it closer to the socially optimal level. The introduction of the LCC has the following impacts, quantified in Table 4:
In the downtown area, the cost of personal car use increases, reducing its share. CO_2 emissions per passenger kilometer decrease due to faster flow, reduced idling, and less slow parking search. The shares of the other three mobility forms increase.

In the city, the share of personal cars slightly decreases, average speed increases, and CO_2 emissions per passenger kilometer decrease, improving social utility.

Table 4: Demonstrating the Impact of Economic Instruments in the Model

Downtown congestion price		distribution %	individual utility (average speed) (m/s)	social utility (CO_2 emission) (gCO_2/pkm)
Downtown	Public transport	36.75	6.05	75
	Personal car	18.25	10.08	140
	Micromobility	25	4	20
	Walking	20	1.42	40
Urban	Public transport	28	8.715	58
	Personal car	42.6	10.5	135
	Micromobility	16.2	6	20
	Walking	14.2	1.42	40
Rural	Public transport	7.65	13.9	60
	Personal car	77.5	19.4	115
	Micromobility	2.1	5.5	20
	Walking	13.1	0	0
Motorway	Public transport	5	7.7	76
	Personal car	95	30.5	140
	Micromobility	0	0	0
	Walking	0	0	0

Source: Own compilation

The initial state was developed using average values typical for a mid-European country. These values are suitable for demonstrating the relationships.

The changes between the initial state and the introduction of the congestion charge are shown in Table 5, and the modified Figure 2 based on the data from Table 4.

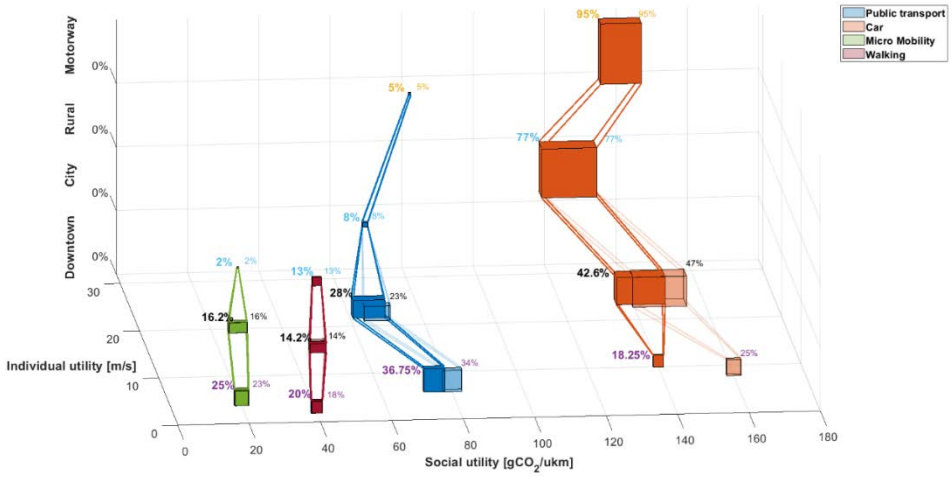
Table 5: Changes Caused by the Introduction of the Downtown Congestion Charge

Downtown Congestion Charge		Distribution change %	Individual utility (m/2s)	Social utility (gco2/passkm)
Downtown	Public transport	2.75	+ 0.55	-5
	Personal car	-6.75	+1.68	-20
	Micromobility	2	0	0
	Walking	2	0	0
Urban	Public transport	5	+0.415	-2
	Personal car	-5.4	+0.5	-5
	Micromobility	0.2	0	0
	Walking	0.2	0	0

Source: Own compilation

The introduction of the London Congestion Charge generates an average annual revenue of £200 million for the city, improving social utility. The model shows that it effectively intervenes in the mobility system, shifting it in a direction more favorable to society. It increases the individual and social utility of personal cars while reducing their share in favor of more socially beneficial forms of mobility, primarily public transport. The social and individual utility of public transport improves as a result of the measure.

Figure 2: London congestion charge effect



Source: Own compilation

The example demonstrates that the model works and is suitable for presenting the impacts of economic measures on mobility.

Further Development

In further developing the model, we aim to create connection points where data available in existing databases can be integrated into the model. The goal is to enable more precise analysis of the impacts of economic measures on mobility by filling the general model with specific data for a country or region. Further refinement of the model will involve creating the possibility for more detailed connections between dimensions, rather than point-to-point connections. At this stage, it is important to consider the accuracy and resolution of the data available for application and to provide the option to return to an aggregated level. Part of the model's development includes analyzing already implemented economic measures and comparing the results with those from other sources.

Conlusion

In our work, we examine the impact of economic instruments on mobility sustainability. The goal of our research is to develop a four-dimensional model that helps identify the effectiveness of economic instruments in different mobility forms and spatial contexts. The methodology is based on analyzing functional space use of mobility, individual and social utility, and mobility alternatives. The results were validated through an existing example. The model is suitable for demonstrating the impacts of economic instruments, such as the downtown congestion charge. Further development of the model will involve integrating existing databases and refining dimension connections.

Acknowledgments

The project presented in this article is supported by OTKA 2021/138053.

References

ALESSANDRETTI, L., SAPIEZYNSKI, P., LEHMANN, S., & BARONCHELLI, A. (2017). Multi-scale spatio-temporal analysis of human mobility. *PLOS ONE, 12*(2), e0171686. https://doi.org/10.1371/journal.pone.0171686

APARICIO, A. (2016). Exploring recent long-distance passenger travel trends in Europe. *Transportation Research Procedia, 14*, 3199-3208. https://doi.org/10.1016/j.trpro.2016.05.262

ATTARD, M., & ISON, S. G. (2010). The implementation of road user charging and the lessons learnt: the case of Valletta, Malta. J*ournal of Transport Geography, 18*(1), 14-22. https://doi.org/10.1016/j.jtrangeo.2009.05.009

BARBOSA, H., BARTHELEMY, M., GHOSHAL, G., JAMES, C. R., LENORMAND, M., LOUAIL, T., MENEZES, R., RAMASCO, J. J., SIMINI, F., & TOMASINI, M. (2018). Human mobility: Models and applications. *Physics Reports, 734*, 1-74. https://doi.org/10.1016/j.physrep.2018.01.001

BOLTZE M., & REUSSWIG, A. (2000). *First Review of Avaliable Data: Modal Split in Different Countries.* AICPR/PIARC C4. Technische Universität Darmstadt, Institut für Verkehr Fachbereich 13 · Bauingenieurwesen und Geodäsie. https://www.verkehr.tu-darmstadt.de/media/verkehr/fgvv/for/publik/S010.pdf (Reached 12.18.2024.)

CRIVELLARI, A., & RESCH, B. (2022). Investigating functional consistency of mobility-related urban zones via motion-driven embedding vectors and local POI-type distributions. *Computational Urban Science, 2*(19). https://doi.org/10.1007/s43762-022-00049-8

CZAJKOWSKI, M., GIERGICZNY, M., KRONENBERG, J., & ENGLIN, J. (2019). The individual travel cost method with consumer-specific values of travel time savings. *Environmental and Resource Economics, 74*, 961-984. https://doi.org/10.1007/s10640-019-00355-6

EEA. (2024, October 10). Passenger transport activity. https://www.eea.europa.eu/en/analysis/publications/sustainability-of-europes-mobility-systems/passenger-transport-activity (Retrieved 2024.12.22.)

ERF (European Union Road Federation). Passanger Transport 2023. https://erf.be/statistics/passenger-transport-2023/ (Retrieved 2024.12.22.)

EUROSTAT. (n.d.). Passenger mobility statistics. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Passenger_mobility_statistics (Retrieved 2024.12.22.)

GALLOTTI, R., SACCO, P., & DE DOMENICO, M. (2021). Complex urban systems: Challenges and integrated solutions for the sustainability and resilience of cities. *Complexity, 2021*(1), 1782354. https://doi.org/10.1155/2021/1782354

GHANBARI, M., KARIMI, M., CLARAMUNT, C., & LAGESSE, C. (2024). A Spatial Interaction Model for the Identification of Urban Functional Regions. In M. Lotfian, & L. L. L. Starace (Eds.), *Web and Wireless Geographical Information Systems. W2GIS 2024* (Vol. 14673, pp. 195–209). Cham: Springer. https://doi.org/10.1007/978-3-031-60796-7_14

HEINEKE, K., LAVERTY, N., MÖLLER, T., & ZIEGLER, F. (2023). The future of mobility. *McKinsey Quarterly, 2023*(April 19), 1-14. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-future-of-mobility-mobility-evolves (Reached 16.12.2024.)

HERMÁNDY-BERENCZ, J. (2003). A mobilitás szerepe az Európai Unióban. *Új Pedagógiai Szemle, 1*, 117-124.

HORVÁTH, I., BERKI, B., SUDÁR, A., CSAPÓ, Á., & BARANYI, P. (2024). Cognitive Mobility. In *Cognitive Aspects of Virtual Reality* (pp. 49-63). Springer. https://doi.org/10.1007/978-3-031-68130-1 https://doi.org/10.1007/978-3-031-68130-1_3

HÖRCHER, D., & TIRACHINI, A. (2021). A review of public transport economics. *Economics of transportation*, *25*, 100196. https://doi.org/10.1016/j.ecotra.2021.100196

INFRASTRUCTURE USA. (2017). *Public transportation's impact on rural and small towns.* American Public Transportation Association (APTA). Retrieved from https://infrastructureusa.org/public-transportations-impact-rural-small-towns/

INTERNATIONAL TRANSPORT FORUM. (2023). *Key Transport Statistics, 2023.* https://www.itf-oecd.org/sites/default/files/docs/key-transport-statistics-2023.pdf (Reached 12.22.2024.)

KOCZISZKY, G. (2022). A New Perspective on Sustainability. *Financial And Economic Review*, *21*(4), 217-219.

LAKATOS, A., & MÁNDOKI, P. (2020). Sustainability analysis of competition in public transport systems: A comparative case study in Hungary and Finland. *Periodica Polytechnica Civil Engineering*, *64(*2), 545-556. https://doi.org/10.3311/PPci.14824

LANG, N., HAGENMAIER, M., SMILKSTINS, A., SACKMANN, S., BOUTENKO, V., SARGEANT, R., BENATTI, E., & WAHL, J. (2024, October 28). *Moving Millions: A Recipe to Make Urban Mobility Work*. BCG Automotive Industry.

ŁUCZYSZYN, K. (2024). Sustainable transport – development and goals. *Cognitive Sustainability*, *3*(1). https://doi.org/10.55343/cogsust.92

MOSLEM, S., MOHAMMADI, M., ISMAEL, K., & ESZTERGÁR-KISS, D. (2025). Fostering sustainable urban mobility via stakeholder engagement: A novel analytic hierarchy process and half-quadratic programming. *Research in Transportation Business & Management*, *59*, 101291. https://doi.org/10.1016/j.rtbm.2025.101291

NAVIT. (n.d.). *Bus, train, car or e-scooter: Carbon emissions of transport modes ranked.* https://www.navit.com/resources/bus-train-car-or-e-scooter-carbon-emissions-of-transport-modes-ranked (Retrieved December 22, 2024)

OESCHGER, G., CAULFIELD, B., & CARROLL, P. (2023). Investigating the role of micromobility for first- and last-mile connections to public transport. *Journal of Cycling and Micromobility Research*, *1*, 100001. https://doi.org/10.1016/j.jcmr.2023.100001

PUCHER, J., & RENNE, J. L. (2005). Rural mobility and mode choice: Evidence from the 2001 National Household Travel Survey. *Transportation*, *32*, 165-186. https://doi.org/10.1007/s11116-004-5508-3

ROTHENGATTER, W. (1994). Do external benefits compensate for external costs of transport?. *Transportation Research Part A: Policy and Practice*, *28*(4), 321-328. https://doi.org/10.1016/0965-8564(94)90006-X

SCHWINGER, F., TANRIVERDI, B., & JARKE, M. (2022). Comparing Micromobility with Public Transportation Trips in a Data-Driven Spatio-Temporal Analysis. *Sustainability*, *14*(14), 8247. https://doi.org/10.3390/su14148247

SMALL, K. A. (2012). Valuation of travel time. *Economics of Transportation 1*(1–2), 2–14. https://doi.org/10.1016/j.ecotra.2012.09.002

SMALL, K. A. & GOMEZ-IBANEZ, J. A. (1998). *Road Pricing, Trafc Congestion and the Environment: Issues of Efficiency and Social Feasibility.* Cheltenham: Edward Elgar.

STATISTA. (2024, January 30). *Transportation and Logistics, Modal split in passenger transport worldwide in 2022 with a forecast for 2030*. Statista Research Department.

SURMAŘOVÁ, S., NEUMANNOVÁ, M., PAŘIL, V., VRÁNA, M., & CHMELÍK, J. (2025). Do I really like to shift to rail? Influence of rail modernisation on passenger preferences. *Research in Transportation Business & Management*, *59*, 101284. https://doi.org/10.1016/j.rtbm.2024.101284

SZALMÁNÉ CS. M., ZÖLDY, M., & TÖRÖK, Á. (2024). Új mobilitási megoldások: technikai lehetőségek és pénzügyi aspektusok a fenntarthatóság tükrében. In *A pénz jövője, a jövő pénze I-II.* Budapest: MNB.

TANG, C. K. (2021). The cost of traffic: Evidence from the London congestion charge. *Journal of Urban Economics*, *121*, 103302. https://doi.org/10.1016/j.jue.2020.103302

TRAIN, K. E. (2009). *Discrete choice methods with simulation*. Cambridge University Press.

TRANSPORT DIRECT (2008). Kilograms of CO2 per passenger kilometre for different modes of transport within the UK. https://www.aef.org.uk/downloads/Grams_CO2_transportmodesUK.pdf&ved=2ahUKEwiW1a6_47uKAxWY_rsIHbzoE0AQFnoECBMQAQ&usg=AOvVaw0hu7xC77NNiwTA6kWycMfg (Retrieved 12.22.2024.)

TRANSPORTATION STATISTICS ANNUAL REPORT. (2023). *Bureau of Transportation Statistics*. https://www.bts.gov/sites/bts.dot.gov/files/2023-12/TSAR-2023_123023.pdf (Retrieved 12.22.2024.)

WARDMAN, M. (2001). A review of British evidence on time and service quality valuations. Transportation Research Part E: Logistics and Transportation Review, 37(2-3), 107-128. https://doi.org/10.1016/S1366-5545(00)00012-0

WENGRITZKY, Z. (2023). Spatial analysis of the BEV market and the corresponding charging infrastructure in Hungary. *Cognitive Sustainability*, *2*(2). https://doi.org/10.55343/cogsust.50

ZAMPROGNO, M. M., & ESZTERGÁR-KISS, D. (2024). Applying Cluster Analysis for the Investigation of Travel Behavior and User Profiles. *Periodica Polytechnica: Transportation Engineering*, *52*(4) 25663. https://doi.org/10.3311/PPtr.25663

ZÖLDY, M., CSETE, M. S., KOLOZSI, P. P., BORDAS, P., & TOROK, A. (2022). Cognitive sustainability. *Cognitive Sustainability*, *1*(1). https://doi.org/10.55343/cogsust.7

ZÖLDY, M., & KOLOZSI, P. P. (2025). Analysis Of Economic Policy Instruments To Promote Sustainable Mobility. *Acta Universitatis Sapientia - Economics and Business, 13*, (online first) 13-29.

ZÖLDY, M. (2024). Changes at mobility space use in the cognitive mobility era. A*cta Technica Jaurinensis*, *17*(4), 163–168. https://doi.org/10.14513/actatechjaur.00750

ZÖLDY, M., & BARANYI, P. (2023). The Cognitive Mobility Concep*t. Infocommunications Journal*,(SP), 35-40. https://doi.org/10.36244/ICJ.2023.SI-IODCR.6

ZÖLDY, M., BARANYI, P., & TÖRÖK, Á. (2024). Trends in Cognitive Mobility in 2022. *Acta Polytecnica Hungarica*, *21*, 189-202. https://doi.org/10.12700/APH.21.7.2024.7.11

Andrea Kelen[7] - Beatrix Faragó[8]

General supply chain and healthcare supply chain specificities, as well as outpatient path management in Hungary

The healthcare supply chain differs significantly from industrial supply chains due to its focus on human life and health. This necessitates time-sensitive, high-quality, and traceable logistics. It involves multiple stakeholders—manufacturers, distributors, providers, and patients—making it inherently complex. To improve efficiency and resilience, innovative solutions are required. The goal is to offer actionable strategies for a more effective, transparent, and equitable healthcare system. Emphasis is placed on digital tools to address structural issues and enhance care delivery. The study examines digital approaches such as blockchain, automation, and data-driven decision-making. Blockchain enhances traceability and authenticity, while automation improves inventory control and reduces errors. In Hungary, the system struggles with underfunding, workforce shortages, and regional disparities. Digital initiatives like EESZT aim to improve coordination, yet challenges like low digital literacy persist. The COVID-19 pandemic highlighted global supply chain vulnerabilities but also accelerated digital transformation. The study focuses on Hungary's unique challenges, integrating theory and data to uncover inefficiencies and propose improvements. Findings confirm that modern technologies can significantly improve healthcare quality and sustainability.
Keywords: Healthcare supply chain; Innovation; Blockchain technology; Electronic Health Service Space (EESZT); Outpatient management system
JEL code: I18, L14, L22, O33, R53

https://doi.org/10.32976/stratfuz.2025.17

Introduction

The concept and importance of the supply chain have garnered increasing attention in global economic and social discourse in recent decades. This complex system spans from the procurement of raw materials to the delivery of the final product to the consumer, and optimizing the various stages fundamentally determines the success of economic actors. The traditional goal of the supply chain has been to minimize costs, increase customer satisfaction, and maintain competitiveness, but in the healthcare sector, these priorities take on a new meaning. The healthcare supply chain is not only a logistical challenge but also a critical tool for ensuring human life and health (Haffar & Ozceylan, 2025). The characteristics, complexity, and significance of the healthcare supply chain differ greatly from those of traditional industrial or commercial supply chains. While the primary goal in the business sector is maximizing profit, the focus in healthcare is on saving lives and ensuring the improvement of patients' conditions. The timely and accurate delivery of medical devices, medicines, and other healthcare products to the right place not only increases efficiency but directly impacts patient survival rates and quality of life. Time sensitivity, precision, and traceability are requirements in this sector that define the logistics processes and every segment of the supply chain (Gelei & Gémesi 2010). Recent events, such as the COVID-19 pandemic, have highlighted the vulnerability of healthcare supply chains and their global significance. The shortages of medical supplies and medicines, along with logistical disruptions during the pandemic, presented challenges to healthcare systems that accelerated the adoption of

[7] PhD Student, University of Sopron Alexandre Lamfalussy Doctoral School of Business and Organizational Sciences; email: Gyalai-KelenA17@student.uni-sopron.hu
[8] PhD, associate professor, University of Sopron Alexandre Lamfalussy Faculty of Economics Research Centre; email: farago.beatrix@uni-sopron.hu

innovative solutions, such as digitalization, blockchain technology, and data-driven decision-making. These innovations not only enhance the efficiency of healthcare supply chains but also contribute to long-term sustainability and resilience. In the healthcare supply chain, innovation is not just a response to problems but also an opportunity to establish a new foundation for the healthcare system (Tisóczki, 2022; Webster, 1995). Modern technologies, such as artificial intelligence, automation, and blockchain, are capable of increasing transparency, speed, and accuracy in the supply chain. The application of cold chain technology ensures the preservation of time-sensitive medicines and vaccines, which is crucial for public health. Improving traceability helps reduce the circulation of counterfeit drugs, which brings not only economic but also direct health benefits. In Hungary, the healthcare supply chain and outpatient care management face particularly significant challenges. Underfunding, shortages of specialist and skilled staff, and inequalities in digital infrastructure all hinder the effective functioning of the system. The introduction of the outpatient management system and the Electronic Health Service Space (EESZT) are steps aimed at improving the coordination and transparency of care. However, these measures still require significant development to fully realize the potential of the system. Capacity shortages and long waiting lists in Hungary's healthcare system are also critical problems. These difficulties are especially severe in rural areas, where access to medical care is often limited. To improve the situation, not only infrastructural development is needed but also support for workforce training and retention. E-health, such as telemedicine, can reduce territorial inequalities in the healthcare system while increasing the speed and quality of patient care (Hattayer & Gál, 2022; Min, 2016, 2017). This study seeks to answer the research question of how the healthcare supply chain—and thus the efficiency of care—can be improved, following the example of supply chains operating efficiently in other sectors. It can be hypothesized that automations and innovations that have already been successfully used elsewhere would also positively influence the efficiency of healthcare. The study is structured to provide a comprehensive analysis of the healthcare supply chain through both theoretical and practical lenses. It begins with a presentation of general concepts and theoretical foundations of supply chain management, offering insights into its significance across various sectors. Following this, the peculiarities of the healthcare supply chain are explored in depth. The paper then reviews examples of innovations and technologies—such as automation, digitalization, and blockchain—from other industries that could be applicable in healthcare. Finally, the findings are synthesized to offer concrete recommendations for the implementation of these tools in healthcare, with particular attention to the Hungarian context.

Materials and methods

Comparing general and healthcare supply chains addresses a significant gap in understanding and health policy development. Learning from mature systems in other sectors helps avoid early-stage mistakes and reveals sector-specific needs in healthcare. This study uses a theoretical and analytical methodology focused on Hungary's outpatient care and patient pathway optimization. It combines literature review, documentary analysis, and statistical data from sources such as the Hungarian Central Statistical Office (KSH) and OECD to provide a multidisciplinary perspective that includes logistics, technology, and policy. The research outlines the theoretical application of supply chain management (SCM) in healthcare, with special attention to innovations like blockchain, automation, and digitalization for improved efficiency. Comparative analysis highlights key differences between general and healthcare supply chains—such as cost-efficiency versus patient-centered care—and stresses the need for precision, traceability, and regulatory compliance. Hungary's Electronic Health Service Space (EESZT) and outpatient system are analyzed as case studies, with attention to digital literacy, workforce shortages, and regional disparities. The study evaluates the potential of technologies like AI, blockchain, and e-health to improve transparency and efficiency, particularly in rural areas and during crises like COVID-19. Based on this analysis, recommendations include increasing funding, enhancing digital

infrastructure, and investing in workforce training to optimize Hungary's healthcare supply chain. The integrated methodology offers a comprehensive view of operational dynamics and supports sustainable healthcare delivery.

Results and discussion

This part of the "Results and Discussion" chapter will focus on the analysis of statistical data, with particular emphasis on healthcare expenditures and resources in OECD countries, especially Hungary. The chapter presents how Hungary significantly lags behind other developed or neighboring countries in terms of healthcare spending as a percentage of GDP. It also highlights trends in human and infrastructural resources (such as the number of doctors, general practitioners, hospital beds, and pharmacies) over the past decade.This analysis is closely linked to the research objective, which is to explore how the efficiency of healthcare delivery can be improved through developments in logistics and supply chains. The statistical findings support the hypothesis that the current underfunding, workforce shortages, and infrastructural deficiencies pose serious challenges, and reinforce the need for the introduction of innovations (such as digital solutions and automation). The comparative analysis and case examples from other countries, as outlined in the methodological framework, also underpin the quantitative approach taken in this chapter.

Statistical data on healthcare in OECD countries and Hungary's performance

Based on healthcare expenditures as a percentage of GDP, Hungary's position in comparison to other European OECD countries is evident in the statistical data. Healthcare expenditures increased in most countries in 2020, likely due to the extraordinary health needs caused by the COVID-19 pandemic. After 2021, a slight decline or stabilization was observed in several countries, although in some, such as Germany and France, expenditures remained at high levels. Hungary's healthcare expenditure as a percentage of GDP is among the lowest in European countries. Expenditures started at 6,9% in 2015, peaked at 7,3% in 2020, and then decreased to 6,4% by 2023. This is lower than neighboring countries, such as Austria and Slovakia. Switzerland and Germany consistently maintained high expenditure levels (above 11% from 2015 to 2023), reflecting the financing of their advanced healthcare systems. Austria showed a significant increase in 2020 (11,3 and has remained high since. Turkey's expenditures are around 4%, which is far below the European average. Luxembourg also exhibited a low ratio (5-6%), which can be partly explained by the country's small size and unique economic structure. In most countries, a significant increase was observed in 2020, for example, in Canada 13% (the highest value during this period), with France and Germany also showing considerable increases. In Central and Eastern European countries (Czech Republic, Slovakia, Hungary, Poland), healthcare expenditures are lower than in Western Europe. Nordic countries (Sweden, Finland, Norway) maintain higher levels of expenditure than the average. Hungary's healthcare system financing has not been able to sustain the elevated levels during the pandemic. Hungary's lag is especially noticeable when compared to Austria, where expenditures reach 11-12% of GDP. Increasing healthcare spending is essential in Hungary, particularly for post-pandemic recovery and long-term sustainability. Comparing with neighboring countries can help adopt best practices. In terms of Hungary and its neighboring countries, Hungary's GDP-based healthcare expenditures remained among the lowest in comparison to its neighboring countries during the examined years. Austria consistently stood out in the region with the highest healthcare expenditures. Slovakia and the Czech Republic showed significant growth in 2020, but this declined by 2023. (Figure 1)

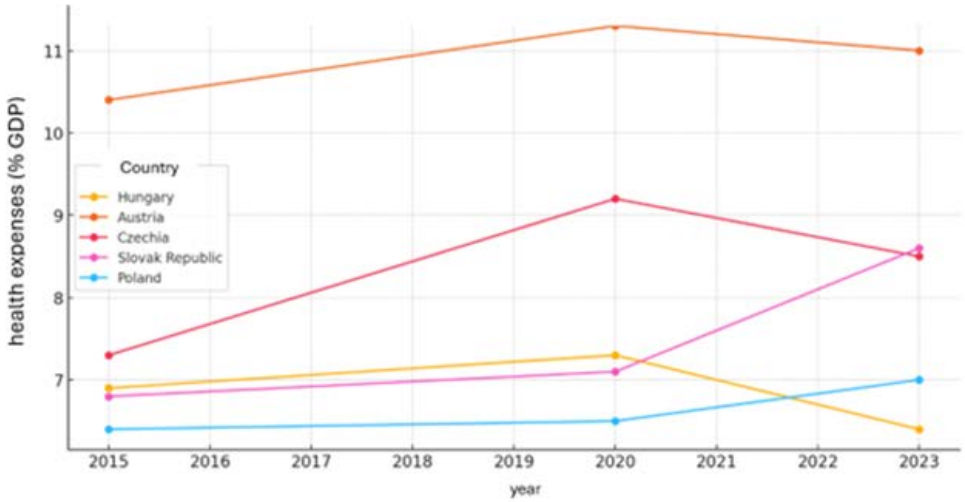


Figure 1: Trends in healthcare expenditures (% of GDP) Hungary and neighboring
Source: based on OECD data, own editing

Based on the data from Source OECD database Health expenditure and financing for 2015, 2020 and 2023, the highest average expenditures were recorded in Germany, France, Canada, Switzerland and Belgium. These five most economically developed European countries consistently showed GDP-based expenditures above 11%, indicating the financing of advanced health systems. Also, based on the data from Source: OECD database Health expenditure and financing 2015, 2020 and 2023, Hungary is among the five countries with the lowest average budget, along with Luxembourg, Ireland, Poland and Turkey. This highlights the underfinancing of the Hungarian healthcare system in an international context. These five least economically developed European countries consistently showed GDP-based expenditures below 7%, which falls significantly short of the financing of advanced healthcare systems. (KSH.hu)
According to data from the Hungarian Central Statistical Office (KSH), healthcare expenditures and indicators of the healthcare system in Hungary have shown fluctuating trends between 2012 and 2022. The ratio of healthcare expenditures to GDP was 7,4% in 2012, which decreased to 6,3% by 2019. Afterward, it jumped to 7,3% in 2020, likely due to the extra healthcare burdens associated with the COVID-19 pandemic, but it again decreased to 6,7% by 2022. (Figure 2)

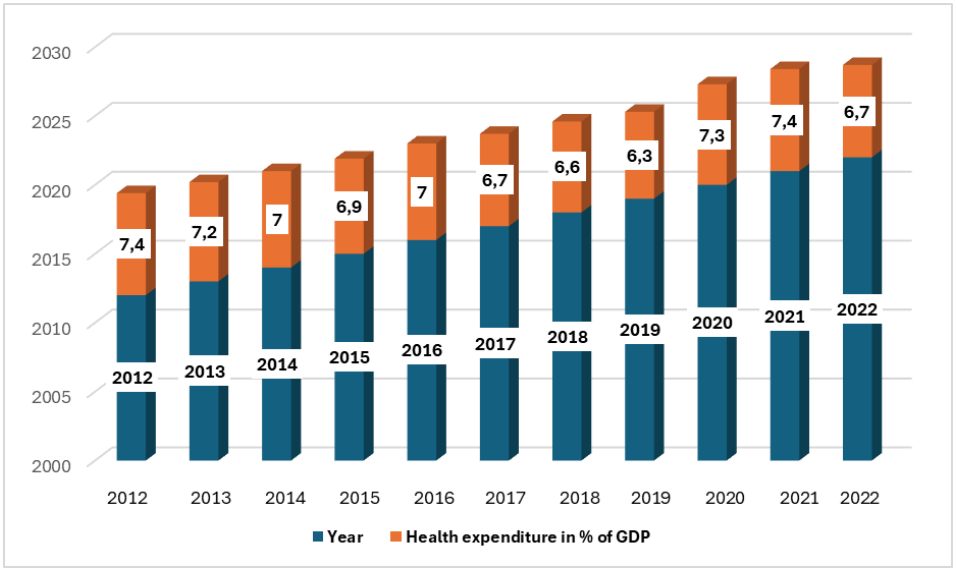


Figure 2: The proportion of healthcare expenditure in relation to GDP in Hungary
Source: based on ksh.hu, own editing

The number of doctors has overall increased, from 36,250 in 2012 to 40,671 in 2022. However, this growth has not been uniform: for example, in 2020, there was a decline (to 37,188 doctors), which may also be linked to the system strain caused by the pandemic and other factors. The number of general practitioners showed a declining trend, from 6,415 in 2012 to 5,748 in 2022. This is a concerning decrease, which has increased the number of residents per doctor (from 1,545 to 1,670).The number of operational hospital beds steadily decreased between 2012 and 2022, from 68,845 to 65,541. This is likely related to the rationalization of healthcare infrastructure, possibly linked to capacity management during the pandemic.The number of public pharmacies slightly decreased (from 2,331 to 2,277), but the number of pharmacists increased, from 5,679 to 6,349. This can be viewed as a positive development for pharmaceutical care. Among the positive trends, the increase in the number of doctors and pharmacists, as well as the improved ratio of pharmacists, suggests progress in human resources. Challenges in the sector include the decline in the number of general practitioners, the reduction in the number of hospital beds, and the decrease in healthcare expenditures relative to GDP—issues that may pose long-term challenges for the healthcare system. The significant data from 2020-2021 highlight the strain that the COVID-19 pandemic placed on resources. (Figure 3,4)

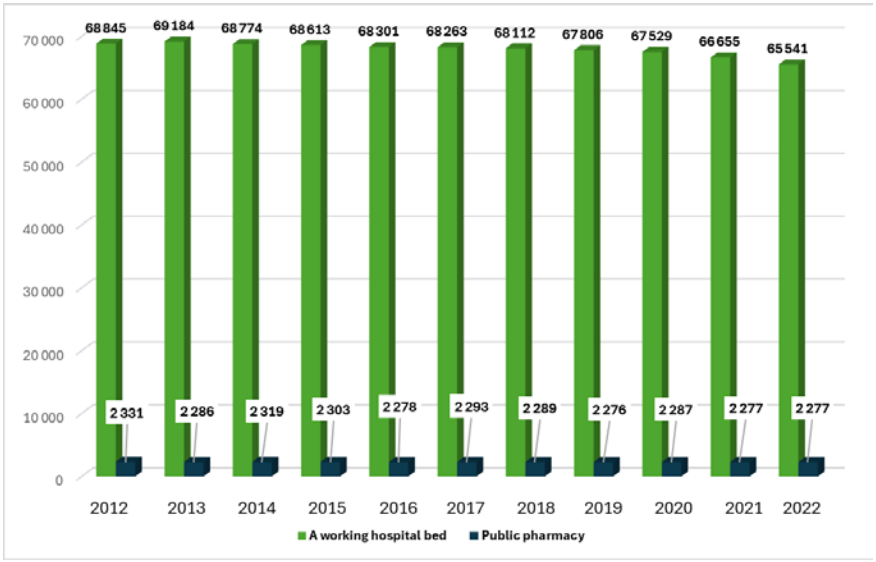


Figure 3: Analyses for healthcare sectors 2. / measured in units
Source: based on KSH.hu, own editing

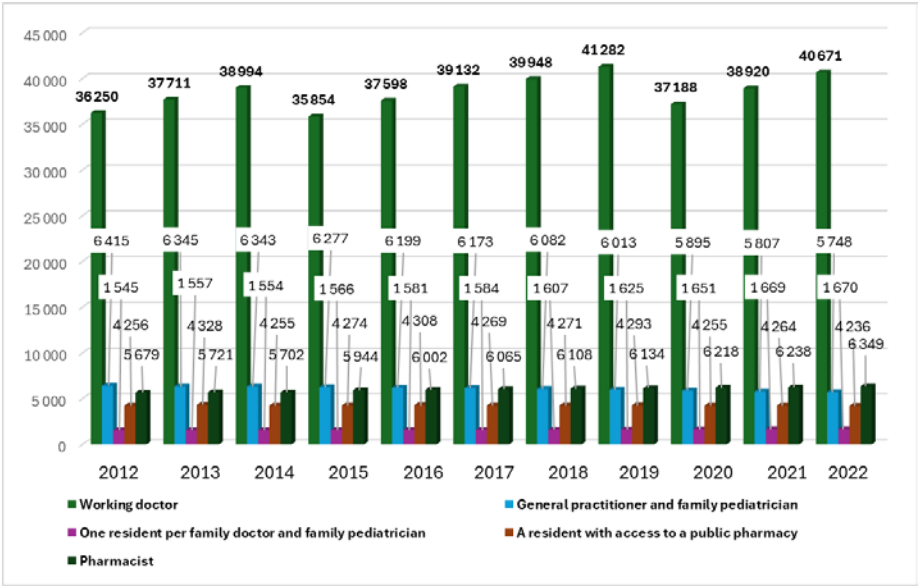


Figure 4: Analyses of healthcare sectors 1. / in number
Source: based on KSH.hu, own editing

Analysis of supply and healthcare supply chain management

The supply chain is a complex system involving multiple actors and processes, ranging from raw material procurement to the delivery of the final product to the consumer. It is generally divided into five main stages: procurement of raw materials, manufacturing, storage, distribution, and serving the end consumer. The efficiency of the supply chain is crucial for reducing costs, increasing customer satisfaction, and maintaining competitiveness. Modern technologies such as automation, artificial intelligence, and data-driven decision-making have significantly contributed to optimizing traditional supply chains (Haffar & Ozceylan, 2025). The healthcare supply chain

is one of the most essential pillars of healthcare system operations. Its task is to ensure the seamless availability of necessary tools, medications, equipment, and other healthcare services for patients. Analyzing the supply chain is particularly important because its efficiency directly affects the quality of patient care, resource utilization, and cost optimization (Gelei & Gémesi, 2010; Kastor, 2003).

Principles of general supply chain and healthcare supply chain management

The goal of supply chain management is to ensure the efficient and transparent flow of materials, information, and financial resources from suppliers to end-users. Effective SCM is based on five distinct key elements: planning, procurement, manufacturing/distribution, logistics/storage, and feedback. The following table illustrates the comparison of the key elements of the general and healthcare supply chain. *(Table 1)* Each process builds on the previous one, forming a chain, although they consist of well-differentiated parts. However, the processes and the resources required for them must be optimized. An essential condition for cost-effective operation is that raw materials and products are procured at the right price and quality and that the finished product reaches customers most shortly and cost-effectively. One of the foundations for increasing efficiency is customer feedback and satisfaction measurement. The healthcare supply chain is a highly complex and multi-layered system, with processes differing only in the first and last steps. While the first element in a general supply chain is planning and the last is feedback, the first element in the healthcare supply chain is procurement, and the last is distribution and use. The successful application of SCM in industries like automobile manufacturing, electronics, or retail has served as a model for the development of healthcare supply chain management (Gelei & Gémesi, 2010; Kastor, 2003).

Table 1: Comparison of Key Elements of General and Healthcare Supply Chains

Process	**General supply chain description**	**Healthcare supply chain description**
Planning	Optimization of processes and resources within the supply chain	
Sourcing	Ensuring materials and products are sourced at appropriate quality and cost.	Procuring necessary raw materials and finished products, such as medicines, medical instruments, and disinfectants, focusing on quality, price, and reliability of suppliers
Manufacturing & Distribution	Production of goods and delivering to customers as quickly and cost-effectively as possible	Meeting strict standards and regulations, such as pharmaceutical manufacturing where precision and sterile conditions are essential
Logistics & Warehousing	Movement, storage, and transportation of goods along optimal routes	Special storage and transportation conditions for products like vaccines, requiring refrigeration or freezing (cold chain)
Feedback Distribution/Usage	Monitoring customer needs and implementing continuous improvements	Distribution to healthcare institutions (hospitals, clinics, pharmacies) where products are used for patient care

Source: own editing

The principles of healthcare supply chain management are similar to those of general SCM, but the implementation methods differ significantly, as in healthcare, the primary goal is the life and well-being of patients. Healthcare supply chain management (HSCM) focuses on the timely procurement and distribution of medications, medical devices, protective equipment, and other healthcare products (Gelei & Gémesi, 2010).

Aspects of healthcare supply chain analysis

When analyzing the healthcare supply chain, several factors must be considered that directly impact the system's efficiency. One of the most important aspects is the cost-effectiveness of the supply chain, which is especially critical due to the sector's underfunding. To minimize costs, analysis must be conducted in areas such as inventory management and the optimization of transportation routes. Excessive inventory can lead to waste, while stock shortages can cause supply disruptions. Disruptions in global supply chains, such as pandemics or geopolitical conflicts, often cause stock shortages. Determining the optimal inventory level is essential. By increasing the efficiency of logistics processes, transportation costs and delivery times can be reduced. In rural areas, the supply chain is often less efficient, which creates disadvantages for patients living there. The quality of healthcare products directly affects patient health. Therefore, the analysis must ensure that strict quality assurance procedures are applied at every stage of the supply chain. Another critical aspect is risk management. Disruptions in the healthcare supply chain—such as the stock shortages experienced during the COVID-19 pandemic—carry significant risks. During the analysis, potential risks that may arise at any stage of the supply chain should be identified, and strategies for managing these risks should be determined. Furthermore, managing the large volume of data generated by the supply chain presents challenges, particularly in terms of protecting patient data. Another crucial part of the analysis is exploring the potential for technological advancements. The use of electronic data interchange (EDI), supply chain management systems (SCMS), artificial intelligence, and blockchain technology can contribute to increased transparency and efficiency. Sustainability considerations, such as eco-friendly packaging, energy-efficient transportation, and waste management, must also be taken into account during supply chain analysis (Tisóczki, 2022; Webster, 1995).

Challenges and development opportunities in the healthcare supply chain

The healthcare sector faces specific challenges, including underfunding, stricter regulatory environments, and managing pandemics and other crises. The pandemic, for instance, highlighted the importance of the supply chain’s flexibility and sustainability, as worldwide shortages of essential tools, medicines, protective equipment, and ventilators emerged (Hattayer & Gál, 2022). Innovations like blockchain technology enable tracking every element of the supply chain, reducing the circulation of counterfeit drugs and improving system transparency (Vazquez Melendez et al., 2024). Based on the analysis, several development opportunities have been identified that could improve the functioning of the healthcare supply chain. Digitalization and automation, including data-driven decision-making and the introduction of automated processes, can increase efficiency and transparency. The use of blockchain is another development opportunity, ensuring data authenticity and preventing counterfeit products, especially in the pharmaceutical sector. Environmentally friendly transportation solutions, recyclable packaging, and energy-saving technologies are also important development points and are crucial from a sustainability perspective. In healthcare, efficient medicine distribution—ensuring the accurate and rapid delivery of pharmaceuticals—is of paramount importance. While pharmaceutical companies already place great emphasis on efficient patient care, another development point could be the use of smaller, local warehouses, which could reduce delivery times and increase flexibility (Min, 2016, 2017).

The relationship between supply chain management and healthcare supply chain management

The relationship between Supply Chain Management (SCM) and Healthcare Supply Chain Management (HSCM) is based on several common principles and practices; however, significant differences exist between the two fields, stemming from their different objectives and priorities. One of the most notable differences lies in the goals of the two types of supply chains: while traditional supply chains aim to maximize profit, the primary objective of the healthcare supply chain is to ensure the health and well-being of patients. In healthcare, logistics processes focus on the fast and reliable delivery of medical devices, pharmaceuticals, diagnostic tools, and other vital supplies. Precision and timing are crucial in this sector, as certain products, such as vaccines, medications, and blood products, are highly time-sensitive and require specific storage and transport conditions. Healthcare supply chains often involve cold chain systems, which incorporate temperature-controlled logistics. Transparency, traceability, and collaboration are also critical factors. (Gelei, 2003; Muhammad et al., 2010)Another fundamental difference lies in the priorities. In a general supply chain, cost efficiency and profitability are the primary goals, whereas in healthcare, timing, accuracy, and quality take precedence. A delay in the delivery of a medical device or medication can even result in the loss of life. There is also a difference in product sensitivity. Healthcare products such as vaccines, blood products, or certain medications require special storage and transport conditions, such as refrigerated environments (cold chain). In contrast, most goods in traditional supply chains are less sensitive to weather or storage conditions. Risk management and regulation are also key considerations. In healthcare, stockouts or product deterioration can have immediate and severe consequences, making risk management stricter and more complex. The procurement and use of healthcare products are subject to strict regulations (e.g., quality certifications, and permits), which are less pronounced in other industries. (Fetter, 2019; Min, 2017)

Challenges and opportunities in integration

One of the biggest challenges in the relationship between SCM and HSCM is aligning their differing priorities. While cost reduction is a key focus in SCM, in healthcare, patient interests take precedence, often leading to additional costs. However, strengthening the relationship between the two systems offers numerous opportunities. Traditional SCM solutions, such as automated warehouse management or technologies ensuring supply chain transparency, can contribute to increasing the reliability of healthcare services. Enhancing the flexibility of the healthcare supply chain (for example, in crises) can be made more efficient by adopting best practices from SCM. (Handfield & Bechtel 2002; Langabeer et al. 2016)

The relationship between international and domestic healthcare supply chain management

Healthcare supply chain management is a fundamental pillar of the functioning of both global and national healthcare systems. The international and domestic supply chains are closely interconnected, as domestic systems rely on foreign suppliers, technologies, and pharmaceuticals, while international systems must adapt to local needs. Analyzing this relationship is particularly important because, with globalization, the mutual dependence between countries increases, while the need to maintain local-level flexibility remains essential. (Ellram et al., 2004) The international supply chain ensures that different countries have access to the latest technologies, medicines, and equipment. The global healthcare industry plays a significant role in shaping the operation of domestic supply chains. Regarding the procurement of medicines and medical devices, most countries, including Hungary, heavily depend on international pharmaceutical manufacturers and medical technology companies. Leading global manufacturers, such as the United States, Germany, China, and India, play a critical role in the global pharmaceutical supply chain. In research and innovation, international research and development collaborations make the latest

medicines, treatments, and diagnostic tools available worldwide. Hungary, for instance, participates in international clinical trials aimed at developing and testing new drugs. The effects of globalization are significant, as it allows for faster distribution of products, while simultaneously increasing the mutual dependency between countries. This is particularly true for the manufacturing of medicines, vaccines, and medical devices, where the supply of raw materials and products often spans multiple continents. (Király et al., 2023) Recently, especially since the COVID-19 pandemic, emergency and humanitarian aid has received greater emphasis. International cooperation is essential in managing pandemics, natural disasters, and other crises. During the COVID-19 pandemic, for example, international supply chains played a key role in the rapid distribution of vaccines, protective equipment, and ventilators. (Hattayer & Gál, 2022) Hungary's healthcare supply chain operates integrally with international systems but faces several unique challenges and characteristics. Hungary has a strong domestic manufacturing capacity in certain areas, such as the production of generic medicines, but in many instances, it heavily depends on international suppliers for raw materials and finished products. This dependency can create critical situations in the event of global supply disruptions. The domestic logistics network often struggles to meet international expectations. Rural healthcare facilities may experience supply difficulties, leading to regional disparities in the quality of care. To comply with international regulations, Hungary's regulatory system continuously aligns with the European Union and other global standards, facilitating the availability of quality products but also increasing procurement and operating costs. Increasing emphasis on digitalization and automation in domestic healthcare institutions is facilitating integration with international supply chains. The introduction of electronic data management systems enhances transparency and inventory management. (Fetter, 2019) The relationship between international and domestic healthcare supply chains can be observed in several areas. A significant portion of the medicines and equipment used by domestic healthcare institutions comes from international sources. During the procurement of imported products, disruptions in international supply chains, such as shipping delays or raw material shortages, directly affect domestic supply. (Fetter, 2019) The COVID-19 pandemic highlighted the risks associated with the mutual dependency between international and domestic supply chains. For example, in the procurement of vaccines and protective equipment, the capacity of international manufacturers and the state of global shipping routes were decisive for domestic distribution. (Ertugrul & Kozma, 2021) Through collaboration with international companies, Hungary gains access to advanced technologies and know-how, which can significantly improve the efficiency of the domestic supply chain. This is especially true for diagnostic tools and innovative medicines. International regulations and expectations impact the sustainability of domestic supply chains. The European Union, for instance, has introduced stringent regulations on environmentally friendly packaging and transportation, which are also mandatory for Hungarian suppliers and manufacturers. (Hausmann, 2020) Expanding domestic manufacturing capacity could reduce import dependency and increase flexibility. This would be particularly important for essential medicines and protective equipment. Closer collaboration with international organizations and manufacturers could facilitate faster access to critical products. The use of digitalization and artificial intelligence could improve supply chain transparency and efficiency at both international and domestic levels. Coordinating global and local emergency supply strategies would enable faster and more efficient responses. (Bokor, 2005; Rawabdeh, 2024)

Outpatient care and patient pathway management in Hungary

Outpatient care is a key component of Hungary's healthcare system. It refers to healthcare services where patients do not require inpatient care but receive ambulatory, complex diagnostic, and treatment through specialist consultations or minor interventions. Patient pathway management aims to ensure the efficient and smooth flow of patients through the healthcare system. In Hungary, patient pathway organization faces significant challenges, such as capacity shortages,

long waiting lists, and uneven geographical distribution of healthcare services. To optimize patient pathway management and primary care, the swift organization of specialist consultations, and the development of information systems play a central role. The development of eHealth, such as telemedicine and the Electronic Health Service Space (EESZT), is an important milestone in care coordination, enabling effective data sharing between doctors, hospitals, and pharmacies. The introduction of the Outpatient Management System in Hungary aimed to increase the efficiency of healthcare services, optimize patient care, and improve transparency and traceability. The system's goal is to provide patients with a clear and seamless pathway between various levels of care, minimizing waiting times, unnecessary examinations, and resource waste. The implementation of the Electronic Health Service Space (EESZT) in 2017 laid a good foundation for this, as it allowed for the centralized storage and sharing of patient data between healthcare providers. However, the system's introduction encountered several challenges. One of the biggest difficulties was the shortage of human resources, especially among specialists and skilled staff. This led to long waiting lists, which hindered prompt patient management. Additionally, due to the regional disparities in healthcare infrastructure, access to high-quality specialist care is challenging in rural areas. From a technological standpoint, the implementation of the Outpatient Management System was not smooth, as many institutions lacked the necessary IT systems and tools. The lack of digital skills required for using the system further slowed the process, particularly among older healthcare workers. For patients, understanding and accepting the new system posed a challenge, especially for older generations less familiar with digital technologies. Despite the obstacles in implementation and the fact that full development is still ongoing, the outpatient management system can bring fundamental positive changes. However, the proper allocation of resources, infrastructure development, and further digitalization is crucial for the system to fully achieve its goal: making patient care faster, more efficient, and fairer. (Falus & Kiss, 2019; Horvath, 2017; Kelen & Kovács, 2024)

Discussion

Analyzing the healthcare supply chain is essential for increasing the efficiency, reliability, and sustainability of healthcare services. The application of modern technologies, the development of risk management strategies, and the reduction of regional disparities can help ensure that healthcare is accessible to all patients promptly and with the appropriate quality. The results derived from supply chain analysis not only promote the improvement of patient care but also contribute to long-term cost-effectiveness. The relationship between supply chain management and healthcare supply chain management offers opportunities to enhance industry efficiency if general logistics methods are adapted to the specific requirements of the healthcare sector. The integration of the two fields is crucial to ensuring high-quality patient care, particularly with the application of modern technologies and data-driven solutions. The development of the healthcare supply chain thus not only improves the quality of medical care but also supports the sustainability of healthcare systems in the long term. The general model of the supply chain and the differences between the healthcare supply chain highlight the varying priorities and requirements of the sectors. In healthcare, preserving human life and ensuring patient well-being is paramount, which carries a significant responsibility and requires precision. In Hungary, the development of outpatient care and patient pathway management is key to increasing system efficiency and improving patient satisfaction. The application of IT solutions and modern logistics principles is essential for sustainable and successful healthcare delivery.

Conclusion

The complexity of modern healthcare supply chains and patient journey management not only highlights the opportunities for technological advancements, but also highlights fundamental societal challenges. Innovations such as blockchain technology and automation can increase the

transparency and efficiency of healthcare, thereby improving its quality. However, real breakthroughs can only be achieved if technological developments are implemented in line with human factors and infrastructure development. In the case of Hungary, reducing inequalities between rural and urban healthcare systems, as well as training and retaining human resources, are of critical importance. While digitalization alone cannot eliminate regional inequalities, a well-designed strategy can significantly mitigate their impact. The introduction of outpatient management systems and the Electronic Health Service Space (EESZT) can improve the sustainability and accessibility of the healthcare system in the long term, provided that these systems are further developed in line with societal needs and with the involvement of stakeholders. Overall, optimizing supply chains, integrating modern technologies, and ensuring transparent and equitable patient pathways are essential for building a more competitive and just healthcare system. It can therefore be stated that the hypothesis posed at the beginning of the study is acceptable and, according to this, automations and innovations already successfully applied in other sectors would also positively influence the efficiency of healthcare.

References

BOKOR, Z. (2005). Az intermodális logisztikai szolgáltatások helyzetének értékelése, fejlesztési lehetőségeinek feltárása. (Assessment of the status of intermodal logistics services and exploration of development opportunities). *Logisztika (Logistics), 10*(3), 22-64.

ELLRAM, L. M., TATE, W. L., & BILLINGTON, C. (2004). Understanding and Managing the Services Supply Chain. *Journal of Supply Chain Management, 40*(3), 17-32. https://doi.org/10.1111/j.1745-493X.2004.tb00176.x

ERTUGRUL, C., & KOZMA, T. (2021). A koronavírus hatása a globális ellátási láncokra (The impact of the coronavirus on global supply chains). *Logisztikai trendek és legjobb gyakorlatok (Logistics Trends and Best Practices), 7*(1), 5-11. https://doi.org/10.21405/logtrend.2021.7.1.5

FALUS, A., & KISS, L. (2019). Miscellanea. Book reviews. The Electronic Health Service Space (EESZT). *Medical Weekly (Orvosi Hetilap), 160*(4), 158-160. https://doi.org/10.1556/650.2019.4M

FETTER, B. (2019). A hazai gyógyszeripari vállalatok beszállítói láncának helye a nemzetközi gyógyszeripari ellátási láncokban. (The position of domestic pharmaceutical companies' supply chains within international pharmaceutical supply chains). *Logisztikai trendek és legjobb gyakorlatok (Logistics Trends and Best Practices), 5*(1), 43-49. https://doi.org/10.21405/logtrend.2019.5.1.43

GELEI, A. (2003). Az ellátási lánc típusai és menedzsment kérdései. (Types of supply chains and their management issues). *Vezetéstudomány* (*Budapest Management Review), 34*(7–8), 24-34.

GELEI, A., & GÉMESI, K. (2010). A szolgáltatások ellátási láncának speciális menedzsmentjellemzői (Specific management characteristics of service supply chains). *Vezetéstudomány,* (*Management Science - Budapest Management Review), 41*(2), 45-58.

HAFFAR, S., & OZCEYLAN, E. (2025). Blockchain in resilient and leagile supply chains: Research themes and opportunities. *Journal of Industrial and Management Optimization, 21*(2), 878–908. Scopus. https://doi.org/10.3934/jimo.2024109

HANDFIELD, R. B., & BECHTEL, C. (2002). The role of trust and relationship structure in improving supply chain responsiveness. *Industrial Marketing Management, 31*(4), 367-382. https://doi.org/10.1016/S0019-8501(01)00169-9

HATTEYER, M., & GÁL, J. (2022). Pharmaceutical aspects of supply chain management. *Current Social and Economic Processes, 17*(1–2), 51-58. https://doi.org/10.14232/jtgf.2022.1-2.51-58

HAUSMANN, R. (2020). The Transformation of Global Supply Chains in Manufacturing Due to the COVID-19 Pandemic. *Hitelintézeti Szemle / Financial and Economic Review*, *19*(3), 130-153. https://doi.org/10.33893/FER.19.3.130153

HORVATH, L. (2017). Toward smart health care: Building a national health information infrastructure(EESZT) in Hungary. *2017 IEEE 30th Neumann Colloquium (NC)*, 000011–000012. https://doi.org/10.1109/NC.2017.8263260

KASTOR, J. A. (2003). *Governance of Teaching Hospitals: Turmoil at Penn and Hopkins*. JHU Press. https://doi.org/10.1353/book.20648

KELEN, A., & KOVÁCS, E. K. (2024). Járóbeteg-irányítási rendszerben történő időpont előjegyzés mérföldköveinek bemutatása a digitális egészségügyet befolyásoló tényezők tükrében (Presentation of the Milestones in Appointment Scheduling within the Outpatient Management System in Light of the Factors Affecting Digital Healthcare). *IME*, *23*(KSZ 1.), 31-37. https://doi.org/10.53020/IME-2024-KSZ-104

KIRÁLY, É., HEGEDŰS, F., & DOMBORÓCZKY, Z. (2023). Globális ellátási láncok aktuális kihívásai (Current Challenges of Global Supply Chains). *Multidiszciplináris kihívások, sokszínű válaszok - Gazdálkodás- és Szervezéstudományi folyóirat* (*Multidisciplinary Challenges, Diverse Responses - Journal of Management and Organization Science)*, 1, 55-92. https://doi.org/10.33565/MKSV.2023.01.03

LANGABEER, J. R., II, J. R. L., & HELTON, J. (2016). *Health Care Operations Management: A Systems Perspective*. Jones & Bartlett Publishers.

MIN, H. (2016). *Global Business Analytics Models: Concepts and Applications in Predictive, Healthcare, Supply Chain, and Finance Analytics*. FT Press.

MIN, H. (2017). Healthcare supply chain research: Where are we going? *Logistics Research*, 10(5), 1–19. https://doi.org/10.23773/2017_5

MUHAMMAD, T., BABA, S. S., ZARIA, L. T., BABA, M. M., THILZA, I. B., BUKBUK, A. N., UNDIANDEYE, U. J., OKWOR, G. O., & MOSES, A. G. (2010). Potency titration of oral polio vaccine by estimation of live virus content using tissue culture technique. *Journal of Applied Sciences Research*, *6*(3), 229–233.

RAWABDEH, A. (2024). Building a global virtual healthcare system. J*ournal of Infrastructure, Policy and Development*, *8*(9), 6765. https://doi.org/10.24294/jipd.v8i9.6765

TISÓCZKI, J. (2022). A mesterséges intelligencia alkalmazása az egészségügyi ellátási folyamatokban (The Application of Artificial Intelligence in Healthcare Delivery Processes). *Biztonságtudományi Szemle (Journal of Security Science)*, *4*(2. Ksz.), 137-153.

VAZQUEZ MENDEZ, E. I., BERGEY, P., & SMITH, B. (2024). Blockchain technology for supply chain provenance: Increasing supply chain efficiency and consumer trust. *Supply Chain Management*, *29*(4), 706–730. Scopus. https://doi.org/10.1108/SCM-08-2023-0383

WEBSTER, J. (1995). Networks of collaboration or conflict? Electronic data interchange and power in the supply chain. *The Journal of Strategic Information Systems*, *4*(1), 31–42. https://doi.org/10.1016/0963-8687(95)80013-G

KSH (2025). Healthcare sector data https://www.ksh.hu/stadat

OECD (2025). https://www.oecd.org/en/data.html

***Zsofia Nguyen*[9]**

A Review of China's High-Speed Trains versus the US and UK's

This comprehensive review paper explores the impacts of China's leading position in developing high-speed trains compared to the US and UK. The study uses multiple research papers to present insights into the development of high-speed trains across Japan, France, Germany, and China as a role model and to draw lessons for countries that follow. The main findings have suggested that government support contributed significantly to the development of these countries' high-speed train networks. But in contrast, politics in Britain and the United States were divided and inconsistent, making the development of this transport industry problematic, overdelays, and uneconomical.
Keywords: High-Speed Train, Government Support, Transport Industry
JEL code: R32

https://doi.org/10.32976/stratfuz.2025.18

Introduction

One of the best travel modes of road transportation designed for efficiency, energy conservation, security, and comfort is high-speed trains (HST) because they reduce significant travel time and e-mission compared to traditional railway transport. Many nations have recognized the social and economic benefits of HST and have been implementing this transportation industry for decades. For instance, Japan was the first Country to build HST technology successfully in 1964 with the Shinkansen S-0 model, which had a high speed of 210 km/h in the commercial operation of the rail train networks. France followed in 1981 with the TGV-PSE model that operates at 280 km/h, and Germany introduced the ICE-1 at 250 km/h in 1991 (Zhou & Shen, 2011). Although China developed its HST network decades after these countries, the country made significant progress by launching its first CRH1 HST operated at 200 km/h in 2007. Within two decades, by 2023, China had constructed the world's largest HST network, with operational mileage reaching 42,000 kilometers, and it operates at speeds up to 380 km/h (Hu et al., 2023). Additionally, China has collaborated with Germany to develop high-speed Maglev Trains (HSMT), resulting in the fastest HSMT in the world, designed to travel at 430 km/h, which connects Shanghai Pudong International Airport with Longyang Road Station. In July 2021, China announced a 600 km/h HSMT project in Qingdao with independent intellectual property rights, which is currently undergoing high-speed trials (Huang et al., 2024) and expanding its influence to export HST technology across Asia, Europe, and Africa via the Belt and Road Initiative (BRI) (Xia et al., 2024).

While China is showing itself as the leader of developing HSTs, similar projects in the US and UK have stalled due to many different factors (The Economist, 2024; Benson, 2024). The objectives of this paper are twofold. First, to examine China's approach to HST development that would become a global leader and practice that other nations such as the US and UK, can adapt to their HST infrastructure planning. Second, to answer whether China can set a precedent for independent technological advancement in future HST projects and potentially reduce reliance on foreign partnerships. To answer these questions, the paper synthesizes the existing literature and the current state of the art. It begins by describing the economic impacts, costs, and the development of the HST network across the world (section two). The focus then shifts to analyzing why HST projects in the US and UK have failed to build (section three). Section fourth introduces

[9] PhD Student University of Sopron István Széchenyi Economics and Management Doctoral School; email: zsofia.trang.nguyen@phd.uni-sopron.hu.

the practices of HST development from Japan, France, Germany, and China before conclusions and recommendations are drawn.

Economic Impact of High-Speed Trains

According to a study from The Economist in 2017, the economic benefits of HSTs are hard to measure precisely because traditional analyses focus on the financial performance of HST lines, plus indirect results such as reduced road congestion. However, HSTs are more than just a mode of transport. China wants to build a "high-speed rail economy", its own twist on the theory of urban agglomeration: the bigger the city, the wealthier and more productive its people tend to be. The idea is to cap the size of megacities but achieve the agglomeration effect with the help of HSTs connecting the megacities with their neighbouring regions. China reckons that the resulting network of large, but not oversized, cities will be easier to manage. In China's three major population centers, the areas around Beijing in the north, Shanghai in the east, and Guangzhou in the south, life and work have started to follow the expansion of the HST network. Trains were previously too infrequent, slow, and crowded to allow daily commutes. Now, these three megacities are developing commuter corridors as housing in satellite towns and cities is significantly more affordable for city workers. The same study also suggested that in outer cities like Kunshan, average home prices are about 70% less than in nearby Shanghai. However, the HST between the two cities takes only 19 minutes and costs a mere 25 yuan ($3.60). Moreover, Kunshan is just one of many options for those seeking to escape Shanghai's high costs. About 75 million people live within an hour of the city by HST.

Not only does HST make travel faster and convenient, but a report published in 2014 from the World Bank said the benefits of HSTs could substantially boost the productivity of businesses in China's coastal regions by an estimated 10% (Ollivier, 2014). Driven by this ambition to develop a high-speed rail economy, China had established the world's largest HST network by 2022, with nearly 40,500 kilometers of HST lines. Spain and Japan followed, each with over 3,000 kilometers. China is also at the forefront of HST expansion. In addition to its existing network, more than 13,000 kilometers of new HST lines are under construction. Completing these projects will increase the Chinese HST network by approximately 32% (Table 1).

Table 1. Length of High-Speed Trains Worldwide in 2022 by Country (kilometer)
(1. In operation: currently operating on High Speed Lines, 2. Under construction: Under construction or upgrade to support High Speed Lines, 3. Planned: Approved and funded lines that haven’t begun construction yet, 4. Long-term planning: Planned High Speed Lines that have been announced, but funding has not been approved as of yet).

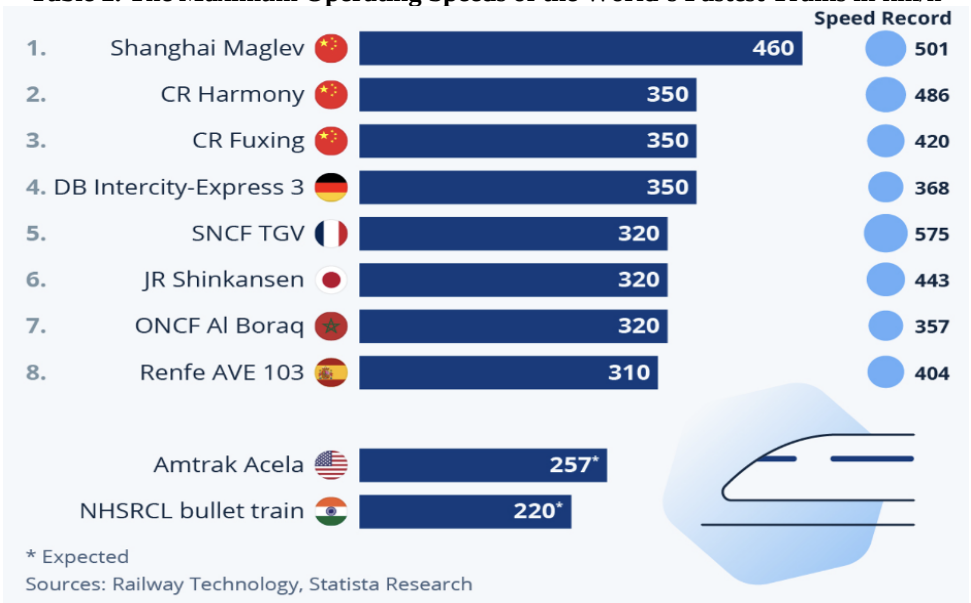
Country/Region	1. In operation	2. Under construction	3. Planned	4. Long-term planning	Total
CHINA	40,493	13,063	4,104	7,134	64,794
SPAIN	3,917	772	789	-	5,478
JAPAN	3,146	336	194	-	3,677
FRANCE	2,735	-	-	1,242	3,977
GERMANY	1,631	87	81	-	1,799
TURKEY	1,232	1,483	2,186	-	4,901
FINLAND	1,120	-	394	-	1,514
ITALY	921	327	-	-	1,248
KOREA	873	104	-	-	977
SWEDEN	860	54	208	1,082	2,204

USA	735	275	1,339	1,830	4,179
SAUDI ARABIA	449	-	-	-	449
AUSTRIA	254	281	71	-	606
POLAND	224	-	805	875	1,904

Source: International Union of railways, October 2023.

Data from Statista Research 2024 in Table 2 also shows China is a world leader in HST. While its regular long-distance trains reach maximum operating speeds of 350 km/h (217 mph), the world's fastest train currently is the Shanghai Maglev, which can operate at 460 km/h (286 mph) although, since 2021, it has operated at 300 km/h (186 mph) due to operational concerns. Germany, meanwhile, has matched China's regular high-speed rail prowess with its newest Intercity-Express 3. The ICE 3 and China Rail's Harmony and Fuxing trains beat the French TGV and Japanese Shinkansen, operating at 320 km/h (199 mph). This is the same speed that a lesser-known HST, Morocco's Al Boraq, is reaching in regular operation between Tangier and Kenitra on the Country's Northern coast (Statista Research, 2024).

Table 2. The Maximum Operating Speeds of the World's Fastest Trains in km/h



Source: Railway Technology, Statista Research

According to data compiled by Railway Technology in 2023, Spain's fastest train, Renfe's AVE 103, follows close behind with a maximum operating speed of 310 km/h (193 mph). For comparison, HSTs under construction and to be introduced in India and the United States won't reach these speeds. The US' new Acela trains entering service this year are expected to reach 257 km/h (160 mph), India is looking to construct trains with an operating speed of 220 km/h (137 mph).

For China's domestic economy, the current HST network accounts for 30% of total operating railways, or about 162,000 km of the national network. The percentage is expected to increase to 30% in 2024 from 20% last year. Despite international concerns about the network's debt and interest burden, China Railway reported a 2.7% increase in operating revenue in 2024 to 990.18 billion yuan, driven by both passenger and freight operations. The Country's railway system links 97% of Chinese cities with populations over 500,000. In 2024, it recorded 4.08 billion passenger trips, an increase of 10.8% yearly. The volume of cargo transported on the network in 2024

reached 3.99 billion tonnes, reflecting a 1.9% year-on-year increase and marking the eighth consecutive year of growth. While the operator did not disclose profit figures, it mentioned that profits reached a "record high" last year. By the end of 2024, its debt-to-asset ratio had declined to 63.8%, which is 1.7% points lower than the previous year. Looking ahead, China Railway has set ambitious goals for 2025, targeting a 2.6% rise in revenue to 1.016 trillion yuan, a 4.9% increase in passenger traffic to 4.28 billion trips, and a 1.1% rise in cargo shipments to reach 4.03 billion tonnes (SCMP, 2025).

The failure of building High-Speed Train projects in the US and UK

While China's HST technology has advanced considerably and a domestic industrial chain is emerging, Western countries, including the United States and parts of Europe, have faced budget overruns and delivery estimate challenges in expanding their HST networks. Constructing large projects like HST systems is inherently challenging, and neither the United States nor the United Kingdom is exempt from these difficulties. A study of 16,000 major projects, including large buildings, bridges, dams, power stations, rockets, railroads, information technology systems, and even the Olympic Games, uncovers significant issues in project management. Only 8.5% of these projects were completed on time and within budget, and just 0.5% were finished on schedule while delivering the expected benefits. In other words, 99.5% of large projects failed to meet their original promises (Flyvbjerg & Gardner, 2023).

For instance, the British government approved the HS2 project in Britain, intended to create a high-speed rail line connecting London and northern England capable of speeds up to 360 km/h, in 2012 with an estimated cost of £30.9 billion to £36 billion and a plan for operation by 2026 and full completion by 2033. The HS2 project underwent multiple delays and financial increases, leading to predicted expenditures reaching £110 billion. Operation of the HS2 project remains uncertain for 2041 despite starting delays in 2008. From financial excess to political debate, HS2 became a major dispute because different reevaluations by successive governments created conflicting viewpoints regarding the project. New governments have triggered project reassessments that created delays when assessing the advantages and disadvantages of continuing with HS2. Therefore, creating numerous unexpected technical obstacles because its execution requires extensive tunneling activities as well as bridge construction, along with land acquisition responsibilities. The project faced technical problems that needed extra resources for designs and plans with extended periods of resolution, which resulted in extra delays. Many British citizens continue to oppose HS2, questioning the stated benefits, including the shortened timeline and the economic growth opportunities that the project would bring. This strong opposition, now linked to the severe environmental consequences, funding costs and resource diversion, has prompted citizens to stage protests and campaign for policy changes that will affect both the decision and the timeline of the project (Benson, 2024).

On the other side of the Atlantic, in 2008, California voters approved a rail service from Los Angeles to San Francisco that would take only 150 minutes, which is well below the typical driving time. The service was planned to be built within 20 years, at a cost of $40 billion. However, construction ran into trouble from the start; the timeline was repeatedly lengthened, and costs ballooned. The project's total cost forecast rapidly escalated to a staggering $100 billion, with an estimated completion date of only partial completion at the time of 2033, five years past the original date (Flyvbjerg & Gardner, 2023). However, recent expectations indicate that even if funds are granted, it would take another decade to complete the middle section. Despite receiving $3 billion in funds from the Biden administration in December 2023, a recent report from the Legislative Analyst's Office (LAO), a non-partisan fiscal adviser to California's legislature, estimated that even after the federal grant, the funding shortfall for the rail line is a whopping $80 billion, more than double the state's annual transport budget and there is no credible plan for raising that money (The Economist, 2024). Some analysts believe that the most important reason why HST has not yet taken off in the United States is a lack of sustained political support and

momentum. The division of power between federal, state, and local governments in the United States often leads to inconsistent funding and opposition from politicians concerned about costs and benefits. Evaluation of public benefits along with air and road traffic displacement increases the complexity of this situation. The US government has allocated its resources primarily to road and highway development, which has resulted in substantial growth of the national road network. The emphasis placed on road infrastructure consumes financial resources and public attention, which would otherwise benefit HSTs (Jones, 2022).

Lesson from existing practices

Globally, four models of HST establishment can be identified: The Japanese model, the French model, the German model, and the Chinese model. All four have achieved significant results in practice, but each has distinct features and differences on the operational level. The following paragraphs discuss the four models to determine the lessons China can adopt to influence global standards and practices in this arena.

The Japanese model

Japan's HST network, often considered the world's first, began with the launch of the Shinkansen or "bullet train" in 1964. It was initially built and owned by the state and then privatized for operation. However, the state still owns most of the infrastructure. The primary motivation was to tackle Japan's overcrowded conventional railways and stimulate economic growth. Japan's HST technology was primarily a result of domestic innovation and research. The Japanese HST technology was developed without assistance from any foreign nation. The Shinkansen was created by Japanese engineers combined with domestic companies such as Kawasaki Heavy Industries and Hitachi in an effort free from major international involvement. The achievement of Japan stems from its robust engineering capabilities, government backing, and culture of technological innovation. Post-Japan, South Korea was the primary beneficiary of Japanese HST technology. A significant deal was signed in 2005 for Japan to assist South Korea in developing its own HST system (Tamaki, 2023).

The French model

France's HST network started the development of Train à Grande Vitesse (TGV) in 1981, with the main purpose of minimizing travel time between key cities in order to strengthen economic development. At the beginning, the state financed most of the costs of the first TGV line (Paris – Lyon). In addition, Alstom, one of France's leading transport multinational companies, which is also a major player in HST building infrastructure, was primarily responsible for TGV's expansion. Alstom undertook a substantial portion of TGV's infrastructure and train components fabrication and design, which also included the assembly (Sato, 2005).
The rest of the HST technology in France contained ingenious engineering efforts, including the design of trains, dedicated tracks, and complex signaling systems, which could then be relied on for exporting. Notably, France managed to achieve success with this model in the international arena. France, for instance, made an agreement for their HST network development with Taiwan back in 1986. Spain became a major recipient of French HST technology after it contracted Alstom to develop the LGV Est. These aren't the only countries to benefit from France's HST technology. Morocco, Saudi Arabia, and the United Arab Emirates have established partnerships between their local state-owned enterprises and Alstom and SNCF. France's success in HST also motivated several other European countries to adopt these practices (Alstom, 2024).

The German model

Germany's HST network was launched in 1991 with the Intercity-Express (ICE). Similar to France, its primary purpose was to minimize travel time between key cities to strengthen economic development. The development of the ICE system was primarily the work of Siemens, which specializes in technology and electrical engineering. Siemens played a crucial role in facilitating the design, construction, and provisioning of the components of the infrastructure and trains of the ICE system (Zhau et al, 2020).
After Germany, numerous other countries adopted Germany's HST technology. One notable example is China in 2004, when China entered into a contract with Germany, acquiring aid for the construction of the HST system. The collaboration between Germany and China laid the initial foundations for the development of China's HST network, which has since become the largest in the world (Huang et al., 2024).

The Chinese model

Chinese leadership has adopted the traditional idiom "getting richer by building roads" to guide its infrastructure development through public financing and state loans (Jie, 2024). The leadership in China backs ongoing investment to support its goals of self-reliant technology development and economic power enhancement (The Economist, 2024). To build the world's most extensive HST network it achieved, China initially relied on technology imported from Europe and Japan and cooperated with global engineering firms like Bombardier, Alstom, and Mitsubishi to assemble the trains and train Chinese engineers. Expeditiously, Chinese engineers have developed extensive expertise, and Chinese domestic companies have emerged as global leaders in HST technology in the past decades. Nowadays, Chinese firms are pioneering innovations such as autonomous train operation, with the driverless "bullet trains" between Beijing and Zhangjiakou reaching 350 km/h speeds. In late 2020, Chinese state-owned firm CRRC, the largest global supplier of railway technology, unveiled a prototype for an HST capable of 400 km/h, equipped to operate in extreme temperatures and featuring gauge-changing technology for compatibility with wider tracks in Russia and Central Asia. This could facilitate direct train services from China to India and Pakistan through neighboring countries. The new 257-mile Laos-China Railway, set to enhance connectivity between southern China and Vientiane, reflects China's rail influence. Additional projects include a railway to Bangkok and beyond to Singapore. As CRRC shifts focus to international markets, rail infrastructure plays a crucial role in China's broader BRI, aiming to recreate a new Silk Road across Asia, Europe, and Africa (Jones, 2022).

Observation and recommendation

After conducting a comprehensive review, it appears that the common starting point of Japan, France, Germany, and China when building HSTs, is that for national governments to set out consistent policies and long-term investments that set clear goals and safeguard funding according to long-term plans, aimed at growing their economy, reducing travel time, connecting cities, and creating jobs. Japan, France, and Germany are the pioneers of HST technologies and have made the most of the intellectual resources from their nations' engineers and corporations. Subsequently, they took advantage of this success to promote the export of HST technology to other countries. Additionally, they also have a strong government behind them that funds HST projects.
Comparing China's HST development with other advanced HST countries reveals that, while all have achieved economies of scale and network effects, China's approach has been characterized by a more aggressive government role, larger-scale investments, and a greater emphasis on domestic innovation and indigenization (Jie, 2024). Furthermore, China's broad expansion of its HST network serves dual purposes of Chinese economic growth and societal requirements. As

stated in the literature review, the construction of HST infrastructure requires considerable spending, which generates economic activity by creating new jobs in the short term. In China's case, it has been one of the most powerful means to strengthen economic growth and stability. In addition, the construction and operation of these trains require maintenance and upgrades, which eternally generates demand (Zhao et al, 2020). In social aspects, HST responds to the problems of rapid urbanization and secondary cities' population agglomeration, as they become suburbs to megacities because of HSTs (Chen, 2012). These transport systems are more advanced compared to railroads and highways, saving considerable time when traveling from one city to another and making city-to-city movement more accessible. The system stimulates more business operations and tourism, thereby easing pressure on present-day transportation systems. The alternative mode of transportation represented by HST promotes environmental sustainability like air travel and private vehicles, thereby supporting Chinese aims to reduce carbon emissions (Zhang et al, 2023).
In the view of this author, China has adopted foreign HST technology to jumpstart its development of its sovereign technology, but since then, it has made significant sovereign domestic innovations to leapfrog its former partners and current competitors. To strengthen its leadership in HST technology and reduce its current reliance on foreign technology, China should continue investing in R&D and human capital formation, encourage tech transfer from universities, research institutions, private sector involvement, and international collaborations, and implement policies that promote the diffusion of knowledge and technology spillovers. A favorable regulatory environment that supports domestic innovation and indigenization is also crucial. There is no denying that China has been investing heavily in this area, from the school level to research institutes and government investment. This has been demonstrated through the Made in China Initiative, which aims to not rely on developed countries in the West but instead to be self-sustaining (Wübbeke et al, 2016). Therefore, if China follows the business-as-usual scenario, with no changes in technology, economics, or policies, China could expect to maintain its current trajectory of technological advancement and market expansion. Under the Technological Leapfrog scenario, when China achieves significant breakthroughs in HST technology, it has the potential to set global standards and dominate the market. However, under a Policy Shift scenario, which is least likely to happen, if China adopts more protectionist policies such as restrictions or limits international trade, its global influence might be limited.
For the US: the history of HST development in the US demonstrates elements of public choice by examining how special interest groups affect governmental policy decisions, as seen in the case of the HST project in California, voted on by its residents. This public choice and lack of political momentum and support explain why extensive HST development in the US has not matched the levels seen in China, Japan or Europe. Moreover, the US infrastructure investment model promotes decentralization with important responsibilities assigned to state and local governments. Decentralization creates advantages but also results in funding and planning inconsistencies. The federal government cannot unilaterally order states to invest, so HST projects are often broken up or canceled, which makes the HST project implementation more difficult (The New York Times, 2025). Additionally, Americans rely on road and air travel; they demonstrate limited knowledge and travel experience with HST (CNN, 2023), which prevents them from understanding the benefits of HST compared to traditional roads and air travel. Therefore, the US government would need to dedicate substantial investment to public education campaigns that explain why alternative travel modes are essential and what advantages they provide. In addition, the US should also consider the Public-Private Partnership option for HST projects. This is a popular form that helps reduce pressure on the state budget, while also creating incentives for private businesses (Li et al, 2003).
For the UK: the HS2 network linking London with Birmingham, Manchester, and Leeds serves as an example for its delays and cost overruns are undeniable, despite many of the expectations, intentions and goals set out from the beginning, such as helping foster economy growth, generate employment opportunities in its construction phase, help develop the regions served by the project, and add to productivity by shortening inter-city travel time. Still, criticism of the additional

expenses and delays is a problem in estimating the cost and benefit of HS2 (Benson, 2024). This is most troublesome because it puts the expectation that the benefits will outnumber the costs into question. In addition, an infrastructure project that consistently overruns its costs tends to limit funding available for other projects, resulting in lowered public trust in the ability of the government actually to improve its rail system. The suggested solutions are fourfold to resolve this problem. First, the UK government needs to provide investment capital or direct subsidies similar to China's state funding for the China Railway company in the early stages. Second, the UK may consider creating favorable conditions for private enterprises and guaranteeing bank loans for railway enterprises. If the project fails, the government must commit to paying a part of the debt, such as bank loans. Of course, if the policy is not attractive enough, it will also make investors wary because the private sector is reluctant to invest; after all, the capital recovery period is very long and difficult to calculate. Third, this is a factor based on option two, which is to reduce turnover tax for enterprises participating in HST development or support, and provide Minimum Revenue Guarantees for enterprises implementing HST. Finally, the UK should learn from China's centralized political structure, promoting simplification of regulations and legal frameworks governing large infrastructure projects. This would reduce red tape and other bureaucratic hurdles. The UK could also develop strategic risk mitigation strategies by learning from China's counter-risk management policies (Tang et al, 2007), which emphasize financial risk acceptance and rapid technological uptake, and set local standards to control safety and social risk, and then provide proactive solutions early in the disruption process to reduce cost overruns.

Conclusion

In conclusion, the development and export of HST technology have greatly benefited the economies of Japan, France, Germany, and especially China. The common HST model of these countries is inspired by strong government backing and a focus on domestic innovation to stimulate economic growth and counter unemployment. China is a country that adopted HST only in the past two decades but has surpassed its competitors to become a world leader in this field. To sustain its position of leadership in HST development, China should continue to invest, even if modestly, in research, technological transfer, and a friendly regulatory environment. In the US, the problem lies with the intersection of government blocking HST development, notwithstanding the favour for government investment in road and air travel. However, if the decision to build HST is voted by the public, the US would need to allocate consistent funds, policy between states and opposition governments, and alternatively promote Public-Private Partnership. In the UK, to address the concerns surrounding HS2's overrun costs and delays, the UK should simplify its regulatory processes for major infrastructure projects. Lastly, more relevant empirical studies about HS2 and the US's California railway project are highly encouraged, as they will be needed and will assist in understanding the real impacts better.

References

ALSTOM. (2024). *Alstom in France, A key player in French mobility*. https://www.alstom.com/alstom-france

BENSON, M. (2024). *High Speed Rail 2 – an overview*. House of Commons Library. https://commonslibrary.parliament.uk/research-briefings/cbp-9313/

CHEN, C. L. (2012). Reshaping Chinese space-economy through high-speed trains: Opportunities and challenges. *Journal of Transport Geography*, *22*, 312-316. https://doi.org/10.1016/j.jtrangeo.2012.01.028

CNN. (2023). *High speed trains are racing across the world. But not in America.* https://edition.cnn.com/travel/article/high-speed-rail-us/index.html

FLYVBJERG, B., & GARDNER, D. (2023). How Frank Gehry delivers on time and on budget. *Harvard Business Review*, *101*(1), 128-137. https://hbr.org/2023/01/how-frank-gehry-delivers-on-time-and-on-budget

HU, W., XIN, G., WU, J., AN, G., LI, Y., FENG, K., & ANTONI, J. (2023). Vibration-based bearing fault diagnosis of high-speed trains: A literature review. *High-speed Railway*, *1*(4), 219-223. https://doi.org/10.1016/j.hspr.2023.11.001

HUANG, H., LI, H., SUN, Y., & HU, X. (2024). Development and Challenges of Maglev Transportation. In M. Mohebbi (Ed.), *Railway Transport and Engineering - A Comprehensive Guide* (pp. Chapter 3). London: IntechOpen. https://doi.org/10.5772/intechopen.1007211

INTERNATIONAL UNION RAILWAYS. (2023). *High Speed Lines in the World 2022 (Summary).* https://static.poder360.com.br/2024/12/uic-malha-trem-bala-mundo.pdf

JIE, Y. (2024). *The world wants China's 290 kmh trains – but at what cost?*. Chatham House. https://www.chathamhouse.org/publications/the-world-today/2024-02/world-wants-chinas-290kmh-trains-what-cost

JONES, B. (2022). *Past, present and future: The evolution of China's incredible high-speed rail network.* CNN. https://www.cnn.com/travel/article/china-high-speed-rail-cmd/

LI, B., & AKINTOYE, A. (2003). An overview of public-private partnership. A. Akintoye, M. Beck, & C. Hardcastle (Eds.), *Public-private partnerships: Managing risks and opportunities* (pp. 3-30). Wiley. https://doi.org/10.1002/9780470690703.ch1

OLLIVIER, G., YING, J., BULLOCK, R., RUNZE, Y., & NANYAN, Z. (2014). *Regional Economic Impact Analysis of High-Speed Rail in China* (Report No. ACS9734). World Bank and the People's Republic of China.

RAILWAY TECHNOLOGY. (2023). *The 10 fastest high-speed trains in the world.* https://www.railway-technology.com/features/the-10-fastest-high-speed-trains-in-the-world/?cf-view

SATO, Y. (2005). Global market of rolling stock manufacturing: present situation and future potential. *Japan Railway and Transport Review*, *41*, 4-13.

SCMP. (2025). *China's high-speed rail network on track to breach 50,000km milestone in 2025.* https://www.scmp.com/economy/china-economy/article/3293188/chinas-high-speed-rail-network-track-breach-50000km-milestone-2025

STATISTA. (2024). *The world's fastest train.* https://www.statista.com/chart/10792/the-worlds-fastest-high-speed-trains/

TAMAKI, T. (2023). Railways as Japanese identity: Riding between confidence and inexperience. *Contemporary Japan*, *37*(1), 1-20. https://doi.org/10.1080/18692729.2023.2218015

TANG, W., QIANG, M., DUFFIELD, C. F., YOUNG, D. M., & LU, Y. (2007). Risk management in the Chinese construction industry. *Journal of Construction Engineering and Management*, *133*(12), 944-956. https://doi.org/10.1061/(ASCE)0733-9364(2007)133:12(944)

THE ECONOMIST. (2017, January 13). *China has built the world's largest bullet-train network.* https://www.economist.com/china/2017/01/13/china-has-built-the-worlds-largest-bullet-train-network

THE ECONOMIST. (2024, March 31). *How Xi Jinping plans to overtake America.* https://www.economist.com/finance-and-economics/2024/03/31/how-xi-jinping-plans-to-overtake-america

THE ECONOMIST. (2024, May 16). *The worlds slowest bullet train trundles ahead in California.* https://www.economist.com/united-states/2024/05/16/the-worlds-slowest-bullet-train-trundles-ahead-in-california

THE NEW YORK TIMES. (2025, April 1). *After a Slow Start, High-Speed Rail Might Finally Arrive in America.* https://www.nytimes.com/2025/04/01/headway/high-speed-rail-trains-america.html

WÜBBEKE, J., MEISSNER, M., ZENGLEIN, M. J., IVES, J., & CONRAD, B. (2016). Made in China 2025: The making of a high-tech superpower and consequences for industrial countries. *Mercator Institute for China Studies. Papers on China*, *2*(74), 4. https://kritisches-netzwerk.de/sites/default/files/merics_-_made_in_china_2025_-_the_making_of_a_high-tech_superpower_and_consequences_for_industrial_countries_-_76_seiten_1.pdf

XIA, J., LIU, Y., XU, Z., YUAN, H., & LEI, J. (2024). *The China Railway Express and the Belt and Road Initiative.* Springer. https://doi.org/10.1007/978-981-97-0964-9

ZHANG, W., ZENG, M., ZHANG, Y., & SU, C. W. (2023). Reducing carbon emissions: can high-speed railway contribute? *Journal of Cleaner Production*, *413*, 137524. https://doi.org/10.1016/j.jclepro.2023.137524

ZHAO, H., LIANG, J., & LIU, C. (2020). High-speed EMUs: characteristics of technological development and trends. *Engineering*, *6*(3), 234-244. https://doi.org/10.1016/j.eng.2020.01.008

ZHOU, L., & SHEN, Z. (2011). Progress in high-speed train technology around the world. *Journal of Modern Transportation*, *19*, 1-6. https://doi.org/10.1007/BF03325733

Mahla Shojae Anari[10] - Ákos Jakobi[11]

Smartening up a Developing City:
Smart City and Urban Big Data Development Challenges in Tehran

Urban big data holds great potential for transforming the way cities are managed, providing insights that can optimize urban systems and improve quality of life. However, harnessing this potential requires overcoming significant challenges, particularly in developing countries like Iran. These challenges include insufficient infrastructure, fragmented data systems, financial constraints, and issues related to data privacy and security. This study aims to highlight the importance of urban big data in smart city management and identifies the key obstacles that must be addressed to enable its effective use. By understanding the unique challenges faced by cities in developing countries, this research aims to contribute to the development of strategies that can leverage urban big data for smarter, more sustainable cities.
Keywords: urban big data, smart city, Tehran, information and communication technology (ICT), urban development
JEL code: R58, O33

https://doi.org/10.32976/stratfuz.2025.19

Introduction

The last two decades have witnessed a significant transformation driven by advances in Information and Communication Technologies (ICT). The early ideas of “cyberville” and “digital city” transformed into “smart city” over the years (Mohanty et al., 2016). Although the term “smart city” is widely used, no single definition has gained universal acceptance. According to some studies, the focus is on integrating with technology but in others the focus is on citizens. In this paper smart city is conceived as a smart ecosystem where advanced ICT and tools from the data universe are used not only for technological efficiency, but also for improved public services, environmental sustainability and economic growth. At the heart of this transformation is the effective use of urban big data generated through utilizing sensors, social media, administrative databases, and other digital sources that forms the basis of evidence-led governance (Yadav & Mohapatra, 2018). Developing cities face unique technological challenges. For example, Tehran is an expanding megacity that is placing serious infrastructural and socioeconomic strain, which is behind the curve of traditional urban management solutions. As a result, this paper examines the role of urban big data in smart city initiatives, with a primary focus on the case of Tehran, Iran. It also aims to propose approaches for overcoming existing challenges. The current study is qualitative and exploratory and is based on an analysis of secondary sources to assess the challenges and opportunities of utilizing urban big data in the smart city development of Tehran. The current study relies on a case study approach and draws on academic literature, policy reports, and institutional documents from the Smart Tehran Program and international study cases to extract key thematic area. Through a synthesis of expert opinions and documentation, the paper investigates Tehran’s urban governance, infrastructure, economic, technological and socio-cultural contexts to identify pervasive barriers to urban big data integration.
This paper is structured into seven sections. Section 1 and 2 present a detailed literature review, including definitions of smart cities and the conceptual framework of urban big data. Section 3 explores the potential and challenges of utilizing urban big data for smart city governance. Section

[10] PhD. student, Department of Regional Science, Eötvös Loránd University; email: mahlashojaee71@gmail.com
[11] PhD., Habil., associate professor, Department of Regional Science, Eötvös Loránd University; email: jakobi.akos@ttk.elte.hu

4 examines the context of urban transition, growth, and the emergence of technological cities, with a particular focus on Tehran. Section 5 discusses the challenges Tehran faces in developing smart dimensions, organized into thematic subsections. Section 6 integrates the findings, and Section 7 summarizes the challenges associated with developing a smart city in Tehran.

Defining the smart city

Smart cities are increasingly prominent in urban development, especially in the Global South. Due to technological advancements, cities in developing countries are establishing digital infrastructure as a foundation for smart city transformation. As described by IBM (2023), smart city programs leverage technological innovation to enhance urban living standards, boost resource efficiency, and support long-term economic and environmental goals. (Hollands, 2008; IBM, 2023). According to Kitchin (2014), big data refers to vast and rapidly generated datasets that exceed the processing capabilities of conventional analytical tools (Kitchin, 2014).

Urban big data results from the interaction between machines, humans and systems. It is observed in an urban environment. When authorities assess this information, they can better optimize service delivery, deploy resources more efficiently and improve governance overall (Batty et al, 2012). Although smart cities have great potential, their implementation is difficult in real life (particularly of developing countries) due to lack of infrastructure, fragmented policy, and insufficient stakeholder coordination (Humayun et al., 2020).

One key issue is the lack of citizen engagement. The smart city project spearheaded by Cisco in Songdo was a failure as it lacked any community involvement. Consequently, the critique of "technology without community" gained popularity (Humayun et al., 2020). Because of this, Kumar (2024) says governments, citizens and technology developers must contribute fairly. Kumar (2024), meanwhile, stresses citizen participation with reference to governments. Mora, Deakin & Reid (2019) highlight the significance of technology.

Due to these complexities, it is important to understand how to make the most of urban big data. This is especially important for a city like Tehran, where asset restraint is the norm as governance becomes more complex. By observing smart city dynamics, the paper analyzes the key issues and opportunities of the urban big data system about spatial development trajectories of Tehran.

The smart city concept has gone through several changes over the years. Giffinger et al, (2007) were the first to sum up the multidimensional outlook of smart cities. They identified six dimensions through which smart cities can be characterized. The six dimensions included economy, mobility, environment, people, living and governance. Hollands (2008) followed this work with research that emphasized the importance of making use of ICT to solve urban problems and enhance the quality of life through the use of ICT. Harrison and Donnelly (2011) stressed the need for social systems, physical systems and technological systems to operate as one for a successful smart-city effort. Up-to-date definitions offered by IBM (2023) and the European Commission (2023) referred to smart cities as urban areas where digital solutions improve the use of city services for the benefit of citizens. Many scholars continue to debate whether technology can sustainably transform urban environments. Despite their differences they all see technology as an enabler. Table 1 below summarizes select definitional approaches.

Table 1: Definitional approaches to Smart City

Author(s)	Year	Key Focus
Giffinger et al.	2007	The six dimensions are economy, mobility, environment, people, living and governance.
Hollands	2008	ICT to improve quality of life and address urban issues
Harrison & Donnelly	2011	Integration of social, physical, technological, and commercial infrastructures
Caragliu et al.	2011	Combining commercial, technological, social, and physical infrastructures

IBM	2023	Utilizing technology and data collection to improve city operations and citizen well-being
European Commission	2023	Using data collecting and technology to enhance city operations and the welfare of citizens

Source: Own compilation

Urban big data: concepts and dimensions

Urban big data is changing how information gets created and used in cities. In the past, data was collected only in large volumes and could be handled traditionally. With the emergence of sensor technology, the Internet of Things (IoT), and the growth of mobile device use, massive amounts of data are now being created that is characterized by the 3V of volume, velocity, and variety (Kitchin, 2014). The foundation of modern data revolves around the "3V" model - Volume, Velocity, and Variety. Gandomi and Haider (2015), additionally, advocated two more dimensions: veracity and value, added to account for the quality and functional utility of the data. In cities, big data is constantly produced from public transport systems, environmental monitors, social media, and other sources. All this information can be used when forming governmental policies, improving public services, and for predictive management of cities.

Table 2: Definitional approaches to Big Data

Author(s)	Year	Definition
Kitchin	2014	Big data refers to datasets that exceed the capacity of conventional data-processing technologies due to their size, velocity, or complexity.
Gandomi and Haider	2015	Big data encompasses extensive, rapidly generated, and diverse information assets that require economical and novel processing methods for insights.
Oracle	2023	Large and complicated data collections that are difficult to handle or analyze using conventional data processing techniques are referred to as "big data."
Google Cloud	2023	Big data refers to extensive, varied databases that are enormous in bulk and expand quickly over time.
SAS Institute	2023	The phrase "big data" refers to the massive, challenging-to-manage amounts of structured and unstructured data that constantly overwhelm enterprises.

Source: Own compilation

Table 3: Definitional approaches to Urban Big Data

Author(s)	Year	Definition
Batty et al.	2012	Urban big data is defined as large-scale, high-frequency, spatially detailed data produced by urban systems and human activities in cities.
Kitchin	2014	Sensors, administrative documents, social media, and mobile devices are some of the sources of urban big data, which provides in-depth understanding of urban dynamics.
Mora et al.	2019	The basis for smart city efforts is urban big data, which makes evidence-based decisions possible to enhance quality of life and urban administration.
Xiao & Miller	2021	Urban big data sources from the public sector include a wide range of topics, including demographics, transportation, the environment, and public health.

Wang & Yin	2022	Urban big data refers to complex data produced in urban areas and characterized by its large, fast-growing volumes which cannot be handled by commonly used data-processing tools.

Source: Own compilation

The role of technology in urban management

Technological progress of the latest advancements in ICT applied in urban systems has changed the way cities are managed across the globe. Cities today are using technology like IoT, AI and big data analytics for condition monitoring and predictive modelling for resource use (Yadav & Mohapatra, 2018). For instance, traffic lights that change according to the traffic. Moreover, public health officials can use social media data to assess if newsworthy disease outbreaks are occurring. The same applies to pollution sensors that can warn about air quality problems. Some developing cities can't benefit from this technology, as they lack the infrastructure money and wrench government. Heeks and Shekhar (2019) explain that not just placing sensors and generating data is good enough. Efficient sharing of information between city departments will require some foundational building blocks like data processing infrastructure, common standards, and integrated platforms.

Urban big data in smart city management: opportunities and barriers

Urban big data can help improve the governance of cities, but the implementation of data is not easy, especially in developing contexts. Big data could help cities bring about novel policies using data. To give an example, the traffic sensors and surveillance systems can help predict congestion patterns and adjust the traffic signals and public transport schedules dynamically (Kitchin, 2014). Cities can use big data to analyze business trends, which will impact investment and development decisions. This information on the stakeholder demand will enable rational allocation of resources for better planning.

Real-time monitoring of hospital admission trends and weather conditions, among others, can support early alert mechanisms and proactive public health measures (Jamarani et al., 2024). City authorities can use information on air quality, energy use, and waste management to create targeted interventions that reduce pollution and increase resilience. Platforms and apps that gather citizen feedback will help create inclusionary governance and improve responsiveness (Tan & Taeihagh, 2020).

Although urban big data can be used for many things, there are still important barriers. Many cities in the developing world boast outdated infrastructure and limited internet connectivity (Tan & Taeihagh, 2020). Data situation in departments of government is fragmented, leading to siloed datasets that are not amenable to more holistic analysis (OECD, 2023). The implementation of big data strategies is limited by financial constraints and a shortage of skills (OECD, 2023).

Due to the legal ambiguities regarding smart city projects along with data ownership and privacy, it may erode public trust that can limit the support for these smart cities (Tan & Taeihagh, 2020). Moreover, a lack of a centralized institutional framework and sufficient political will frequently slows down or halts city-wide data initiatives (Tan & Taeihagh, 2020). Tackling these challenges is a must for cities looking to evolve into smart, data-driven urban systems.

Tehran as a case study: urban growth, challenges and potentials

Tehran is the capital of Iran and a megacity with over 9 million inhabitants. The national economy highly depends on it. In addition, it adds more than 25 percent to Iran's GDP. Rapid urbanization has placed immense pressure on Tehran’s infrastructure and public services. When a city’s population increases, it creates an overcrowded environment. The rising population can also cause pollution and hampering public service delivery. For instance, recent findings show Tehran

generates over 8000 tons of waste, has unhealthy air for 105 days a year, and a Gini coefficient of almost 0.38 (Smart Tehran, 2020). Tehran still has considerable scientific and technological potential despite these problems. The city that ranks 43rd on global science and technology clusters (i.e. Bergquist and Fink, 2020) has shown capacity for research and innovation. Efforts are made to integrate ICT into urban management. Traffic management, citizen services, and a plan for public-private partnerships are just some sectors that are included in the Smart Tehran Program

Tehran grew very fast leading to environmental problems and social disintegration. With public transport not being utilized as much, people rely heavily on private vehicles which affects traffic and air pollution. All of these issues, along with ineffective management of resources and rising cost of living, create a feeling of stress among residents of the city. To resolve these structural obstacles, we need integrated, data-rich solutions that bridge the technological chasm and reality on the ground.

Tehran suffers from more institutional fragmentation than almost any other city. Many agencies operate independently which leads to inconsistent data collection, redundant effort and inefficient policy making. The absence of a common governance structure and clear data-sharing mechanisms adds another layer of complexity to the implementation of smart cities. Carefulness to have structures and better set up cannot reach their full potential yet.

Challenges of implementing smart city dimensions and urban big data in Tehran

Institutional and governance challenges

Tehran’s urban governance is highly fragmented, with multiple independent agencies and ministries often duplicating efforts. This results in siloed data systems and inefficient delivery service. The breakdown of the data greatly impacts the application of urban big data. For example, although the Tehran Municipality collects data on traffic, pollution, and waste, the absence of a centralized data collection point hinders effective collaboration and data integration (Khansari et al., 2013). The Smart Tehran Program (STP), which was started in 2017, aimed to unify these efforts, but data standardization issues and political inertia remain a challenge.

Tehran's Smart Tehran Program explicitly aims to improve transparency, citizen engagement and decision-making through integrated ICT platforms. To give an example, applications and e-services like the municipal “My Tehran” app allow residents to track services and give feedback. But there are major barriers to data- driven governance.

Tehran could be explained by data fragmentation, namely agencies have data in silos and not on common platforms. In the absence of a single data governance framework, data quality suffers, and data sharing is limited between departments. Privacy and security concerns also impede progress: without policies and trust, officials are guarded in opening or linking datasets, including personal information. Many city managers still just do not have the analytical skills or institutional processes to exploit big data. Critical stakeholders cannot utilize insightful data for planning or performance evaluation in the absence of a strong, transparent framework for data governance. Besides, citizen participation and accountability are constrained because of the lack of open-data policies and digital trust mechanisms (UN-Habitat, 2020). To sum it up, governance in Tehran can become more evidence-based and participatory through urban big data, but success would depend on overcoming silos and building a sound data-sharing and decision framework.

Environmental and infrastructural challenges

Tehran is faced with serious environmental problems such as air pollution, waste generation and urban heath islands. There is a lot that big data can do to monitor and mitigate these issues. According to the Air Quality Control Company, sensors follow air quality in Tehran and all around. According to the Iran Meteorological Organization (2022), these sensors produce hourly data on pollutants PM2.5, NO2 etc. Startups also have developed data-driven waste collection

systems that optimize routes and reduce fuel consumption (Shahmoradi & Heidari, 2021). But the problems stemming from the poor coverage of sensors, absent data integration between agencies and limited access to the public to environmental data make the systems less useful. It could be possible to build early warning systems for pollution episodes, or disease outbreaks, by bringing together datasets from the environment with mobility or health records, but this requires investment in interoperable platforms and high-capacity data infrastructure (Heidari et al., 2021).
Tehran has embarked on collection of huge volumes of data related to the environment, but integration and analysis are still infancy. The city operates a large network of air quality monitors. For example, several monitoring stations that register pollutant levels once every hour, are run by government agencies (Air Quality Control Company and Department of Environment). A big data resource has been created for tracking smog and health risks in Tehran. Today, waste management pilot projects use IoT platforms for better efficiency. In 2019, a successful startup launched a mobile/web app to schedule the pickup of solid waste from universities.
According to tehrantimes.com, the application's backend utilizes Artificial Intelligence which can cut costs and optimize route. An example of environmental big data (GPS of vehicles, collection volumes…) with the aim of reducing pollutant discharges and traffic jams. Tehran struggles to utilize these data streams to their full potential. Because environmental sensors are unevenly distributed and poorly serviced, data gaps and quality issues are common. Agencies are run by different systems (e.g. air, waste and water) seldom interoperate, making holistic analysis difficult. In addition, the level of public participation is limited. In other words, citizens do not crowd sense data or receive alerts based on data in a timely manner. Overcoming these hurdles could greatly improve outcomes. For instance, air-quality indicators synced with traffic datasets might trigger dynamic pollution alerts and traffic control measures. Data analysis can help predict the chances of a drought or flood based on meteorological data. It is important that data is better used to optimize recycling routes and promote source separation in waste management. In short, deploying sensors comprehensively and integrating data can turn the environmental challenges of Tehran into opportunities for smarter management (Shamsipour, 2024).

Economic and investment challenges

Urban big data is a trigger for the economic dimension of Tehran's smart city vision. The digital economy of the city is growing rapidly. Already ride-hailing, fintech, e-commerce, and delivery apps are collecting massive flows of data concerning consumer behavior, movement in traffic and market trend data. Looking at data can help a business speed up supply chains, target market, and make new services. For example, in 2022, Tehran's e-commerce behemoth Digikala (94% of the local online market) managed more than 35 million users. This provided big data on buying patterns.
The platform economy in Tehran, led by firms such as Digikala and Snapp, generates vast amounts of consumer, logistics, and behavioral data. Location-based data makes it possible to detect investment gaps and improve market efficiency. Sanctions, low foreign direct investment, and a lack of digital infrastructure, however, limit Tehran's wider economy (Honarmand, 2019). Many companies lack access to the data tools or skills necessary to assess those datasets. Moreover, agencies of the government have not made any economic data open or machine-readable for businesses. No cooperation between private and public data. To foster economically smart development, changes must be made to the current system. The government must allow local start-ups access to urban datasets. These datasets must be anonymized and concern city mobility, energy use, zoning permits, and more. Further, these start-ups must be enabled to create scalable services (Honarmand, 2019).
In theory, urban datasets could be mined by both city planners and businesses to identify growth sectors, match labor supply and demand, and support entrepreneurship activities. However, Tehran's smart economy faces barriers in practice. Numerous SMEs do not have data or have the knowledge to analyze the data. Investment is hindered in high-end analytics due to finance. High-

speed internet and cloud infrastructure is in short supply, which hampers the use of data in real time. As a result of this, most Tehran businesses remain "data poor" and either do not collect enough data or cannot convert it into insights. For Tehran to access the benefits of big data, it needs to improve data literacy in the private sector and open datasets. Policy changes, such as publishing anonymized public data on citywide mobility or demographics, can help startups refine the offering of their services. If these challenges are overcome with the help of training programs and public–private partnerships, data-driven strategies could transform Tehran's economy with enhanced efficiency, job creation, and inclusive growth.

Mobility and transportation challenges

As for the mobility characteristics of the city, Tehran suffers from chronic congestions: 3 million cars are operating in the metropolitan area of Tehran. The city has access to many mobility datasets including GPS traces of buses and taxis, smart-card logs of the metro and BRT systems, and the locations recorded on mobile phones and ride-hailing apps including Snapp and Tap30. However, so far, big data has yet to be used in the city's urban transport. A disconnect between public transport authorities, municipality, and private mobility providers remain with little interaction or interoperability between datasets (Khansari et al, 2013). For instance, Snapp and Tap30 collect comprehensive trip data, but do not coordinate with the relevant city agencies. Moreover, a good deal of traffic sensors are either outdated or offline while extensive real-time data is seriously underused. By combining data of this kind, the city could manage traffic flows in real time, optimize bus routes, implement on-demand bus systems and pre-emptive maintenance of infrastructure through smart traffic signals. Yet, for this potential to be realized, technological upgrades and strong political will are required to centralize and share sensitive transport data. Lack of a unified data governance framework limits the potential of big data to transform urban mobility in Tehran (Habibi & Hoveyda, 2020).
Currently, there is no data dashboard for mobility in Tehran that integrates all that data and presents an overview of the movement of individuals throughout the city. The city suffers from data fragmentation as well as old traffic management systems, overcrowded public transport and lack of bus lanes. These issues cannot be solved by better use of data alone. Deployment of key IoT infrastructure, such as traffic sensors and smart traffic lights, has been impeded by connectivity issues, especially lack of high-speed internet. Nevertheless, there are signs of incremental progress. Tehran's traffic police are piloting sensor-based technologies and big-name ride-hailing companies have started sharing their mobility data anonymously with city planners (Tehran Traffic Control Company 2022). In the future, development and continued investment in a common mobility data platform and digital infrastructure must happen. These improvements and the findings of this study will help the policymakers to make rational choices for metro expansion, bus timing, and other planning measures for a long period in Tehran.

Sociocultural and digital literacy challenges

In a smart city, digital literacy is essential for equality. In Tehran, many older individuals, as well as low-income groups, often lack the digital skills required to access online services (Lusianai et al., 2022). The aim of the "My Tehran" app is to offer various public services in one application. The main problem, however, remains the untrained public. They are unaware of the application and its specific opening hours. In addition, big data initiatives rely on citizens participating, by reporting problems with infrastructure or by responding to health alerts, but these cannot occur when people are not digitally literate (UN-Habitat, 2020).
This challenge is increased by a lack of faith in government surveillance. The Iranian government has ramped up the use of digital surveillance tools, including facial recognition software, mobile applications such as the Nazer app, looser security web cameras and US-sourced drone technology (The Guardian, 2025). Such measures have especially affected women by relevance dress code

and putting them in fear along with mental stress. To combat these problems, Tehran must implement specialized digital literacy campaigns such as community workshops, school programming on data science, and user-friendly tools for users with little experience. Pilot projects like SMS-based pollution alerts can penetrate less-tech-savvy sections of society (UN-Habitat, 2020). More ambitious initiatives, including a major broadband expansion effort and transparent governance of data, are required to support digital inclusion so that everyone can benefit from smart city initiatives (AlYahya, 2024).

In Tehran, urban big data can help manage natural disasters, mitigate the effects of climate change, and improve biodiversity conservation efforts (Aqbelaghi et al., 2018; Zali et al., 2024). Real-time environmental data can be used to predict and prevent problems such as flooding or extreme weather events, making urban areas more resilient to climate change (Zali et al., 2024). However, Tehran needs more advanced infrastructure for environmental data collection, as well as collaboration between public and private sectors for effective implementation (Aqbelaghi et al., 2018). Data-driven solutions for environmental monitoring can help the city address sustainability goals while mitigating the impacts of urban sprawl (Smart Tehran Programme, n.d.; Talkhabi et al., 2024).

Summary of challenges in developing a smart city in Tehran

Tehran is constrained by overlapping authorities, bad data, low trust among the public, and a lack of investment in technology and people. There are some instances of digital innovations like air quality monitoring systems, data-driven waste collection systems, and ride-hailing applications which have been developed. But the lack of a common strategic plan has not allowed these successes to scale across the city.

Cities like Barcelona, Amsterdam, and Songdo have international experiences which show that technological adoption only succeeds when the public is engaged, governments are transparent, and policies are continually adapted. In the context of Tehran, the enablers of a resilient smart city include building digital literacy, enabling public-private partnerships and developing a trustworthy data governance framework.

In the future, Tehran must invest in digital infrastructure, institutional cooperation, and open data initiatives to balance innovation and privacy. By tackling these structural and sociocultural issues, urban big data may assist the city to develop sustainably, improve the quality of life and enhance its capability to address complex urban challenges.

Table 4: Key Challenges Facing Urban Big Data and Smart City Development in Tehran

Challenge Area	Description
Institutional and Governance	Fragmentation of authorities, lack of coordination, data silos, and political inertia hinder the effective implementation of smart city initiatives and urban big data usage.
Environmental and Infrastructural	Environmental data collection is limited due to poorly distributed sensors, lack of integration across agencies, and insufficient public access to data.
Economics and Investment	Limited investment in data tools and infrastructure, insufficient digital economy support, and lack of data sharing between public and private sectors hinder progress.
Mobility and Transportation	Traffic congestion and underutilized mobility data due to siloed data systems between public and private sectors impede dynamic traffic management and optimized public transport.
Sociocultural and Digital Literacy	Digital literacy gaps among certain populations (e.g., elderly, low-income groups, and women) limit participation in smart city services and hinder the use of open data.

Source: Own compilation

Acknowledgement

„The publication is based on the Hungarian data of the Global Entrepreneurship Monitor research coordinated by Budapest LAB – Office for Entrepreneurship Development, which was provided by Budapest Business School as the Hungarian partner of the consortium on the basis of an individual permit. Project no. (TKP2021-NKTA-44) has been implemented with the support provided by the the Ministry of Innovation and Technology of Hungary from the National research, Development and Innovation Fund, financed under the Tématerületi Kiválósági program 2021 (TKP2021-NKTA) funding scheme"

References

AQBELAGHI, A. S., GHORBANI, M., FARHADI, E., & SHAFIEE, H. (2018). Environmental approach in modelling of urban growth: Tehran City, Iran. *Asian Journal of Water, Environment and Pollution, 15*(2), 47–56. https://doi.org/10.3233/AJW-180017

ALYAHYA, D. (2024, September 17). Together we can end the digital divide that disenfranchises 2.6 billion people. *Reuters*. https://www.reuters.com/sustainability/society-equity/comment-together-we-can-end-digital-divide-that-disenfranchises-26-billion-2024-09-17/

BATTY, M., AXHAUSEN, K. W., GIANNOTTI, F., POZDNOUKHOV, A., BAZZANI, A., WACHOWICZ, M., & OUZOUNIS, G. (2012). Smart cities of the future. *European Physical Journal Special Topics, 214*, 481–518. https://doi.org/10.1140/epjst/e2012-01703-3

BERGQUIST, K., & FINK, C. (2020). *The Top 100 Science and Technology Clusters*. World Intellectual Property Organization, The Global Innovation Index. Retrieved from https://www.globalinnovationindex.org

CARAGLIU, A., DEL BO, C., & NIJKAMP, P. (2011). Smart Cities in Europe. *Journal of Urban Technology, · 18*(2), 45-59. https://doi.org/10.1080/10630732.2011.601117

EUROPEAN COMMISSION. (2023). *Smart Cities.* Retrieved from https://commission.europa.eu/eu-regional-and-urban-development/topics/cities-and-urban-development/city-initiatives/smart-cities_en

GANDOMI, A., & HAIDER, M. (2015). Beyond the hype: Big data concepts, methods, and analytics. *International Journal of Information Management, 35*(2), 137–144. https://doi.org/10.1016/j.ijinfomgt.2014.10.007

GIFFINGER, R., FERTNER, C., KRAMAR, H., KALASEK, R., MEIJERS, E & PICHLER-MILANOVIC, N. (2007). *Smart Cities: Ranking European Medium-sized Cities.* (Final report). Vienna University of Technology. https://www.researchgate.net/publication/261367640_Smart_cities_-_Ranking_of_European_medium-sized_cities https://doi.org/10.34726/3565

GOOGLE CLOUD. (2023). *Big data: Definition, benefits, and challenges.* Google LLC. Retrieved from https://cloud.google.com/learn/what-is-big-data

HABIBI, A., & HOVEYDA, SH. (2020). The effect of mobile application quality dimensions on user satisfaction and loyalty: A case study of the Snapp application. *Contemporary Research in Management and Accounting Sciences, 2*(6), 203–223. https://www.noormags.ir/view/en/articlepage/1697149/تاثیر-ابعاد-کیفیت-اپلیکیشن-های-موبایل-بر-رضایت-و-وفاداری-کاربران-مطالعه-موردی-اپلیکیشن-اسنپ (In Persian)

HARRISON, C., & DONNELLY, I. A. (2011). A theory of smart cities. In *Proceedings of the 55th Annual Meeting of the ISSS*. Hull, UK. https://journals.isss.org/index.php/proceedings55th/article/view/1703

HEEKS, R., & SHEKHAR, S. (2019). Datafication, Development and Marginalized Urban Communities: An Applied Data Justice Framework. *Information, Communication & Society, 22*(7), 992–1011. https://doi.org/10.1080/1369118X.2019.1599039

HEIDARI, H., ARABI, M., WARZINIACK, T., & SHARVELLE, S. (2021). Effects of urban development patterns on municipal water shortage. *Frontiers in Water*, *3*, 694817. https://doi.org/10.3389/frwa.2021.694817

HOLLANDS, R. G. (2008). Will the Real Smart City Please Stand Up? *City*, *12*(3), 303-320. https://doi.org/10.1080/13604810802479126

HONARMAND, R. (2019). Investigating the impact of online shopping experience on customer satisfaction and online purchase intention: A case study of Digikala Company. *Scientific Journal of New Research Approaches in Management and Accounting*, *3*(9), 89–103. (Published: September 5, 2019) https://majournal.ir/index.php/ma/article/view/206 (In Persian)

HUMAYUN, M., JHANJHI, N. Z., ALAMRI, M. Z., & KHAN, A. (2020). Smart cities and digital governance. In V. Ponnusamy, K. Rafique, & N. Z. Jhanjhi (Eds.), *Employing Recent Technologies for Improved Digital Governance* (pp. 87-106). IGI Global Scientific Publishing. https://doi.org/10.4018/978-1-7998-1851-9.ch005

IBM. (2023). *What is a smart city?* IBM Corporation. https://www.ibm.com/topics/smart-cities

JAMARANI, A., HADDADI, S., SARVIZADEH, R., HAGHI KASHANI, M., AKBARI, M., & MORADI, S. (2024). Big data and predictive analytics: A systematic review of applications. *Artificial Intelligence Review, 57*(176). https://doi.org/10.1007/s10462-024-10811-5

KHANSARI, N., MOSTASHARI, A., & MANSOURI, M. (2013). Impacting Sustainable Behavior and Planning in Smart City. *International Journal of Sustainable Land Use and Urban Planning*, *1*(2), 46-61. https://www.researchgate.net/publication/268037209_Impacting_Sustainable_Behavior_and_Planning_in_Smart_City https://doi.org/10.24102/ijslup.v1i2.365

KITCHIN, R. (2014). Big Data and Human Geography: Opportunities, Challenges, and Implications. *Dialogues in Human Geography*, *3(*3), 262-267. https://doi.org/10.1177/2043820613513388

KUMAR, A. (2024). Actual practices of citizen participation in smart cities. *Smart Cities and Regional Development (SCRD) Journal*, 8(2), 19-30. https://doi.org/10.25019/4c05yr24

LUSIANAI, W. O., RACHIM, M. D., MULIATI, & ASTIN. (2022). Digital literacy of open access services to support online learning during the COVID-19 pandemic. *Jurnal Pemberdayaan Masyarakat Madani*, *6*(2), 325–350. https://doi.org/10.21009/JPMM.006.2.09

MASONI, A. (2024). Cultural Biases in the Smart City: Implications and Challenges. In S. Elias Bibri (Ed.), *Smart City Innovations: Navigating Urban Transformation with Sustainable Mobility*, *FSC 2023* (pp. 51–65). (Advances in Science, Technology & Innovation). Cham: Springer. https://doi.org/10.1007/978-3-031-57385-9_5

MOHANTY, S. P., CHOPPALI, U., & KOUGIANOS, E. (2016). Everything You Wanted to Know About Smart Cities: The Internet of Things Is the Backbone. *IEEE Consumer Electronics Magazine*, *5*(3), 60–70. https://doi.org/10.1109/MCE.2016.2556879

MORA, L., DEAKIN, M., & REID, A. (2019). Strategic Principles for Smart City Development: A Multiple Case Study Analysis of European Best Practices. *Technological Forecasting and Social Change*, *142*, 70-97. https://doi.org/10.1016/j.techfore.2018.07.035

OECD. *Global State of National Urban Policy 2021*: *Achieving Sustainable Development Goals and Delivering Climate Action*. OECD Publishing, Paris. https://www.oecd.org/content/dam/oecd/en/publications/reports/2021/06/global-state-of-national-urban-policy-2021_b535f2b4/96eee083-en.pdf https://doi.org/10.1787/96eee083-en

ORACLE. (2023). *What is Big Data?* Oracle Corporation. Retrieved from https://www.oracle.com/big-data/what-is-big-data/

POMEGRANATE INVESTMENT AB. (2023). *Digikala Annual Report.* Retrieved from https://about.digikala.com/en/reports/digikala1401/

SHAMSIPOUR, M., FARZADFAR, F., GOHARI, K., PARSAEIAN, M., AMINI, H., RABIEI, K., HASSANVAND, M. S., NAVIDI, I., FOTOUHI, A., NADDAFI, K., SARRAFZADEGAN, N., MANSOURI, A., MESDAGHINIA, A., LARIJANI, B., & YUNESIAN, M. (2014). A Framework for Exploration and Cleaning of Environmental Data – Tehran Air Quality Data Experience. *Archives of Iranian Medicine*, *17*(12), 821. https://www.researchgate.net/publication/269284298_A_Framework_for_Exploration_and_Cleaning_of_Environmental_Data__Tehran_Air_Quality_Data_Experience

SMART TEHRAN. (2020). *About Us.* Retrieved from https://smart.tehran.ir

TAN, S. Y., & TAEIHAGH, A. (2020). Smart city governance in developing countries: A systematic literature review. *Sustainability*, *12*(3), 899. https://doi.org/10.3390/su12030899

TALKHABI, H., JAFARPOUR GHALEHTEIMOURI, K., & TOULABI NEJAD, M. (2024). Integrating Tehran metropolitan air pollution into the current transport system and sprawl growth: An emphasis on urban performance and accessibility. *Discover Cities*, *1*, 6. https://doi.org/10.1007/s44327-024-00008-4

TEHRAN TRAFFIC CONTROL COMPANY. (2022). *Assessment of Urban Transport System in Tehran.* United Nations Economic and Social Commission for Asia and the Pacific. https://www.clodura.ai/directory/company/tehran-traffic-control-company

THE GUARDIAN. (2025, March 24). *Drones, informers and apps: Iran intensifies surveillance on women to enforce hijab law.* Retrieved from https://www.theguardian.com/global-development/2025/mar/24/iran-police-women-surveillance-hijab-drones-dress code-law

UN-HABITAT. (2020). *Smart Cities and Digital Inclusion: Challenges and Opportunities.* United Nations Human Settlements Programme. https://unhabitat.org/programme/legacy/people-centered-smart-cities/centering-people-in-smart-cities

WANG, C., & YIN, L. (2022). Defining urban big data in urban planning: Literature review. *Journal of Urban Planning and Development*, *149*(1), 896. https://doi.org/10.1061/(ASCE)UP.1943-5444.0000896

XIAO, N., & MILLER, H. J. (2021). Cultivating urban big data: Urban Informatics. In W. Shi, M. F. Goodchild, M. Batty, M-P. Kwan, & A. Zhang (Eds.), *Urban Informatics* (pp. 547–565). Singapore: Springer. https://link.springer.com/chapter/10.1007/978-981-15-8983-6_31

YADAV, S., & MOHAPATRA, G. (2018). Big Data in the Context of Smart Cities: Exploring Urban Planning and Governance. In U. M. Munshi, & N. Verma (Eds.), *Data Science Landscape: Towards Research Standards and Protocols* (pp. 141–150). (Studies in Big Data, 38). Singapore: Springer. https://doi.org/10.1007/978-981-10-7515-5_10

ZALI, N., SOLTANI, A., NAJAFI, P., EBADI QAJARI, S., & MEHRJU, M. (2024). Digital twins for smarter Iranian cities: A future studies perspective. *Computational Urban Science*, *4*(43). https://doi.org/10.1007/s43762-024-00155-9

***Lajos Kasza*[12]**

Investigation of relationships between entrepreneurial attitude and business performance in regional comparison

In my study I give an overview of the interrelationships between entrepreneurial attitudes, which have a major impact on the performance, economic and social perception and success of enterprises. In the literature review, I define entrepreneurship as an economic unit as defined by researchers in the field, and I interpret entrepreneurial attitudes, raising the issue that its regional analysis is far from simple, and its interpretation is complicated. I present my independent research on the impact of entrepreneurial attitudes on family entrepreneurship based on the Global Entrepreneurship Monitor (GEM) 2021-2022-2023. I will explain in detail the methodological issues, such as the source of data, the sample of the analysis, formulate research questions, outline my analytical approach and the statistical methods used for the research.
Keywords: entrepreneurial attitude, entrepreneurship, regional differences, economic performance
JEL codes: L26, R11, D22, L25

https://doi.org/10.32976/stratfuz.2025.20

Introduction

In my research, based on the GEM (Global Entrepreneurship Monitor) 2021-2022-2023 data, I am looking for the answer to the question of what similarities and differences in entrepreneurial attitudes can be found in the different regions of Hungary, how the individual characteristics of family entrepreneurs (demographic characteristics, motivations, individual entrepreneurial characteristics) and the indicators of the family businesses they run (age, size, sector, objective) are related to entrepreneurial attitudes.
This paper is presented as part of a wider study. This research will form the backbone of my doctoral thesis, in which I will examine the succession practices of domestic family commercial enterprises, compare their success and failure dimensions across regions, and explore the effects of change.
Numerous organizations uniting family businesses operate in Hungary; however, these typically form closed communities, primarily consisting of companies with multi-billion forint revenues and diverse market presence. Associations that bring together family businesses based on regional affiliation or operating in the commercial sector are nearly invisible. My study addresses a significant research gap by exploring the relationship between entrepreneurial attitudes and business performance in two regions characterized by markedly different structural conditions and developmental trajectories. The insights derived from the analysis contribute to a deeper understanding and identification of firms' operational dynamics and succession-related characteristics
In the literature, the issue of business succession is described as a human resource management problem. In my opinion, succession needs to be examined from a competitive perspective (at macro, meso and micro levels), as its economic and financial impact is closely related to the productivity indicators of the company, its organisational efficiency and thus ultimately has a direct impact on the success of succession.

[12] Teaching Professor, Budapest University of Economics and Business, Faculty of Commerce, Hospitality and Tourism, Department of Commerce; PhD student, University of Miskolc, kasza.lajos@uni-bge.hu

Literature review

The mapping and accurate knowledge of the macro and micro environment surrounding entrepreneurship, as well as the attitudes (attitudes) related to the establishment and operation of an enterprise, is important both economically and socially, as the value-creating capacity of enterprises is indisputable in both national and regional economic terms. Business organisations' behaviour as learning organisations and their capacity for innovation can contribute to solving countless economic, environmental and social problems. Jackson and Rodkey's (1994) research highlights the fact that successful enterprises are essential to the functioning of the market economy and also play a significant role in job creation.
According to Timmons (2003), entrepreneurship is a set of human creative acts. Those with the basic and necessary competences and the real motivation are capable of starting and running their own business. The attributes and motivations that most influence the success of an enterprise are those that include the creation, definition, retention and distribution of value.
Entrepreneurial attitude has been interpreted as "a mental and nervous state of readiness, organised through experience, that exerts a dynamic or directive influence on the individual's response to the objects and situations to which the attitude applies" (Rozgonyi, 2001). In general, the approaches show that attitudes are formed and reinforced by experience, are a kind of mental representation and reflect our value judgements about an object. On this basis, we consider attitudes to entrepreneurship as attitudes. According to Wardana et al. (2020), entrepreneurial attitudes are nothing more than individual responses to existing potentials, facts and other information, feedback and events.
„Measuring entrepreneurial attitudes is in practice a complex process, including the collection of data for regional level analyses. Little empirical research has focused on regional culture and the measurement of entrepreneurial attitudes (Kangasharju, 2000), one reason being the lack of measures that can adequately represent entrepreneurial activity. Attitude is essentially a combination of initiative, will, innovation and motivation, and is closely related to entrepreneurial competences. Both entrepreneurial attitudes and self-employment competences are important for future entrepreneurs. Unfortunately, the available literature is not always clear about the relationship between entrepreneurial attitudes and actual entrepreneurial behaviour and, consequently, it is not easy to identify and analyse entrepreneurial attitudes quantitatively and qualitatively." (Kasza & Lipták, 2022)

Small and medium-sized enterprises (SMEs) in Hungary

There are several definitions of small and medium-sized enterprises around the world, with several influencing factors that determine this. The 3 important questions of the definition are "what is considered an enterprise, on the basis of which indicators, where do we draw the boundaries of the different size categories" (Kállay, 2012)
Activities that are profit-oriented and carried out on a market basis can be considered as enterprises. The presence of both elements together defines an enterprise, so non-profit organisations cannot be considered strictly as such. Although the legislation tries to make a clear distinction between the two forms of activity, the distinction between business and non-profit activities can be problematic. The entrepreneurial activity of non-profit and budget organisations can be considered as one and the same business sector, but this does not mean that these organisations should be included in the enterprise sector.
Medium-sized enterprises are one of the driving forces of the economy and play an important role in every country in the world, as shown by the fact that they account for 56% of EU GDP. Their main characteristics are that they employ fewer than 250 people and have an average annual turnover of less than €50 million. SMEs tend to be more flexible than large multinationals, can respond more quickly to major and minor changes due to their small size and are easier to organise. SMEs face a number of difficulties, such as limited access to finance, a complex regulatory

framework and increasing market competition, and their success depends on overcoming these obstacles. The figures clearly show that the SME sector represents a truly distinct and significant plurality, but the efficiency of these enterprises lags far behind that of multinationals, so they clearly have room for improvement (Horváth et al, 2019)

Main problems of the SME sector

1. Poor efficiency: the productivity of an average Hungarian SME is only a third of that of large companies.
2. Poor bargaining power: they are at a significant disadvantage because of their small size and consequently their small economic power: in price negotiations, whether for the final product or for raw materials. Limited access to capital markets, difficult to attract customers.
3. Lack of skilled management: according to research by Budapest LAB, only around 29% of SMEs have entered new markets in recent years and 60% do not engage in any export activity.
4. Gaps in the public and EU support system: SMEs have particular difficulties in accessing finance compared to larger firms.
5. High public charges and administrative burdens: public charges for SMEs are higher than for large companies and the time spent on administration is too high.
6. Moderate research and innovation performance: a significant proportion of SMEs lack the knowledge and capital to innovate, and there is a lack of confidence in where to turn to for knowledge. Very few SMEs use modern business management software, and one in five do not even have a website.
7. Low wage levels: access to skilled and experienced labour is also limited. Labour emigration to Western Europe, estimated at around 600,000, hits the SME sector hardest. (Horváth et al, 2019)

Family businesses

Defining the concept of family business

The definition of family business was first addressed by the European Commission in 2009. Although the concept is still not widely accepted, family businesses are still included in the SME group, i.e. they try to retain the characteristics of SMEs, the main reason being to avoid that family businesses are excluded from the support possibilities for SMEs. Despite this pragmatic approach, family businesses cannot be included in the SME system because of their many different and specific characteristics, and it is therefore timely to review the definition of the concept.
Across Europe, there are more than 90 concepts of family business in the public consciousness. As a result of the different definitions, there is no comparability between family businesses in the Member States (European Parliament - Plenary Session Paper, 2015)
In 2009, the concept of family business, as formulated by the EU's expert groups, was based on the family, the business and the property, grouped around four main aspects (European Commission, 2009):
A family business is defined as a firm where, ignoring the size of the firm:

1) The natural person(s) who founded the company, or the natural person(s) who contributed to the share capital, or their spouses, parents, children and their direct heirs, have a majority of the decision-making rights;
2) The majority of decision-making rights may be direct or indirect;
3) At least one family or relative contributes to the management of the company's activities;
4) The person who participated in the establishment of the company, who may be the founder, family or descendant, must hold 25% of the decision-making rights.

Peter Leach (2007) does not set any criteria for defining a family business, but considers those businesses where a family or relative has an influence on the operation and the business itself is considered a family business.

Opinions on the concepts are very divided in the foreign literature. Similarly to Leach's conception, Tatoglu et al (2008) focus only on the presence of the family without setting any criteria, and consider as acceptable those enterprises where the family has the predominant decision-making power. A similar definition of a family business, but based on a clear set of criteria, is used by PricewaterhouseCoopers (2008), which, on the basis of surveys, considers businesses to be family businesses where more than 50% of the ownership is held within the family and where one member of the family is represented at the top of the decision-making and is involved in the day-to-day operational work.
Donnelly's (1964) definition of the family business does not focus on the proportion of decision-making rights or ownership, but on the need for two generations to participate in the politics of the firm and to influence the family's goals and satisfy its interests. Donnelly's hard-criterion definition shows that it is not necessary to focus on just one criterion in the definition, such as ownership or the proportion of family involvement in the business (Harms, 2014).
In Perez-Gonzalez's (2006) definition, a firm can be considered a family firm if two of the following criteria are met:

1) there is a blood relationship between at least two of the employees, shareholders or managers of the company,
2) a natural person owns at least 5 percent of the shares,
3) the founding member is present as an executive officer or director.

In Hungary, Budapest LAB (2017) launched a long research programme to explore the characteristics and data of family businesses. In defining the concept, they did not focus on just one dimension, but took into account several elements and defined family businesses as "those firms that consider themselves to be family businesses, or where at least 51% of the firm is owned by a family and the family participates in the management of the business, or where family members participate in the operation of the business as employees, or where the management and ownership are intended to be transferred partly or entirely within the family." (Budapest Lab, 2017).

Methodological background of the analysis

Data source

The source of the data used in this research is the Global Entrepreneurship Monitor (GEM) survey. The GEM is the world's largest entrepreneurship survey: it has been running since 1999 and in Hungary since 2020. Its research questions include the assessment of entrepreneurial activity and the state of the entrepreneurial ecosystem.
The data collection in Hungary was conducted by the LAB Business Development Office of the Budapest University of Economics and Business Administration, and the data collection was carried out by the TÁRKI Public Opinion Research Institute by telephone among the population aged 18-64, with 2014 respondents in 2021, 2015 respondents in 2022 and 2023 respondents in 2023. The data collection was carried out among a sample of multiple probability samples stratified in equal proportions, representative of the total population according to demographic characteristics such as gender, age, type of municipality and region of residence. Analyses were conducted on the national weighted sample.

The sample of the analysis

16.9% of the population aged 18-64 were self-employed in Hungary in 2023. This is similar to the proportion in previous years, which was 17.8% in 2021 and 16.8% in 2022. Of these entrepreneurs, 29% were self-employed or self-employed to continue the family tradition: they are considered family entrepreneurs. In previous years, the proportion of family entrepreneurs among entrepreneurs was lower: 23.3% in 2022 and 22.5% in 2021 (Figure 1). These proportions have

been calculated on the basis of aggregated data for businesses at different stages. (Due to the survey methodology, the questionnaires ask separate sets of questions to managers of early - birth and start-up - and established businesses.)

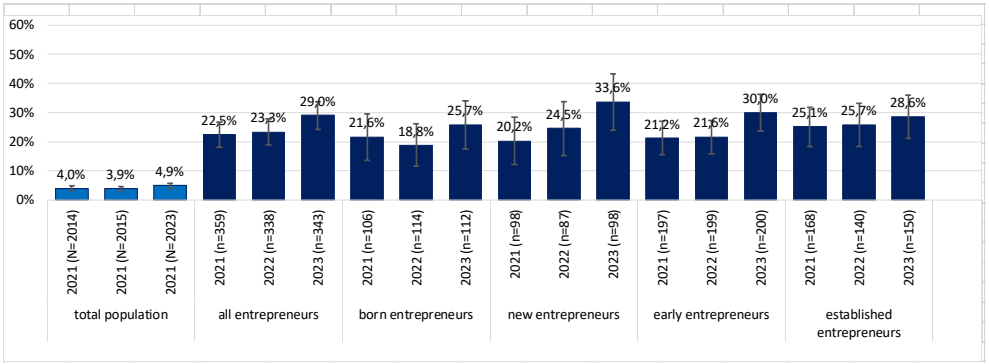


Figure 1. Proportion of family entrepreneurs in each group

Source: GEM research, Hungary, 2021, 2022, 2023. Note: the number of population belonging to the given group is given in brackets. CI: confidence interval.

Looking at the enterprises separately, the share of family entrepreneurs among early stage entrepreneurs is 30.0%, while the share among established enterprises is 28.6% (Figure 1). The share of family entrepreneurs among entrepreneurs was highest among new entrepreneurs in 2023 (33.6%); while in 2021 and 2022 it was highest among established enterprises (25.1% and 25.7% respectively). At the same time, the GEM survey asked about the prevalence of entrepreneurship, and within this the prevalence of family entrepreneurship (entrepreneurial motivations), among the total population, so we can estimate the proportion of family entrepreneurs among the total population aged 18-64 in Hungary.

According to the GEM national representative survey, the share of family entrepreneurs in the population aged 18-64 was 4.1% in Hungary in 2021 (95% CI: 3.2%-4.9%); 3.9% in 2022 (95% CI: 3.1%-4.8%) and 4.9% in 2023 (95% CI: 4.0%-5.9%). Thus, their share did not change significantly in these three years.

Someone is significantly less likely to be a family entrepreneur if one is female and also if one has a primary education, controlling for all other demographic characteristics and the year of the survey.

Research questions

The research questions of the analysis are: 1) what are the similarities and differences in entrepreneurial attitudes; and 2) whether there are differences in these attitudes in different regions of Hungary, how do the individual characteristics of family entrepreneurs (demographic characteristics, motivations, individual entrepreneurial characteristics) and the indicators of the family businesses they run (age of the business, size, sector, objective) relate to entrepreneurial attitudes.

Description of the conceptual framework used for the analysis

The GEM (2022) defines an entrepreneur as a person who, alone or with others, attempts to start a new business, including self-employment or the sale of a product or service; or who, alone or with others, attempts to start a new business or a new business for his or her employer as part of his or her main job

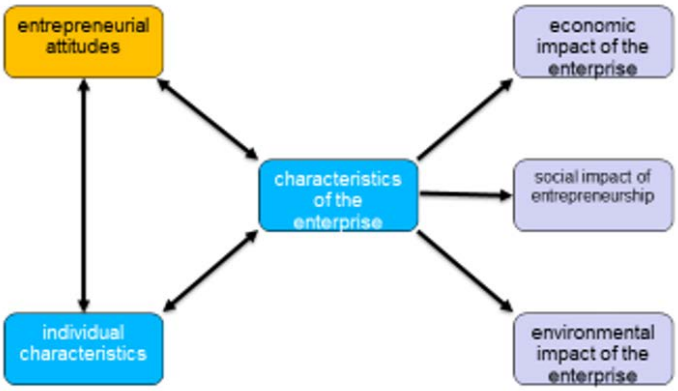


Figure 2. Simplified concept of analysis
Source: own editing, based on GEM-Global-Report-2021–22

Family business owners and managers are defined as entrepreneurs who responded that they start or manage a business to continue the family tradition. The exact question was "Please tell us to what extent the following statements reflect the reasons why you want to start a business." Those who strongly agreed or tended to agree with the statement "To continue the family tradition." are defined as family entrepreneurs in this analysis.

The second research question, whether there are similarities or differences in entrepreneurial attitudes across geographical regions, requires that the data from the three survey years be analysed together. This is because, if we were to analyse the data within geographical regions separately for each survey year, this would lead to statistically unreliable results due to the low number of items: the sample of 18-64 year olds in each region could identify few family entrepreneurs in any one year, but if the data from the three years are combined, the data can be analysed at the regional level.

However, if we want to look at certain correlations not only by region, but also by year, it is essential to aggregate the regions because of the low number of elements. In these cases, regions are divided into two groups based on GDP per capita: developed and less developed regions. The GDP per capita is consistently higher than the national average in Central Hungary (thanks to the data for the capital) and consistently around the national average in Central and Western Transdanubia. In these three regions, GDP per capita was respectively HUF 10,541, HUF 6,325 and HUF 6,100 in 2022, according to preliminary data from the Hungarian Central Statistical Office. Thus, in my analysis, I include family entrepreneurs living in Central Hungary, Central Transdanubia and Western Transdanubia among those living in developed regions (2021: n=37; 2022: n=51; 2023: n=57), and family entrepreneurs living in South Transdanubia, Southern Great Plain, Northern Great Plain and Northern Hungary among those living in less developed regions (2021: n=44; 2022: n=28; 2023: n=42).

Assessing entrepreneurial attitudes along individual characteristics and indicators of entrepreneurship. Bivariate analyses.
Entrepreneurial attitudes by demographic background characteristics

The demographic groups do not differ significantly in their perceptions of entrepreneurial attitudes: there is no significant difference in the proportion of people who rate each attitude very positively, and this was the case in 2021 and 2022. Thus, the differences highlighted in this sub-chapter are only indicative.
On average, women were more positive than men about entrepreneurial attitudes in 2023, and vice versa in previous years, with men being more positive. Looking at the assessment of attitudes by age group, it is interesting to note that while self-employment attitudes and the entrepreneurial environment were more positively assessed by older people, entrepreneurship was more positively assessed by younger people. We highlight that in 2021, all three entrepreneurial attitudes were rated positively by older people at the lowest rates, and in 2022 we see a more U-shaped correlation across the three age groups. By educational attainment, I highlight that while in 2023 those with a high level of education were the least positive about their self-employment attitudes, in the previous years they were the most positive. The entrepreneurial environment is perceived as least positive by those with a secondary education in all three years.
There is also no trend difference in the perception of family entrepreneurs living in different types of settlements. Those living in cities with county status had the lowest proportion of people who reported a very positive view of their entrepreneurial environment and entrepreneurship, with none in 2022 rating entrepreneurship very positively. Those living in villages, on the other hand, were the most positive in their attitudes towards self-employment, both in 2023 and 2022.

Family entrepreneurs do not differ in their attitudes according to their demographic background characteristics in either year.

The relationship between entrepreneurial attitudes and entrepreneurial and firm characteristics. Multivariate analyses

In the first step of the multivariate analyses, I used logistic regression models to test the factors that predict positive entrepreneurial attitudes in three different models. The dependent variables are the bivariate variables 0/1 of the indices of individual attitude, entrepreneurial environment and perception of entrepreneurship, where (1) indicates that attitudes were rated as very positive by the respondents. All explanatory variables analysed so far were included in the models, but only entrepreneurial characteristics and indicators of entrepreneurship were plotted for ease of clarity and also because individual demographic characteristics, motivations, region of residence and year of survey were not significantly related to the dependent variables.

Family entrepreneurs are significantly more likely to rate individual attitudes as very positive if they identify themselves as very talented (OR=2.874; 95% CI: 2.135-3.868); if they own their business (OR=1.570; 95% CI: 1.147-2.148); if they are self-employed (OR=1.683; 95% CI: 1,235-2,293); if they have at least 6 employees in their enterprise (OR=2,772; 95% CI: 1,499-5,126); or if they have formulated objectives for the future of their enterprise (OR=1,793; 95% CI: 1,225-2,625), controlling for all other aspects analysed in this chapter (Figure 3).

The entrepreneurial environment was significantly more likely to be rated as very positive by talented entrepreneurs (OR=2.407; 95% CI: 1.625-3.566), early-stage entrepreneur managers (OR=1.950; 95% CI: 1,122-3,391), those with higher business growth expectations than one year before the survey (OR=1,801; 95% CI: 1,190-2,727) and those with a national or international market (OR=1,605; 95% CI: 1,002-2,573; Figure 3).

Entrepreneurship was significantly more likely to be rated as very positive by entrepreneurs who prioritised environmental and/or social impacts over business growth and profit (OR=1.648; 95% CI: 1.181-2.299; Figure 3).

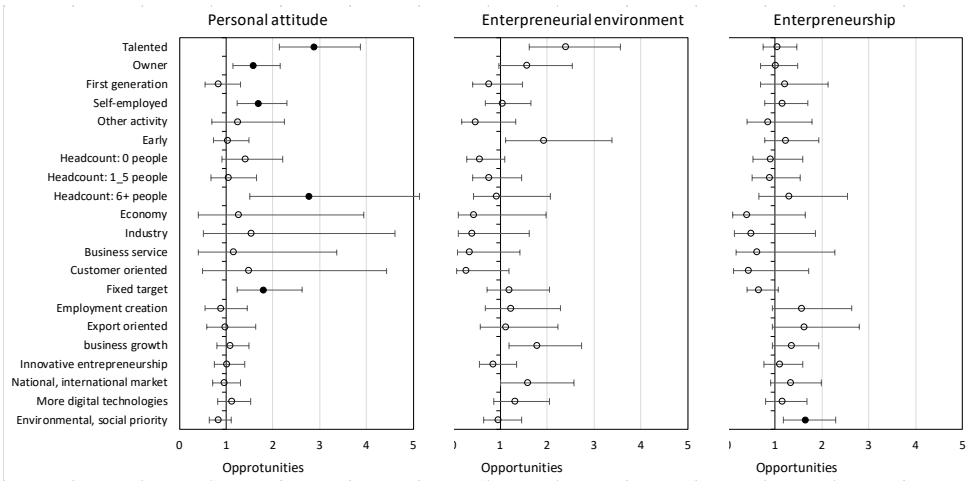


Figure 3: Factors for a very positive assessment of entrepreneurial attitudes (opportunities, 95% CI)

Source: own editing, based on GEM Hungary, 2021, 2022, 2023. (Note: controlling for demographic characteristics, motivations, region of residence and year of survey.)

As another type of multivariate analysis, I conducted a cluster analysis on the three-year pooled database. Our aim is to answer the question whether any co-movement can be observed between family entrepreneurs in each region and their entrepreneurial attitudes. The clustering of variables is used to organise the variables into homogeneous groups (clusters) that are closely related to each other. In cases where we want to cluster variables with a low (dichotomous) level of measurement, such as variables containing individual characteristics and business indicators, it is useful to measure the distances (correlations) between variables using some measure based on association. For dichotomous variables, the most appropriate measure is the Phi coefficient.
Similar to Pearson's correlation coefficient, it ranges between (-1) and 1, where (-1) indicates no relationship at all between the two variables, and 1 indicates a close relationship. The cluster analysis is run on a similarity-input matrix consisting of the Phi-coefficients calculated by the pairwise correlation between the variables. In the first step, I used hierarchical cluster analysis with Ward's full chain method based on squared Euclidean distances. Using the resulting dendogram (which shows the hierarchical relationship between objects), I concluded that it is worth reviewing both two-, three- and four-cluster clustering. Since my cluster analysis started from a similarity matrix of Phi indicators, the dendogram actually shows the cooccurrences between the variables (a larger or a narrower group, depending on the number of clusters chosen) belonging to a given cluster.

Cut off at a given distance, we can determine how many cluster groupings to analyse (Figure 4). If we cut the dendogram at distance 14, we get a two-cluster solution; if we cut at distance 13, we get a three-cluster solution; if we cut at distance 10, we get a four-cluster solution. Both the two- and three-cluster solutions seem quite robust (you have to move the vertical cut-line very little between distances 13 and 14 to get immediately to a two- and a three-cluster solution, respectively).

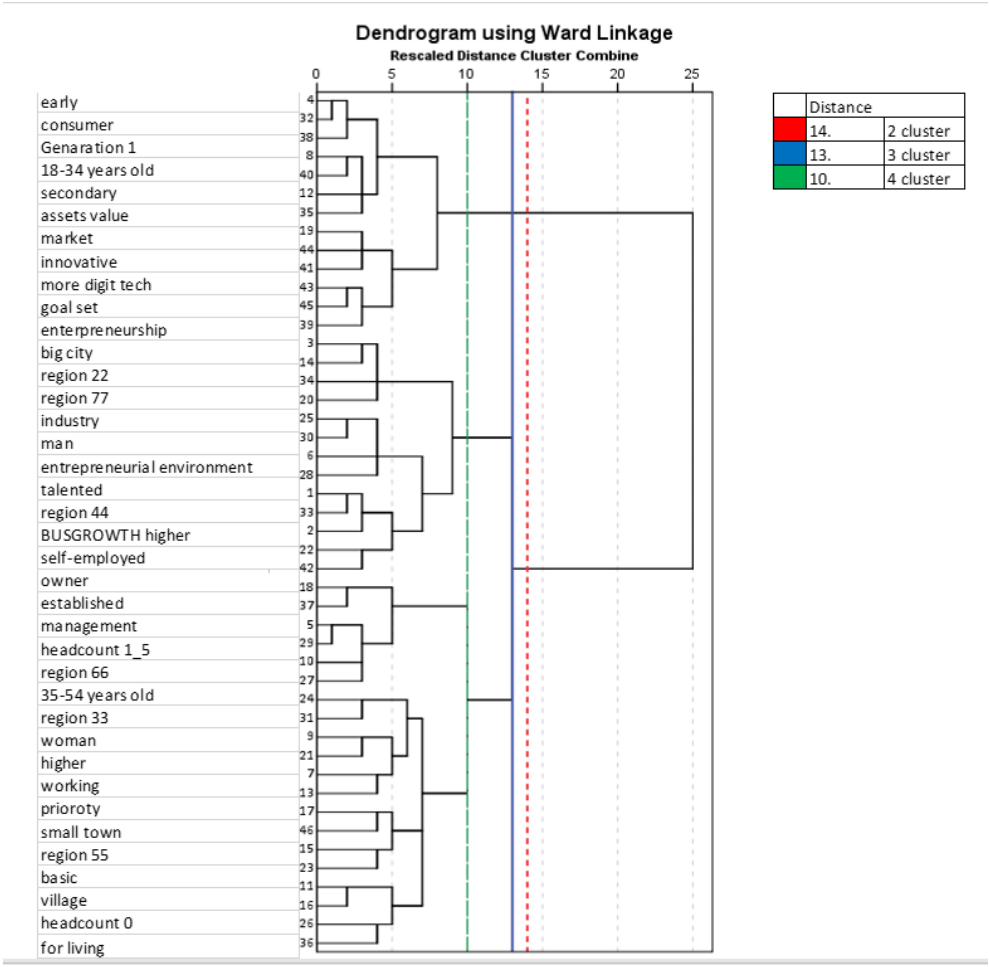


Figure 4: Clustering of variables describing individual characteristics and company indicators based on a similarity matrix, dendogram
Source: GEM research, Hungary, 2021-2023.

In Table 4 I summarise the variables that are closely correlated according to the given groupings of 2 clusters, 3 clusters or 4 clusters. The regions are separated into separate clusters when the three-cluster solution is considered.
Regardless of which clustering attempt is considered, the indicators belonging to the first cluster always belong together: family entrepreneurs in the Central Hungary region are characterised by being young, having a secondary education, having an early-stage business, having a family cause, having a high wealth and high income, having a consumer-oriented sector, having a national and international market, having more than 25 percent of their turnover exported, being innovative,

having a target definition, expecting an increase in the number of employees next year and using more digital technologies.
The second cluster includes family businesses in the West Transdanubia, Southern Great Plain and Northern Great Plain regions, and they are the ones who rated all entrepreneurial attitudes very positively. In addition, they are characterised by being male, having at least 6 employees and operating in the industrial, transport and warehousing sector (mainly entrepreneurs from the Western Transdanubia region), living in a big city and operating in order to do something substantial (mainly entrepreneurs from the Southern Great Plain region), and considering themselves as talented entrepreneurs and expecting to grow their business in the future (mainly entrepreneurs from the Northern Great Plain region). Finally, family entrepreneurs from Central Transdanubia, Southern Transdanubia and Northern Hungary belong to the third cluster. They are more likely to be entrepreneurs in the business services sector (mainly in Central Transdanubia), middle-aged women with tertiary education (mainly family entrepreneurs in Southern Transdanubia), either living in small towns, working as employees, or in villages, with primary education, running a one-man business and having started a business to earn a living (mainly entrepreneurs in Northern Hungary).

Table 1. Profile of family entrepreneurs in developed and less developed regions

Cluster 1	Cluster 2	Cluster 2	Cluster 2
Cluster 1	Cluster 2	Cluster 3	Cluster 3
Cluster 1	Cluster 2	Cluster 3	Cluster 4
Közép-Magyarország	**Dél-Alföld**	55-64 years old	**Közép-Dunántúl**
18-34 years old	Entrepreneurship: positive	Well-established business	Business services
Secondary education	Living in a big city	Owner	**Dél-Dunántúl**
Early business	Reason: do something important	Self-employed	35-54 years old
First generation	**Nyugat-Dunántúl**	Headcount 1-5 people	Woman
Customer oriented	Man	Economic sector	Higher education
Reason: great wealth	Headcount: 6+ people		**Észak-Magyarország**
Market: national, international	Industrial sector		Lives in a small town
Export: 25%+	**Észak-Alföld**		Employee
Innovative business	Entrepreneurial environment: positive		Priority for social and environmental impacts
More digital technologies next year	Personal attitude: positive		Primary education
Specified target	Talented entrepreneur		Lives in a village
Headcount increase expected	Expecting business growth		Reason: for a living
			Headcount: 0 people

Source: GEM research, Hungary, 2021-2023.

The two cluster groupings clearly distinguish family entrepreneurs living in the Central Hungary region (cluster 1) from family entrepreneurs living in other regions (cluster 2). In the 4-cluster grouping, a group of entrepreneurs is separated within cluster 3, regardless of region, who are elderly, run established businesses with 1-5 employees, are self-employed in their business and are engaged in the farming sector.
Using the K-Means Cluster procedure, I calculated the distance of the indicators from the cluster centres, in this case from the centre of the clusters separated within the three-cluster solution. Based on these distances, I placed the indicators in a three-dimensional space, which I visualized using two or three dimensions. I have placed the variables according to the distances from the cluster centres of cluster1 and cluster2, because here it is possible to separate an enterprise sector axis (Y-axis) and an enterprise age axis (X-axis). The space bounded by the first and second cluster distances shows that the Central Hungary region is located in the lower right quadrant, with characteristics such as the number of entrepreneurs with secondary education, employees and enterprises in the consumer-oriented sector. All other regions are located in the top left and show a close relationship with the characteristics shown there. It can also be seen that the positive perception of entrepreneurial attitudes is most pronounced for family entrepreneurs living in the Northern Great Plain region and less so for those living in Central Hungary.

Summary

In the course of my study, I interviewed and participated in discussions with numerous business owners and managers. It became clear to me that businesses in different industries and different market sectors face very different challenges. These challenges are related to economic, social and legal conditions, as well as to financial, financing and profitability conditions. However, business life-cycle models can be very different, as can entrepreneurial attitudes, family models, traditions, attitudes of successors, or succession ideas and strategies.
In Hungary KSH does not register family businesses as a separate category, but the number of small and medium-sized enterprises (SMEs) is a very good starting point for estimating their number, as most of these types of businesses can be considered family businesses. In Hungary, 96.1% of enterprises are SMEs and two thirds of enterprises have no employees. SMEs provide 74% of employment in the competitive sector and contribute 54.4% to the gross national product. Their importance is undeniable, but their productivity and competitiveness are below the EU average. Recognising this, the government launched the Sándor Demján Programme, which to reduce this gap and increase the competitiveness of the SME sector.
I found that family entrepreneurs did not differ in their attitudes according to their demographic background characteristics in either year. However, family entrepreneurs are significantly more likely to rate their individual attitudes very positively if they perceive themselves as very talented, and, in turn, are more likely to rate the entrepreneurial environment more positively.
An interesting finding of my research is that entrepreneurs who put environmental and/or social impacts ahead of business growth and profit were significantly more likely to rate entrepreneurship as very positive.

References

BUDAPEST LAB. (2017). *Az első generációnál még csak nevében „családi" a családi vállalkozás*. https://budapestlab.hu/index.php/az-elso-generacional-meg-csak-neveben-csaladi-a-csaladi-vallalkozas/

DONNELLY, R. G. (1964). The Family Business. *Harvard Business Review*, *42*, 93–105.

EURÓPAI PARLAMENT. (2015). *Jelentés az európai családi vállalkozásokról* (A8-0223/2015).

EUROPEAN COMMISSION. (2009). *Final report of the expert group, Overview of family business relevant issues: Research, networks, policy measures and existing studies*. https://ec.europa.eu/docsroom/documents/10388/attachments/1/translations/en/renditions/native

GEM (Global Entrepreneurship Monitor) (2022). *Global Entrepreneurship Monitor 2021/2022 Global Report: Opportunity Amid Disruption.* London: GEM.

GEM (Global Entrepreneurship Monitor) (2022). *Nemzeti jelentés, Magyarország 2021-2022; Vállalkozási környezet és attitűdök Magyarországon.* Budapest: BGE. https://publikaciotar.uni-bge.hu/id/eprint/1881/1/BGE_GEM_Nemzeti_jelentes_2021_2022_online.pdf

GEM (Global Entrepreneurship Monitor) (2023). *Nemzeti jelentés, Magyarország 2022-2023; Tenni akarás és megélhetés.* Budapest: BGE. https://budapestlab.hu/wp-content/uploads/2023/05/GEM-BGE_2023_web.pdf

HARMS, H. (2014). Review of Family Business Definitions: Cluster Approach and Implications of Heterogeneous Application for Family Business Research. *International Journal of Family Studies, 2*(3), 1–35. https://doi.org/10.3390/ijfs2030280

HORVÁTH, B., KOVÁCS B., & ELLA, O. (2019). Vállalkozásokból vállalatok - a kkv-szektor problémái és lehetőségei. *Pénzügyi Szemle Online.* https://www.penzugyiszemle.hu/tanulmanyok-eloadasok/vallalkozasokbol-vallalatok-a-kkv-szektor-problemai-es-lehetosegei

JACKSON, J. E., & RODKEY, G. R. (1994). The attitudinal climate for entrepreneurial activity. *Public Opinion Quarterly, 58*(3), 358–380. https://doi.org/10.1086/269432

KANGASHARJU, A. (2000). Regional variations in firm formation: Panel and cross-section data evidence from Finland. *Papers in Regional Science, 79*(4), 355–373. https://doi.org/10.1111/j.1435-5597.2000.tb01762.x

KASZA, L., & LIPTÁK, K. (2023). Analysis of the Entrepreneurial Environment and Attitudes in Hungary. In O. Uçan (Ed.), *Discussions Between Economic Agents: Global Problems* (pp. 73–93). Ankara: İksad Publishing House.

KÁLLAY, L. (2012). *KKV-szektor: Versenyképesség, munkahelyteremtés, szerkezetátalakítás* (TM 58.sz. műhelytanulmány). BCE Vállalatgazdaságtan Intézet Versenyképesség Kutató Központ.

LEACH, P. (2007). *Family businesses the essentials*. London: Profile Books.

PEREZ GONZALEZ, F. (2006). Inherited Control and Firm Performance. *American Economic Review, 96*(5), 1559-1588. https://www.jstor.org/stable/pdf/30034985.pdf

PRICEWATERHOUSE COOPERS (2008). *Making a difference – the PricewaterhouseCoopers family business survey 2007/08.* 1-60. https://www.pwc.com/gr/en/surveys/assets/family-business-2007-2008.pdf

ROZGONYI T. (2011). *Személypercepció és attitűd. A társas világ kognitív és érzelmi vonatkozásai.* („Tanár kockázati program", Jegyzet és szemelvénygyűjtemény, 2). 1-74.

TATOGLU, E., KULA, V., & GLAISTER, K. W. (2008). Succession planning in family – owned businesses: Evidence from Turkey. *International Small Business Journal, 26*(2), 155–173. https://doi.org/10.1177/0266242607086572

TIMMONS, J. A. (2003). *New Venture Creation, Entrepreneurship for the 21st century*. Irwin: McGraw-Hill.

WARDANA, L. W., NARMADITYA, B. S., WIBOWO, A., MAHENDRA, A. M., WIBOWO, N. A., HARWIDA, G., & ROHMAN, A. N. (2020). The impact of entrepreneurship education and students' entrepreneurial mindset: The mediating role of attitude and self-efficacy. *Heliyon, 6*(9), e04922. https://doi.org/10.1016/j.heliyon.2020.e04922

Boglárka Bánné Gál[13]

The impact of investments on the economic performance of Borsod-Abaúj-Zemplén county in relation to the 2014-2020 European Union development cycle

In my study, I examined the territorial dimensions of Hungary's economic performance between 2013 and 2021. The choice of the time interval was based on a conscious methodological choice. The evaluation of the EU development cycle 2014-2020 requires knowledge of the economic situation before that period, so it was justified to choose 2013 as the starting year. This year can be considered as a record of the situation prior to the allocation of development funds, which provides a basis for an objective assessment of the economic situation prior to the interventions. The year 2021 was used as the upper limit for the period under consideration, as it already partly reflects the economic impact of the investments of the 2014-2020 development cycle. EU funds often have a multi-stage, longer-term impact on the local economy, so a timeframe beyond one year is necessary to measure results (ESF, 2018). Thus, analysing the period up to 2021 provides an opportunity to examine the after-effects of the funds in more detail and to capture structural changes.
Keywords: county economic power, investments, European Union grants, Borsod-Abaúj-Zemplén county
JEL code: R11; R12; R58

https://doi.org/10.32976/stratfuz.2025.21

Introduction

For this purpose, I have used district-level small district estimates of GDP data, which I refer to in the literature as *district economic power*. I investigated how the economic power of districts changed between 2013 and 2021, whether the spatial structure of the Hungarian economy changed, including the position of the districts of Borsod-Abaúj-Zemplén county, and what role the investments in the period 2014-2020 played in the changes. Finally, I used the example of Borsod-Abaúj-Zemplén county to examine the stimulative effects of EU funding between 2014-2020.

The analysis covered the whole territory of Hungary, including 175 districts and 22 districts of Budapest. Within the spatial comparison, Borsod-Abaúj-Zemplén county was given special attention as the central case study of the study.

My results show that between 2013 and 2021, economic spatial inequalities in Hungary decreased slightly, but this change hardly altered the ranking of economic power between districts.

Between 2014 and 2020, a quarter of the districts concentrated 80% of investment. The relative differences in investment are due at least as much to differences within counties as between counties. The analysis shows that investment also plays a key role at district level. In nine tenths of the districts, investment determines in part or in whole the economic growth potential.

Between 2014 and 2020, the economic stimulus from EU funds in the districts of Borsod-Abaúj-Zemplén county lagged significantly behind non-EU investments. In the districts where EU investment has become dominant, less substantial economic improvement is visible. A territorial alignment of the two sources could in the future achieve a higher rate of regional economic growth.

[13] Phd student, University of Miskolc Faculty of Economics Institute of World and Regional Studies; email: banne.gal@gmail.com

Regional changes in district economic power in Hungary between 2013 and 2021

In order to assess the economic activity of the country's districts from a macroeconomic perspective, detailed territorial data are needed. A breakdown of GDP by county is regularly published by the HCSO at[14] .
The territorial accounts are compiled by sector and industry, based on the methodology of the production accounts of the national accounts. Its sources are output and its uses are intermediate consumption, the difference being gross value added. GDP, as a macroeconomic indicator, by definition, cannot be provided in a precise form more detailed than at county level (Dusek T. - Kiss J. P., 2008) and no other stable and complex economic indicator exists at district level. However, there is a well-known estimation procedure of district GDP values in the literature, called district economic power (JGE) (Lőcsei & Nemes Nagy, 2003; Tóth G., 2024)
The procedure for estimating district GDP/JGE is as follows:

- The first step was to determine the share of the districts belonging to each county on the basis of the total taxable income of the county, the volume of local taxes and the number of active enterprises. That is, the following calculations were made for county j:

$$\frac{J_{ij}^{A}}{\sum_{i=1}^{n} J_{ij}^{A}};\ ;\ .\frac{H_{ij}^{A}}{\sum_{i=1}^{n} H_{ij}^{A}}\frac{V_{ij}^{M}}{\sum_{i=1}^{n} V_{ij}^{M}}$$

whereJ_{ij}^{A} is the total taxable income of district i of county j;H_{ij}^{A} is the total local taxes of district i of county j;V_{ij}^{M} is the total number of active enterprises of district i of county j; n is the number of districts in county j.

- In a second step, I calculate the estimated GDP of each district in relation to the county GDP, as reported by the CSO, based on the average of the shares (percentage share). This ensures that the total JGE of the districts belonging to a given county is equal to the county GDP (Tóth G., 2024).

$$JGE_{ij} = \left\{ \frac{\frac{J_{ij}^{A}}{\sum_{i=1}^{n} J_{ij}^{A}} + \frac{H_{ij}^{A}}{\sum_{i=1}^{n} H_{ij}^{A}} + \frac{V_{ij}^{M}}{\sum_{i=1}^{n} V_{ij}^{M}}}{3} \right\} * GDP_{j}$$

In Hungary, KSH data show that nominal GDP increased by 82% between 2013 and 2021, so all districts increased their JGE by a minimum of 1.3 (Szentgotthárd district) and a maximum of 10 times (Budapest 5th district). 54% of districts had an increase below the national average, while the rest had an increase above the national average (44 districts had an increase of 70-90% of the national average and 62 districts had an increase of 90-100% of the national average). For 61 districts, the increase in district economic power relative to the national increase was 100-115%, for 20 districts 115-130% and for 10 districts above 130%: Budapest 5th district, Szigetvár, Cigandi, Kazincbarcikai, Szikszó, Kisteleki, Mórahalmi, Bicskei, Gárdonyi and Gyáli districts).

[14] https://www.ksh.hu/stadat_files/gdp/hu/gdp0077.html

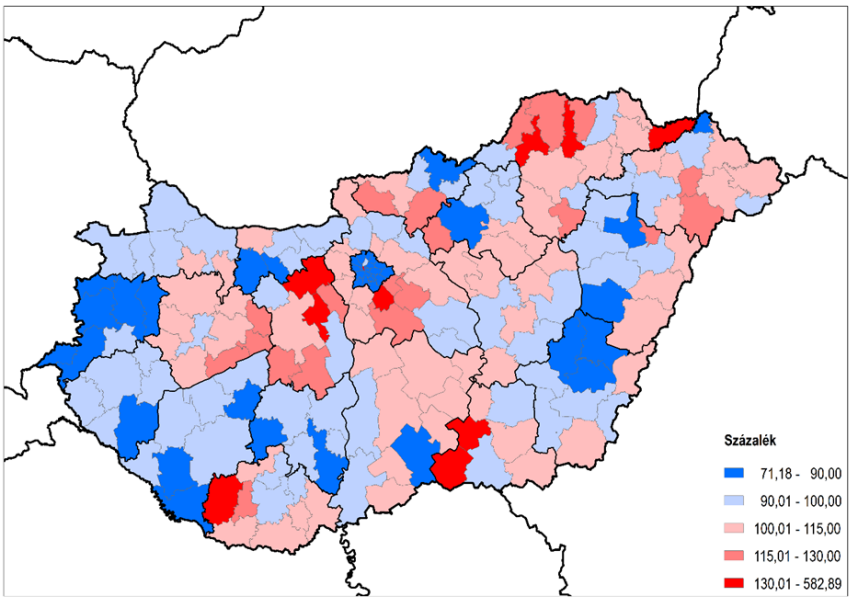


Figure 1: Change in JGE between 2013 and 2021 as % of national change
Source: based on KSH own editing

In terms of district economic power, of the 16 districts in Borsod-Abaúj-Zemplén county, the districts of Gönc (99.2%), Ózdi (99.5%) and Tiszaújváros (95.4%) performed below the national average, while the other 13 districts performed above the average. The districts of Cigándi (132.7%), Szikszó (157.5%) and Kazincbarcikai (145.4%) were outstanding (Figure 1). Thus, the districts of Borsod-Abaúj-Zemplén county followed a catching-up path during the period under study (Kocziszky & Szendi, 2021; Varga Á., 2023; Tóth & Varga, 2022), while most of Budapest and Vas counties recorded below-average growth.
Spatial disparities decreased slightly between 2013 and 2021 (similar to the research of Dobó and Pintér, 2022), with below-average increases in most parts of Budapest, Győr, Zala, Somogy and Vas counties, and above-average increases in most districts of Pest, Fejér, Veszprém, Borsod-Abaúj-Zemplén, Bács-Kiskun, Baranya and Szabolcs-Szatmár-Bereg counties.
Table 1 shows the change in average JGE for each group between 2013 and 2021 by district quintile calculated from the 2013 JGE. The two districts in the lowest and highest quintiles showed above national average increases, while the middle (2nd and 3rd) quintiles showed below average increases. So, in general, the districts with the lowest base had the most dynamic increase in JGE, which is also due to the low base value.

Table 1: Change in the JGE value of districts between 2013 and 2021 according to the 2013 JGE quintile

Ötöd	Change (%)
1	190,5
2	184,4
3	176,6
4	173,6
5	184,5
Total	181,9

source: own calculation

Changes in dynamics were examined by rank correlation according to the order of economic power between districts:

$$\rho = 1 - \frac{6*\sum_{i=1}^{N} d_i^2}{N^3 - N} \quad , \quad d_i = x_i - y_i$$

where x: the order of districts in 2013, y: the order of districts in 2021 based on the JGE, N: the number of districts, ρ: the economic power between districts is the Spearman rank correlation coefficient.

In the present case, there is a very close (ρ=0.98), almost deterministic relationship between the order of the two periods.

Overall, there was a slight reduction in spatial disparities over the period, but this change only slightly altered the ranking of economic power between districts (Figure 2).

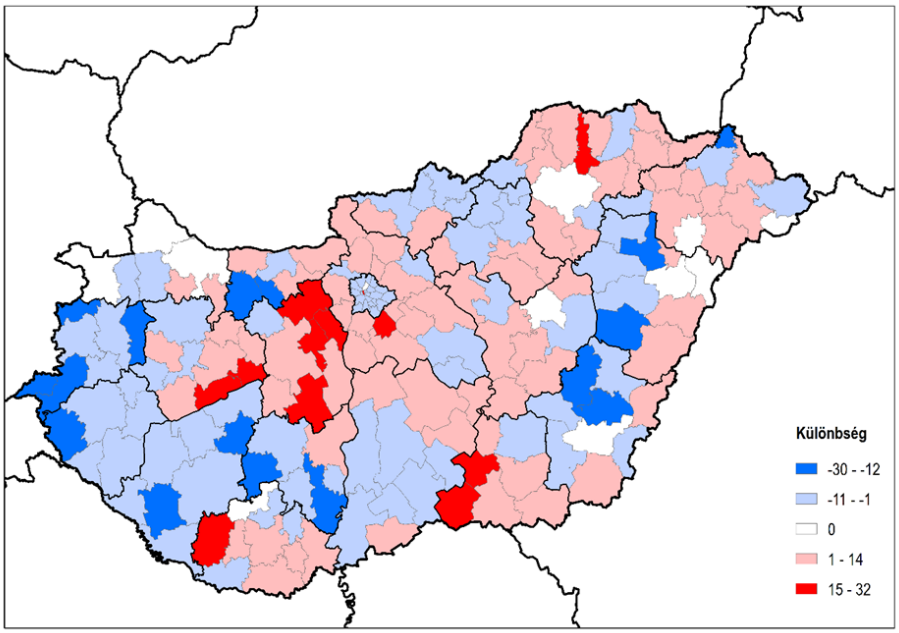


Figure 2: Change in JGE district ranking between 2013 and 2021*

* The difference in the order of the JGE between the two periods (1 being the weakest, 197 the strongest). The positive signs thus represent the degree of improvement from 2013 to 2021, while the negative numbers measure the slippage in the ranking compared to the other districts.

Source: based on KSH own editing

District difference in investment between 2013 and 2020

High added value investments are an important prerequisite for sustainable economic growth and adaptability (Nagy et al., 2022; Kocziszky, 2024). Therefore, it is essential to examine the spatial distribution of investments in addition to the economic strength of the district (investment data include data on enterprises, budgetary and budget-regulated entities and non-profit organisations with legal personality, by investments in the given district), including EU subsidies.

Between 2014 and 2020, the districts invested HUF 46 thousand billion (an average of HUF 233 billion per district), with a differentiated territorial pattern (Figure 3). Most investments were made in the 13th district of Budapest (HUF 6.3 thousand billion), the 11th district of Budapest (HUF 2 thousand billion) and Győr (HUF 1.9 thousand billion). The least investments were made in the districts of Szécsényi, Bélapátfalva, Téti and Cigándi (less than HUF 13 billion per district). The Partetto principle also applies here, with a quarter of investments made in 2% of districts and 80% of investments concentrated in a quarter of districts

(Table 2). In Vas-, Somogy-, Zala-, Békés- and Nógrád counties, the amount of investments was significantly below the national average. However, the larger investments were generally diversified in Budapest and in the cities with county status.

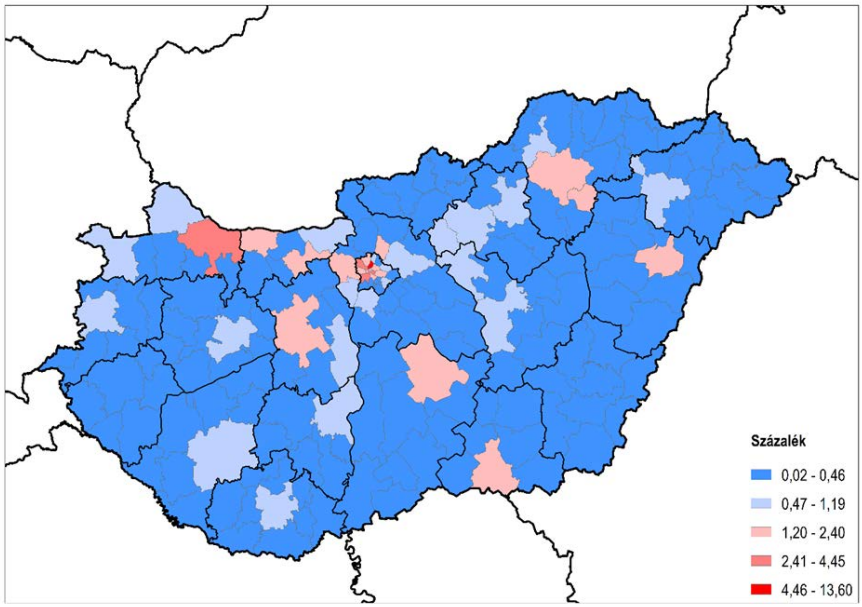


Figure 3: Breakdown of investment in Hungary between 2014 and 2020 (country total =100)
Source: based on KSH own editing

Table 2: Quantified distribution of districts by district average investment between 2014 and 2020 (national district average = 100)

National average %	Districts (pcs)
0-50	130
50-100	21
100-150	9
150-200	11
200-X	26
Total	**197**

source: own calculation

In Borsod-Abaúj-Zemplén county, compared to the national average, most investments were made in Miskolc (343% of the national average), Tiszaújváros (253%), Kazincbarcikai (141%), while the lowest were in Cigándi (3.5%), Encsi, Mezőcsáti and Putnok districts (6-6%).
Total investment between 2014 and 2020 is one and a half times GDP in nominal terms compared to 2013. Compared to the national average, there are also significant regional differences in the relative indicator, but the picture is much more balanced than for investment (Figure 4). For 96 districts, the amount of investments made over the whole period is lower than their 2013 JGE, while for 101 districts, these investments exceed the 2013 territorial JGE.

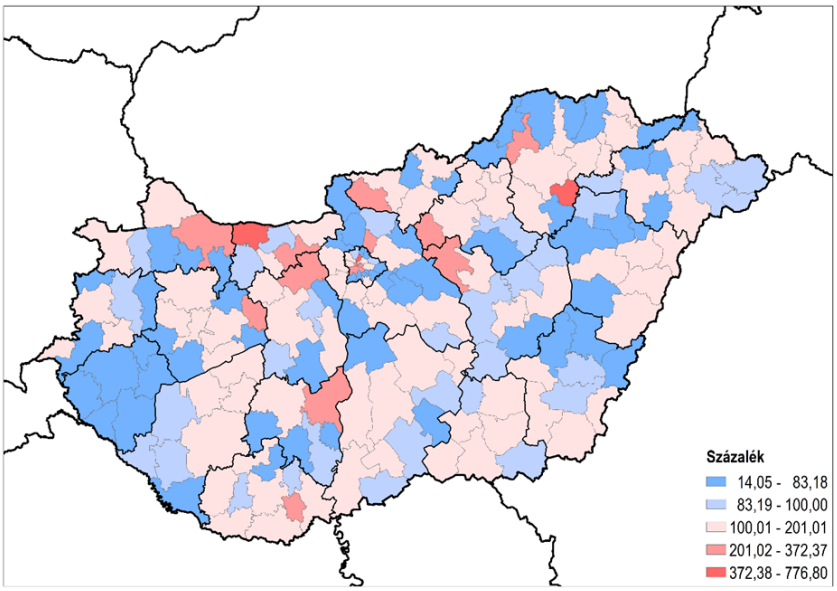


Figure 4: Investments 2014-2020 as % of JGE 2013
Source: own editing

All counties except Zala had above average and below average JGE ratio investments. In other words, the relative differences in investment are due as much to differences within counties as between counties. Below-average areas include cross-county regions in Somogy - Zala - Vas - Győr-Moson-Sopron - Komárom-Esztergom - Veszprém and parts of Bács-Kiskun - Csongrád - Jász-Nagykun-Szolnok - Heves - Hajdú-Bihar, while coherent clusters of above-average JGE-ratio areas are much smaller.
In Borsod-Abaúj-Zemplén county, seven districts have an investment value of less than 100% of the JGE ratio, while 9 have an investment value above 100%. The lowest values are in the districts of Cigándi (67%), Encsi (59%) and Ózdi (70%), while the highest are in the districts of Tiszaújváros (411%), Kazincbarcikai (248%), Tokaji (182%) and Sárospatak (152%).

Linking investment to the economic strength of the district

Investment plays a decisive role in economic performance (Bágер & Cseh, 2020; Halmai, 2023). The question is how strong this correlation is at the district level. Plotting the change in JGE between 2013 and 2021 by investment, I measure a weak relationship of R^2= 0.21. That is, only 21% of the variance in the change in district economic power is explained by investment between the two periods. Here I find two outliers, both for Budapest districts. One is the 13th district, where a unique, specific investment was made. The other is district 5, where low investment also leads to high JGE. This is because this district is the financial centre of Hungary and Budapest (Figure 5).

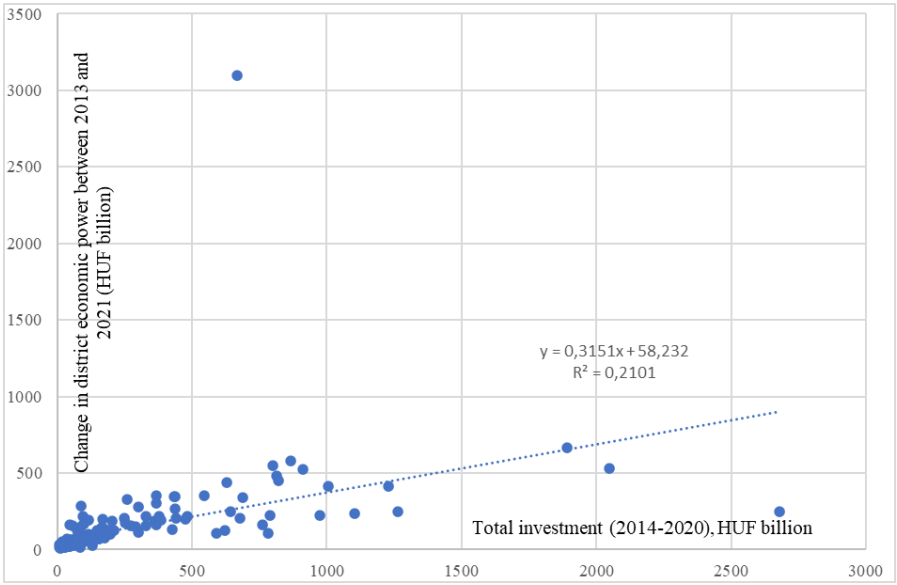


Figure 5: Changes in district economic power as a function of investment
source: based on KSH own editing

When the question outlier is removed, a stronger correlation (R^2=0.65) between the two variables is found. Thus, a moderately strong relationship between investment and economic power at the district level can be observed (Figure 6).

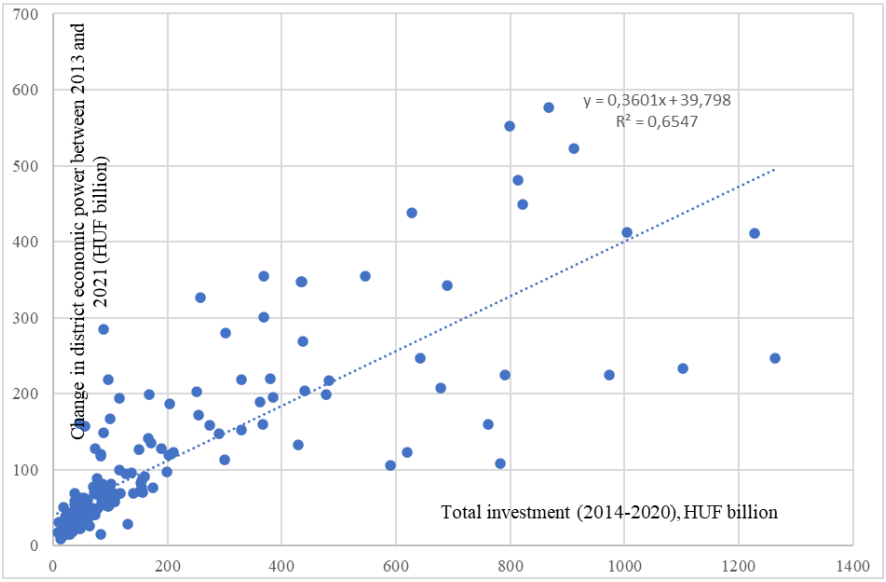


Figure 6: Change in district economic power as a function of investment (without outliers)
source: based on KSH own editing

If I group both JGE changes and investments into clusters (below average and above average), I can distinguish four clusters between districts in the comparison of investment and JGE (without the two outliers). The results are summarized in Table 3.

Table 1: Number of districts in the JGE and investment change groups*

Category	Number of districts
Above average investment and above average JGE increase	45
Above average investment, below average JGE increase	3
Below average investment, above average JGE increase	15
Below average investment, below average JGE increase	132
Total	195

* Except for the two outlier districts
Source: own calculation

In other words, in 90% of districts, investment partly or entirely determines the rate of change in economic performance. In 45 districts, above-average investment was associated with above-average increases in JGE, while in 132 districts, below-average investment was associated with below-average increases in JGE. In three districts (1st district of Budapest, Bajai-, Tiszaújváros districts), higher investment did not induce a significant increase in GDP, while in 15 districts, below average investment also led to an above average increase in GDP. The latter areas are mostly clustered around Budapest and its agglomeration (e.g. Budapest districts 15, 17, 19, 20, 21, 22, Monori, Vecsési).
Among the districts of Borsod-Abaúj-Zemplén county, the districts of Kazincbarcik and Miskolc fall into the first category (above average investment and JGE growth), the district of Tiszaújváros into the second (above average investment and below average JGE growth), while the other districts are in the fourth group (Figure 7).

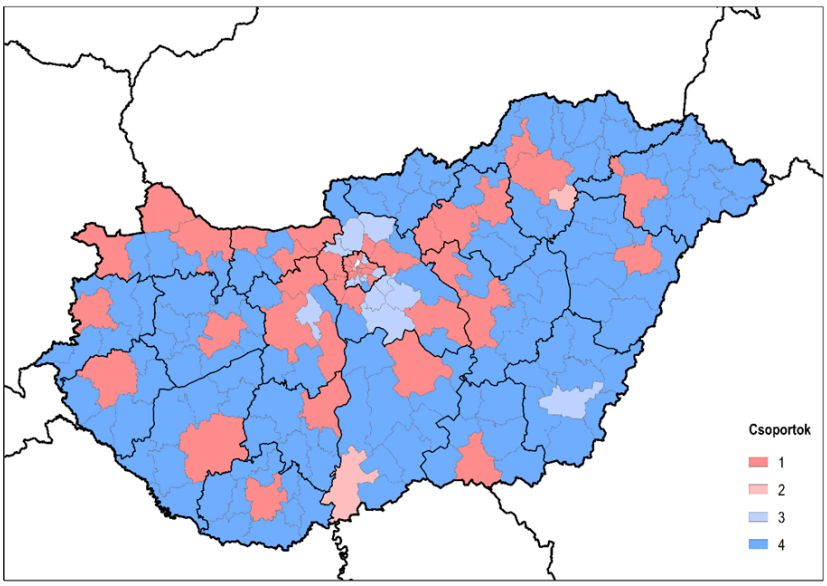


Figure 7: Groups of districts by JGE and changes in investment
source: own editing

The role of EU grants in the economic development of Borsod-Abaúj-Zemplén county

In the county, one fifth of investments in the period 2014-2020 were financed by EU funds (Figure 8). The three best performing districts in economic terms had the lowest share of EU funds in total investments: the district of Kazincbarcik (8.4%), the district of Tiszaújváros (3.4%), the district of Miskolc (21.5%), and the highest share of EU funds in the districts of Cigánd and Encsi (above 95%).
Overall, it can be concluded that EU investments alone cannot explain the change in the economic strength of the districts, and thus they have not been able to influence the economic processes in the districts in any meaningful way. This is partly due to the fact that EU funds have not only economic but also, where appropriate, social and environmental objectives.
With HUF 173 billion of investment in the Miskolc district, the percentage of economic growth was similar to that of the Tokaj district, where the amount of EU TOP, GINOP and EFOP projects between 2014 and 2020 was below HUF 20 billion.

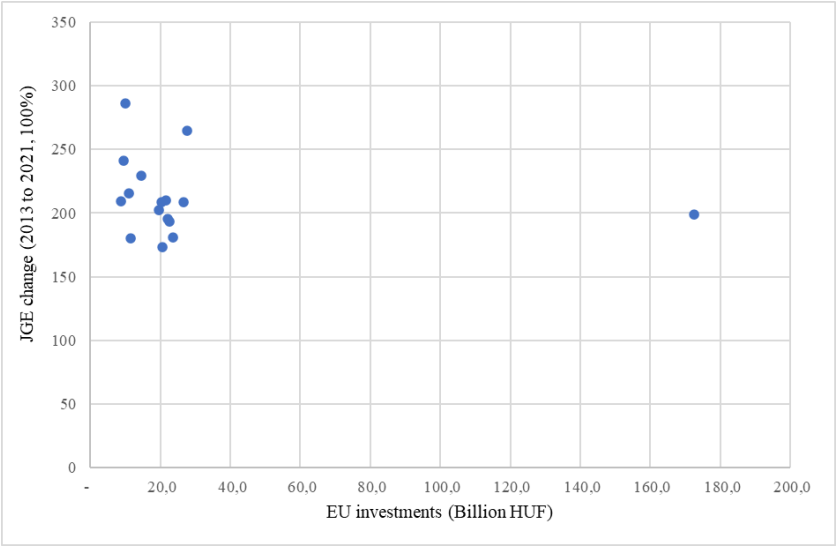


Figure 1: Change in district JGE by value of EU investments
source: based on KSH own editing

A similar finding holds true for changes in economic power and the share of EU funds in total investment. The share of EU funds is almost invariant with the increase in the economic power of the district (Table 4).

Table 4: Relationship between EU investment rates and changes in economic power in Borsod-Abaúj-Zemplén county

Share of EU investment in district investment (%)	Average JGE change between 2013 and 2021 (%)
0-25	208,0
25-50	213,4
50-75	200,0
75-100	228,7
Total County	**212,4**

source: own calculation

This apparent discrepancy stems from differences in the size and territorial coverage of EU and non-EU investments. Table 5 shows that regions with a low share of EU investment had a high share of non-EU investment. The regions with an EU investment rate below 25% (Kazincbarcik, Mezőkövesdi, Miskolc, Tiszaújváros districts) accounted for 82% of total county investment in 2014-2020.

Table 5: Share of EU investment by total district investment, 2014-2020

Share of EU investment in district investment (%)	Total investment (HUF billion)
0-25	1814,4
25-50	288,4
50-75	61,3
75-100	36,4
Total County	**2200,4**

Source: own calculation

In other words, EU investment alone can only have a moderate stimulating effect on economic growth and development, and can help the economy perform better where the role of market investment is stronger and the conditions are favourable for economic actors. Where there is no major non-EU investment, the economic impact of European Union projects is smaller. More effective development takes place in regions where economic actors see opportunities. EU aid alone can only reduce the dynamics of the gap, but there is also a need to stimulate domestic investment. In the future, more targeted synergies and coordination of both types of investment at district level (Jakobi et al., 2024) can make a major contribution to promoting regional economic development.

Table 6: Summary data of the districts of Borsod-Abaúj-Zemplén county

Go to	JGE national ranking*, 2013	JGE national ranking*, 2021	Difference in order between 2021 and 2013**	Change in JGE between 2013-2021 (%)	Change in JGE between 2013-2021 as % of national change (national= 100)	Investments 2014-2020 (total county=100)	Investment between 2014-2020 (country total=100)	Investment between 2014-2020 (national district average = 100)	Investments between 2014-2020 as % of JGE2013 (JGE2013= 100)	Relationship between JGE and investment during the period under review***	EU investments between 2014-2020 (county=100)	EU investment as a share of total investment between 2014-2020
Cigandi	1	3	2	241,4	132,7	0,4	0,02	3,5	67,2	4	2,1	75-100
Edelényi	46	53	7	210,2	115,6	1,3	0,06	12,4	78,9	4	4,9	50-75
Encsi	22	31	9	229,2	126,0	0,6	0,03	5,9	58,7	4	3,3	75-100
Gönci	21	13	-8	180,4	99,2	0,8	0,04	7,8	79,7	4	2,6	50-75
Kazincbarcikai	137	151	14	264,5	145,4	15,0	0,72	141,2	248,5	1	6,3	0-25
Mezőcsáti	5	8	3	215,6	118,6	0,7	0,03	6,3	83,2	4	2,5	75-100
Mezőkövesdi	106	114	8	195,3	107,4	4,3	0,21	40,6	118,5	4	5,0	0-25
Miskolc	188	188	0	198,7	109,2	36,3	1,74	342,5	143,0	1	39,0	0-25
Ózdi	103	102	-1	181,0	99,5	2,2	0,11	20,9	69,9	4	5,3	25-50
Putnoki	9	12	3	209,3	115,1	0,6	0,03	6,0	72,9	4	2,0	50-75
Sárospataki	55	64	9	208,5	114,7	2,9	0,14	27,3	152,3	4	4,6	25-50
Sátoraljaújhely	62	63	1	193,2	106,2	2,5	0,12	23,4	122,2	4	5,1	25-50
Szerencsi	80	93	13	208,4	114,6	2,8	0,13	25,9	108,0	4	6,0	25-50
Sicily	13	36	23	286,4	157,5	1,0	0,05	9,2	103,4	4	2,3	25-50
Tiszaújváros	142	138	-4	173,5	95,4	26,8	1,28	252,8	411,2	2	4,6	0-25
Tokaji	16	17	1	202,7	111,4	1,8	0,09	16,8	182,1	4	4,4	25-50

* from the district with the lowest value to the highest; ** positive improvement, negative deterioration;*** 1=above average investment and above average GDP growth; 2=above average investment and below average GDP growth; 3=below average investment and above average GDP growth; 4=below average investment and below average GDP growth,

Source: based on KSH own editing

Summary

In the first part of my study, I investigated the changes in district economic power between 2013 and 2021, as well as the spatial distributions of investment and the relationship between them, obtained from small area estimates of the GDP value of Hungarian counties. In the second part, I analysed the stimulus effects of EU and Hungarian investments in Borsod-Abaúj-Zemplén county and their differences.

In 2013, the top ten districts with the highest economic performance accounted for a quarter of the country's GDP and 37% of districts accounted for 80% of GDP. I find that the regional differences in economic performance between districts have narrowed slightly over the period. However, this has not been accompanied by a significant shift in the balance of power between districts. Thus, the narrowing of spatial development gaps is not necessarily associated with a substantial reordering of the economic hierarchy between regions - a finding confirmed by recent research on European regions, which points to the persistent nature of economic concentration (Iammarino et al., 2019). In districts where key economic resources are already present, such as high employment, skilled labour, developed infrastructure, services and institutions, positive feedback processes are established. These factors attract additional investment and labour, further increasing the competitiveness of the region. In our country, the Budapest, Győr, Debrecen, Székesfehérvár, Miskolc, Szeged and Kecskemét districts continue to dominate. The overwhelming majority of districts in Borsod-Abaúj-Zemplén county grew at a higher rate than the national average (Table 6).

Due to the nature of the investments, they were differentiated by area (mainly in Budapest and the cities with county status), with 80% of their value concentrated in a quarter of the districts. In Borsod-Abaúj-Zemplén county, compared to the national average, most investments were made in the districts of Miskolc (343% of the national average), Tiszaújváros (253%) and Kazincbarcika (141%).

In 96 districts, the amount of investments made over the whole period was lower than their 2013 JGE value, while in 101 districts it was higher. All counties except Zala have investment rates above the national average and below the national average. The relative differences in investment are due at least as much to differences within counties as between counties.

I find a medium-strong relationship between investment between 2014 and 2020 and the district values of JGE changes between 2013 and 2021, so investment plays a crucial role in the dynamics of economic performance at the district level. In nine tenths of the districts, investment determines the future economic growth potential in part or in whole. In Borsod-Abaúj-Zemplén county, the districts of Kazincbarcik and Miskolc have above average investment and JGE growth rates.

Between 2014 and 2020, one fifth of the investments in Borsod-Abaúj-Zemplén county were financed by EU funds. I found that the stimulating effect of EU funds in the county's districts lags behind non-EU investments by businesses, budget and budget-managed entities. There are several reasons for this: firstly, the purposes for which EU funds are used are more diversified than those of Hungarian investments, and secondly, the volume and location of EU and non-EU investments differ significantly. In those districts where EU investment dominates, there is less evidence of substantial economic improvement. Domestic investment plays a dominant economic role. In the future, greater territorial coordination between the two types of investment could contribute more effectively to the economic development of the county. This is also in line with international regional development guidelines, which argue that a decentralised and strategic approach to development based on local specificities significantly increases the effectiveness of interventions (Pike et al., 2017).

References

BÁGER, G., & CSEH, T. (2020). Beruházási csúcsteljesítmény a magyar gazdaságban. (Peak investment performance in the Hungarian economy). *Pénzügyi Szemle*, *2020*(1), 83–109. https://doi.org/10.35551/PSZ_2020_1_7

DOBÓ, R., & PINTÉR, T. (2022). Regionális különbségek alakulása különböző területi szinteken értelmezve Magyarországon (Regional differences at different territorial levels in Hungary). In *BGE Szemelvények (Proceedings of Budapest University of Economics and Business)* (pp. 58–63). Budapest: Budapest University of Economics and Business. https://doi.org/10.29180/978-615-6342-49-2_6

DUSEK, T., & KISS, P. J. (2008). A regionális GDP értelmezésének és használatának problémái. (*Problems of interpretation and use of regional). Területi Statisztika, 11(48)*(3), 264-280. https://real.mtak.hu/194015/1/ts2008_03_03.pdf

ESF. (2018). *Selection and monitoring of ERDF and ESF projects for the period 2014-2020* (No. 21). European Court of Auditors. https://www.eca.europa.eu/Lists/ECADocuments/SR18_21/SR_PROJECT_PERFORMANCE_EN.pdf

HALMAI, P. (2023): Fenntartható növekedés, növekedési potenciál — A potenciális növekedés irányzatai az Európai Unióban (Sustainable growth, growth potential). *Pénzügyi Szemle = Public Finance Quarterly*, *69(*1), 47-64. https://doi.org/10.35551/PSZ_2023_1_3

IAMMARINO, S., RODRÍGUEZ-POSE, A., & STORPER, M. (2019). Regional inequality in Europe: Evidence, theory and policy implications. *Journal of Economic Geography*, *19*(2), 273–298. https://doi.org/10.1093/jeg/lby021

JAKOBI, Á., SZABÓ, M., MISZLIVETZ, F., & MORVAY, SZ. (2024). A területi stratégiai gondolkodás egy lehetséges komplex közelítése: a „Kreatív Város Fenntartható Vidék" koncepció friss tapasztalatai. (A possible complex approach to spatial strategic thinking: recent experiences of the "Creative City Sustainable Countryside" concept). *COMITATUS*, *34*(250), 137-146. https://doi.org/10.59809/Comitatus.2024.34-250.137

KOCZISZKY GY. (Ed.) (2024). A jövő fenntarthatósága – A fenntarthatóság jövője. (The Future of Sustainability - The Future of Sustainability). Budapest: Budapest Metropolitan University.

KOCZISZKY, GY., & SZENDI, D. (2021). Quo vadis Észak-Magyarország? A régió lehetséges fejlődési pályáinak ex-ante vizsgálata (Quo vadis North Hungary? An ex-ante analysis of possible development paths in the region). *Területi Statisztika*, *61*(6), 679-711. https://doi.org/10.15196/TS610601

NAGY, Z., TÓTH, G., & SZÉP, T. (2022). A magyarországi városok rezilienciájának vizsgálata (Examining the Resilience of Hungarian Cities). *Észak-magyarországi Stratégiai Füzetek*, *19*(3), 84–99 https://doi.org/10.32976/stratfuz.2022.37

PIKE, A., RODRÍGUEZ-POSE, A., & TOMANEY, J. (2017). Shifting horizons in local and regional development. *Regional Studies*, *51*(1), 46-57. https://doi.org/10.1080/00343404.2016.1158802

TÓTH, G. (2024). A társadalmi innovációs potenciál és a területi jóllét számszerűsítésének lehetőségei. (Possibilities of quantifying social innovation potential and territorial well-being). *Statisztikai Szenle (Statistical Review)*, *102*(7), 679–713. https://doi.org/10.20311/stat2024.07.hu0679

VARGA, Á. (2023). A gazdasági függőséget meghatározó tényezők területi egyenlőtlenségeinek változása Borsod-Abaúj-Zemplén vármegyében, 2000–2020 (Changes in the spatial inequalities of the determinants of economic dependence in Borsod-Abaúj-Zemplén county, 2000-2020). *Területi Statisztika*, *63*(6), 758–797. https://doi.org/10.15196/TS630605

Szerzőink figyelmébe

A szerkesztőség kéri a szerzőket, vegyék figyelembe a formai megjelenésre vonatkozó alábbi szempontokat:

Terjedelem, kiegészítések:

A „Tanulmány" rovatban maximálisan 35.000, a többi rovatokban maximálisan 18.000 karakter terjedelmű tanulmány közölhető.
A tanulmány elejére öt soros összefoglalót, valamint 3-5 kulcsszó megnevezését és JEL-kód meghatározást kérünk.
A szöveget fájlban kérjük leadni, lemezen vagy e-mailen. (MS WORD bármelyik változatában lementve.)
Kb. 10-15 sorban rövid összefoglalót kérünk a tanulmányról angolul, valamint a cikkben szereplő ábrák és táblázatok címét is kérjük angolul.
Kérjük a szerző adatainak megadását az alábbiak szerint: név, tudományos fokozat, beosztás, munkahely

Szöveg formázása

Oldalméret: JIS B5 – 18,2 x 25,7 cm.
Margók: fent: 2,22, alul: 2,5, balról: 2,5, jobbról: 2 cm; fejléc és lábléc: 1,25 cm.
Betűtípus és betűméret: Times New Roman 10-es, a jegyzetek 9-es betűmérettel.
Bekezdések: cím után nincs behúzás, egyébként 0,7 cm, a bekezdések között sorkihagyás nincs.
Címek: stílusbeállítás nélkül, fő cím és a fejezetek címek vastag, az alfejezetek címei vastag és dőlt betűtípussal.
Szövegközi kiemelések: szimpla dőlt betűtípussal.

Ábrák, táblázatok:

Terjedelmi okok miatt kérjük, hogy egy tanulmányban legfeljebb 4-5 ábra szerepeljen.
Az ábrákat (pl.: térképek, diagramok, rajzok, fényképek) és táblázatokat megfelelően formázva a szövegbe építve kérjük elküldeni. A fénymásolással, szkenneléssel készült ábrákat nem tudjuk elfogadni, mert a nyomda számára nem megfelelő a minőségük. Színes ábrák közlésére sincs módunk. Mindenképpen szükséges az ábrák és táblázatok külön számozása (pl.: 1. ábra; 2. ábra; 1. táblázat; 2. táblázat), s hivatkozásuk pontos feltüntetése a szövegközben, zárójelben, döntve: (1. ábra) vagy (1. táblázat).
Az ábra címét az ábra alatt, középen elhelyezve, a táblázatok címét a táblázat fölött balra igazítva kérjük elhelyezni. Az ábrák és táblázatok alatt fel kell tüntetni a forrást is. Ha saját készítésű az ábra, akkor a „Forrás: Saját szerkesztés, ill. Saját számítás." megnevezést kell használni.

Irodalmi hivatkozások, jegyzetek:

Az irodalmi hivatkozásokat minden esetben kérjük feltüntetni, a szerző vezetéknevét és a kiadását évét zárójelbe téve az **APA 7.0** szerint. Pl.: (Conti, 1993). Pontos idézetnél az oldalszám is szükséges. Pl.: (Conti, 1993, p. 76) vagy (Conti, 1993, pp. 76-86). A hivatkozások ne lábjegyzetként, hanem csak a fent leírt formában kerüljenek a szövegbe.
Az irodalomjegyzékben csak olyan tételek szerepeljenek, amelyekre a szövegközben hivatkozás található, s minden meghivatkozott irodalmat feltétlenül fel kell tüntetni az irodalomjegyzékben.

A jegyzeteket kérjük a szöveg végén, számozott formában elhelyezni. A jegyzetek a főszöveg kiegészítéseit tartalmazzák, ne legyen bennük pl. ábramagyarázat, hivatkozás.

A szöveg után kérjük beírni **az irodalomjegyzéket APA 7.0 hivatkozási stílusban**: https://bit.ly/APA70description

Könyv:
Szerző vezeténeve, Keresztnevének monogramja. (2020). *A könyv címe*. Kiadás helye: Kiadó.

Folyóiratcikk:
Szerző vezeténeve, Keresztnevének monogramja., & Szerző vezeténeve, Keresztnevének monogramja. (Megjelenés dátuma). A cikk címe. *A Folyóirat Címe, Évfolyam sorszáma*(a Szám sorszáma), a cikk kezdő-befejező oldalszáma. https://doi.org/xxxxxx

Könyvrészlet:
Szerző vezeténeve, Keresztnevének monogramja. (Megjelenés dátuma). Cím. In A gyűjteményes kötet szerkesztője keresztnevének monogramja. Vezetéknéve (Szerk. vagy Ed(s).), *A gyűjteményes könyv címe* (pp. a könyvrészlet kezdő-befejező oldalszáma). Kiadás helye: Kiadó. DOI/URL (ha van)

Példák:
Cronauge, U. (1992). *Kommunale Unternehmen*. Berlin: Erich Schmidt Verlag.

Alchian, A., & Demsetz, H. (1972). Production, information costs and economic organisation. *American Economic Review*, *62*(5). 775-795.
Carree, M., & Thurik, R. (1998). Small Firms and Economic Growth in Europe. *Atlantic Economic Journal*, *26*(2), 137-146. https://doi.org/10.1007/BF02299356

Péteri, G. (1991). Az önkormányzatok és oktatási intézményeinek viszonya, finanszírozási kérdések. In: T. Kozma (Szerk.), *Önkormányzat és iskola* (pp. 122-154). Budapest: Oktatáskutató Intézet.
Verhoef, P. C. (2012). Multichannel customer management strategy. In V. Shankar & G. S. Carpenter (Eds.), *Handbook of marketing strategy* (pp. 135–150). Cheltenham: Edward Elgar Publishing. https://doi.org/10.4337/9781781005224.00017

Kérjük, hogyha a felhasznált irodalomnak van DOI száma, azt feltétlenül tűntessék fel az irodalomjegyzékben!

Köszönjük!

Szerkesztőség

Notes for Contributors

The editorial board of the journal welcomes studies on economic, regional and social issues in Hungarian and in English language. Our journal was launched in 2004. It is published four times a year from 2021 (of which once in English and three times in Hungarian). We are waiting for studies, essays and book reviews submitted for the first publication only. The studies are rated by two double-blind reviewers in each case.

There is no publication fee!

The papers are duoble blind reviewed before publication. The Editorial Office does not retain manuscripts and reserves the right to decide about the publication of papers submitted.

The maximum length of a paper that can be accepted is 35,000 characters. An abstract in five lines followed by 3-5 keywords is to be given at the beginning of the paper and JEL-code.
Please provide the author's details as follows: name, academic degree, position, job.
The text is to be submitted in file by e-mail. (Any version of MS WORD can be used for saving it.)
Tables are to be incorporated in the text in the appropriate format. Their exact place in the text and captions are to be signalled by numbering.
A maximum of 4-5 figures can be included in a paper for reasons of length.
Figures (e.g. maps, diagrams, drawings, photos) and the tables are to be appropriately formatted and incorporated in the text. Figures produced by photocopying and/or scanning cannot be accepted, for their quality is not suitable for the press. It is not possible to publish colour figures.
Figures and tables are to be numbered separately (e.g. Figure 1, Figure 2, Table 1, Table 2.), and their references (Figure 1) or (Table 1) given in italics in the right place in the text in brackets.
The caption of a figure is to be given below the figure, in the middle of the line, and the caption of a table is to be given above the table in the middle of the line. Figures and tables are to be followed by the source. If the figure is the author's own work, then 'Source: author's own work or Author's own calculation' is to be used. .
References to literature are to be given in every case: the author's name and the year of publication in brackets. E.g.: (Conti 1993). For quotations the page is also to be given. E.g.: (Conti 1993, p.76) or (Conti 1993, pp.76-86). References are not to be given as footnotes, but only in the above format in the body of the text.
The list of literature should include only works with reference to them in the body of the text. Every work referred to should be included in the list of literature.
Notes are to be given as footnotes in a numbered format. Notes are to include additions to the main body of the text, and they should not contain explanations of figures or references.
The text is to be followed by the list of literature, in the following formats:
Text formatting:

Side size: JIS B5 - 18.2 x 25.7 cm.
Margins: top: 2.22, bottom: 2.5, left: 2.5, right: 2 cm; header and footer: 1.25 cm.
Font and font size: Times New Roman 10, footnotes 9.
Paragraphs: no indentation after the title, otherwise 0.7 cm, no line spacing between paragraphs.
Titles: without style setting, main title and chapter titles in bold, subchapter titles in bold and italics.

References:

Books: author (year of publication) Title of the work, name of publisher, place of publication.

Periodicals: author(s) (year of publication) Title of the paper. Name of the periodical. (Number of volume), number of issue, numbers of the first and last pages of the paper.

Books with several authors: author(s) (year of publication) Title of the paper. In: Title of the book. (szerk. or ed(s), or Hrsg.: Name(s) of editor(s)), name of publisher, place of publication, numbers of the first and last pages of the paper referred to.

Examples:

Cronauge, U. (1992): Kommunale Unternehmen. Erich Schmidt Verlag, Berlin.

Alchian, A.-Demsetz, II. (1972): Production, information costs and economic organisation. American Economic Review (XII.) 2. pp. 775-795.

Péteri G. (1991): Az önkormányzatok és oktatási intézményeinek viszonya, finanszírozási kérdések. In: Önkormányzat és iskola. (szerk.: Kozma T.) Oktatáskutató Intézet, Budapest, pp. 122-154.

Please make sure that if the literature used has a DOI number, it must be listed in the bibliography!

Thank you!

The Editorial Board