

Measuring the Complex Socio-economic Development of the Danube-adjacent NUTS2 Regions

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Abstract

The existing inner socio-economic discrepancies are one of the major stumbling-blocks to the sustainable development of the Danube region and to the successful realization of its different macro-regional development programmes, strategies, and action plans. That is why it is of extreme importance to assess these discrepancies on a complex base, going beyond the analysis of single indicators. From that point of view, we suggest that sophisticated methodology and approach are needed, similar to those used to elaborate thorough European spatial development models. In order to measure the current socio-economic spatial development of the Danube regions on a complex basis, we apply author's "Development and Prosperity Index" (DPI) calculated by using the latest available data for 8 key indicators. By contrast with the majority of the scientific studies that build their conclusions on NUTS0, or rarely on NUTS1 level analysis, our research is suited at NUTS2 level so that we can take a detailed picture of the situation in the Danube region. Another significant difference from the mainstream studies is that we concentrate predominantly on the Danube-adjacent NUTS2 regions, but not on the whole area (as defined in the EU Danube Region Strategy). That approach provides us with an opportunity to divide the study in two important stages. Firstly, we make a comparative analysis and a classification of the Danube-adjacent NUTS2 regions providing empirical evidence for the significant complex socio-economic discrepancies between them. Secondly, in a view to estimate the development role of Danube in different countries, we confront the DPI results for Danube-adjacent NUTS2 regions against those for the other regions in a given country. Although this approach is characterized with certain conditionality considering that development is a function of many diverse factors, the results of the study provide solid ground for building up adequate future policies.

Keywords: *Danube regions, socio-economic analysis, regional development, complex assessment, development and prosperity index*

Măsurarea nivelului de dezvoltare socio-economică a regiunilor NUTS2 adiacente Dunării

Rezumat. Existența discrepanțelor socio-economice interne reprezintă una din principalele piedici în dezvoltarea durabilă a regiunii dunărene și ducerea la îndeplinire a diferitelor programe, strategii și planuri de acțiune pentru dezvoltare macro-regională. De aceea, este extrem de important să se evalueze aceste discrepanțe ținând cont de bază complexă, care nu doar analizează individual anumiți indicatori. Prin urmare, considerăm necesare o metodologie și o abordare mai complexe, similare cu cele utilizate pentru elaborarea modelelor europene de dezvoltare spațială. Pentru a măsura nivelul actual al dezvoltării socio-economice a regiunilor dunărene în mod complex, am elaborat indicele denumit *Indicele de Dezvoltare și Prosperitate*, ce a fost calculat utilizând cele mai noi date disponibile pentru 8 indicatori cheie. Spre deosebire de majoritatea studiilor care analizează regiunile NUTS0 și foarte rar NUTS1, studiul de față se axează pe analiza la nivel NUTS2, astfel încât să ofere o imagine detaliată a regiunilor dunărene. O altă diferență semnificativă comparativ cu literatura de specialitate este dată de faptul că am analizat în general doar regiunile NUTS adiacente cursului Dunării, și nu toată regiunea în ansamblu (așa cum este definită în cadrul Strategiei Regiunii Dunării). Această abordare ne oferă șansa de a desfășura această analiză în două etape importante. Mai întâi, se face o analiză comparativă și o clasificare a regiunilor NUTS adiacente Dunării, ceea ce oferă mărturie empirică privind discrepanțele socio-economice destul de complexe. Apoi, pentru a putea estima rolul Dunării pentru dezvoltare în regiunile NUTS2 adiacente, am comparat rezultatele obținute pentru DPI pentru regiunile analizate cu cele pentru alte regiuni dintr-o anumită țară. Deși există unele limitări ale acestei abordări, întrucât dezvoltarea depinde de numeroși factori, foarte diferiți, rezultatele acestui studiu oferă o bază solidă pentru elaborarea unor politici adecvate pe viitor.

Cuvinte-cheie: *regiuni dunărene, analiză socio-economică, dezvoltare regională, evaluare complexă, indicele dezvoltării și prosperității*

Introduction

The spatial socio-economic disparities signify different development patterns, social environment conditions, distribution of resources, uneven opportunities, etc. Thus they could be treated as a major threat ahead of sustainable development. The reasons for the inequalities are numerous: different natural conditions; historically inherited patterns; diverse role of the factors determining social, economic, and political development; specifics in the mobility of labour forces and capitals; uneven

dispersion of technology and innovations; regional and local traditions of the population. The growing scientific interests in studying the inequalities, their dimension and impact over the society, and in finding possible ways and models of fostering more balanced development, has recently provoked many researchers to dedicate their work to these topics. Given that the Danube River is often perceived as "a central axis of the EU" (Nedeu et al., 2012), there are also a number of studies on the socio-economic development of the Danube countries and regions over the past years. A good example of a large-scale study conducted by an international team is "Socio-

Economic Assessment of the Danube Region: State of the Region, Challenges and Strategy Development" (2014). The research follows the notion of the term "Danube region" laid in "The EU Strategy for Danube Region" (2010), thus providing the widest possible spatial coverage and including, besides the typical Danube countries, also the Czech Republic, Slovenia, Bosnia and Herzegovina, Montenegro, Moldova, as well as border regions of Ukraine. The authors build their thesis after studying separately various economic, social, demographic, infrastructural, environmental, and other indicators. The analyses basically seek to scrutinize the overall competitiveness of the Danube region, while the inner comparisons are generally made at country level. Some of the focal points in that paper are themes such as: Macroeconomic Performance and Competitiveness; Labour Market and Migration; Regional Development; Infrastructure and Environment; Entrepreneurship; SME Financing; Cluster Development. The research aims to find out potential opportunities, challenges, needs, and preliminary recommendations within each of these key topics.

In 2016, the Central European Service for Cross-Border Initiatives issued another study in accordance with the countries included in "The EU Strategy for the Danube Region". By analysing various indicators at the lowest possible administrative level, the authors provide convincing proofs for the existence of regional inequalities. Seventeen natural, economic, social, and infrastructural thematic areas are discussed in the study demonstrating in this way clearly the disparities between Western and Eastern Europe in different spheres.

Czakó et al., 2014 analysed the economic imbalances among the countries within the Danube basin, concluding that the German states of Baden-Württemberg and Bavaria, as well as Austria, are characterized by much higher growth rates than the other four countries, with Bulgaria and Romania particularly lagging behind. Winiwarter and Haidvogel (2015) emphasize that financial and institutional cooperation between prosperous areas in the upper catchment and less developed ones in the middle, and especially in the lower basin, is lacking. Building their analysis on a long-term sustainable development perspective, the authors state that "socio-economic disparities, a characteristic for the Danube region, are a huge challenge". Moreover, environmental issues have been created or exacerbated by economic and social inequalities, while also leading, among other things, to a veritable brain drain of much-needed expertise. The brain drain problem is also a key issue in the study of Savić and Dakić (2016). The researchers come to the conclusion that demographic variations in the

Danube region have negative impacts not only on the overall economic development of the area but they also generate unfavourable trends in political relations between the countries.

By studying the economic transition in Central and Eastern Europe and the gap in the standards of living, Philipov and Dorbritz (2003) explain how the overall political, economic, and social transformation resulted in abrupt and significant demographic changes in the region. In line with that conclusion, the Common Spatial Development Strategy of the V4+2 Countries (2014) suggests increasing demographic imbalances between urban and rural, central and peripheral areas of the V4+2 territories, identifying also some development poles and development axes. Despite Central Europe is generally more developed than Eastern Europe, it is also characterized by significant variations in its spatial structure - a result of the region's pre-existing historical conditions (Central Europe Programme, 2012).

Research projects Donauregionen and Donauregionen+, aimed to strengthen the NUTS 3 level functional regions located on the Danube River corridor in supporting the European growth and competitiveness, offered a general scheme of spatial indicators, generally valid for all regions studied, to assess the potential socio-economic development of the Danube region in a broader context. Modern methods were used to assess the potential socio-economic development of the regions and define their typology. In addition, 5 Danube regions and 19 areas of Transdanube cooperation were identified based on GIS and on tools and techniques specific for spatial planning. Finally, development scenarios were made for the five Danube sub-regions based on external and internal factors that can influence the socio-economic development of the researched area (Tache et al., 2014). Territorial scenarios for the Danube region are also developed in a study by Gál et al. (2013) where diverse economic, social, demographic, and ecological indicators are taken into consideration.

The majority of these scientific works studying the development of the Danube region emphasize basically on the analyses of separate indicators and thematic fields, while at the same time attempts to assess the complex socio-economic development are rare. In line with the broader sustainable development goals and the evolution of the widening cohesion concept, there is an exigent need to create and apply innovative approaches suitable for making comparative analyses of the complex development at regional level. This could help us find out the essence of the existing problems and their solutions, estimate and coordinate better the general impact of different policies, as well as create alternatives strategies for the future development of

the regions. In the light of the above considerations, the main goal of this article is to offer a new approach and methodology for better understanding the inequalities in the complex socio-economic development of the Danube region. The term "Danube region" is used in the analysis of our study to indicate exclusively the territory covered by the Danube-adjacent NUTS2 regions (including Bucuresti-Ilfov that is surrounded by Sud-Muntenia and gravitates in many aspects to the Danube).

The paper is organized as follows. Chapter 2 outlines the methodology for calculation of the so called "Development and Prosperity Index" (DPI) – an integral index created through author's algorithm in a view to provide a single measurement for the overall development of a particular region. After describing the precise algorithm, in Chapter 3 we present the general results and how the Danube region fits within our thorough European development model. Chapter 4 discusses the results from the "first level" of our empirical researches – the inequalities between the Danube-adjacent NUTS2 regions, while Chapter 5 is built upon the "second level" of analyses – the development patterns within the countries themselves. Finally

chapter 6 summarizes the main results and points out the key conclusions and messages.

Methodological framework

Given the specific task of measuring the current socio-economic spatial development on a complex basis, we elaborate an integral "Development and Prosperity Index" (DPI). The author's index is calculated by using the latest available data for the NUTS2 regions, which is the most adequate level for the analysis as on one hand NUTS1 don't provide detailed picture and on the other – the data at NUTS3 level is largely insufficient. As one of our major goals is to compare the complex development of the Danube-adjacent regions to that of the other European regions, the DPI is calculated for all the NUTS2 regions of the EU countries, Switzerland, Norway, and Serbia, with the exception of the territories situated far outside continental Europe. However, the analysis in this paper concerns exclusively the NUTS2 regions of the Danube countries (Germany, Austria, Slovakia, Hungary, Croatia, Serbia, Bulgaria, and Romania), while the DPI results for the other regions are used solely to build the general spatial development model at European level.

Table 1: The model for calculating the DPI result for a separate indicator

	interval between average and extremal values	relation to the average value	logical correlation between indicator's value and rating	formula for calculation
When	$I_{max} - I_{av} \geq I_{av} - I_{min}$	$I \geq I_{av}$	positive	$R = \left(5 + \frac{\left(\frac{I - I_{av}}{(I_{max} - I_{av}) \div 5} \right)^x}{y} \right) \times \frac{W}{11}$
		$I < I_{av}$	negative	
When	$I_{max} - I_{av} < I_{av} - I_{min}$	$I \geq I_{av}$	positive	$R = \left(5 + \frac{\left(\frac{I - I_{av}}{(I_{av} - I_{min}) \div 5} \right)^x}{y} \right) \times \frac{W}{11}$
		$I < I_{av}$	negative	
When	$I_{max} - I_{av} \geq I_{av} - I_{min}$	$I \geq I_{av}$	negative	$R = \left(5 - \frac{\left(\frac{I_{av} - I}{(I_{max} - I_{av}) \div 5} \right)^x}{y} \right) \times \frac{W}{11}$
		$I < I_{av}$	positive	
When	$I_{max} - I_{av} < I_{av} - I_{min}$	$I \geq I_{av}$	negative	$R = \left(5 - \frac{\left(\frac{I_{av} - I}{(I_{av} - I_{min}) \div 5} \right)^x}{y} \right) \times \frac{W}{11}$
		$I < I_{av}$	positive	
Where:	R = the result, i.e. the number of DPI points that a region receives for the particular indicator I = the value of the indicator for a given region I _{av} = the average value of the indicator for all the 281 NUTS2 regions (not weighted) I _{max} = the highest value of the indicator (from all the 281 NUTS2 regions) I _{min} = the lowest value of the indicator (from all the 281 NUTS2 regions) x = variable (from 0.57 to 1) determined after calculating the specific coefficient of dispersion for the indicator y = variable (from 0.50 to 1) determined after calculating the specific coefficient of dispersion for the indicator W = the set nominal weight of the indicator			

The DPI is grounded on eight separate indicators: Regional GDP (measured in PPS per inhabitant), Unemployment rate (%), Employment in high-tech sectors (%), Total intramural R&D expenditure (% of GDP), Motorways network (km. per 1000 km.²), Population density (persons per km.²), Life expectancy at birth (years) and People at risk of poverty or social exclusion (%).

As DPI in its essence is an index for comparative analysis, the methodology itself strives for building an algorithm reasonable for a benchmarking tool. From that point of view estimates for the different indicators are formed within the framework of the calculation model (i.e. they are determined by the relative advantages or disadvantages of a region against the others) and are not dependent on preliminary set criteria and thresholds that could be more abstract and inapplicable when comparing different time periods.

The algorithm for calculating the index is based on the following steps:

1) We determine specific weight for each of the indicators with "Regional GDP" receiving the highest one (3) – it account for 3/11 of the final DPI result, „Population density” – for 2/11, while the other six – each for 1/11;

2) In order to optimize the methodology for calculating the results and eliminate the undesired effect of the extremities, we determine in advance certain limits for each indicator, i.e. either maximal or minimal value that would correspond to rating 10 or 0 in our assessment scale (so even if a value for a particular region surpasses that limit, the rating stays in the above-mentioned scale – from 0 to 10).

3) By using the average and the extremal values, we make mathematical normalization of each indicator's values into a scale ranging from 0 to 10. Moreover, aiming to avoid the unrealistic clustering of the ratings at the mean (that would undermine the significance of the differences), in the process of normalization we use complex algorithm based on non-linear functions when calculating the ratings for a particular indicator. Table 1 summarizes the complete methodology for calculating of the number of points that a region receives for a specific criteria (indicator).

4) Following the algorithm set by the previous steps, we calculate the DPI results for all the 281 NUTS2 regions in a scale from 0 to 10. The DPI for a particular region is in practice the sum of its points received for each of the eight indicators.

The Danube region within the general European spatial development model

First, on the base of the DPI calculations, we build generalized spatial development model at European level (Dokov and Stamenkov, 2015). The results suggest that the economic "heart" of Europe,

the territory with the greatest potential for development and prosperity, lies within the green zone (Fig. 1) where NUTS2 regions' DPI is generally over 5.50. Outside the central/core zone we can also separate relatively easy the semiperiphery from the periphery. NUTS2 regions' DPI results in the semiperiphery are generally from 4.00 to 5.50, while those situated in the periphery have in most cases values under 4.00.

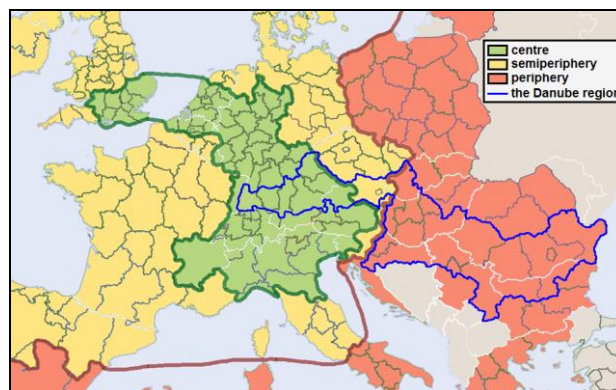


Fig. 1: The Danube region within the general European spatial development model

The Danube region falls into the three different zones, with the larger part of its territory being in the periphery. There are situated the Danube NUTS2 regions of Romania, Bulgaria, Serbia, Croatia, Hungary, as well as Západoé Slovensko (Slovakia). The semiperiphery is represented by the regions of Bratislava, Vienna, and Lower Austria, while the central area – only by Upper Austria and the German Danube regions.

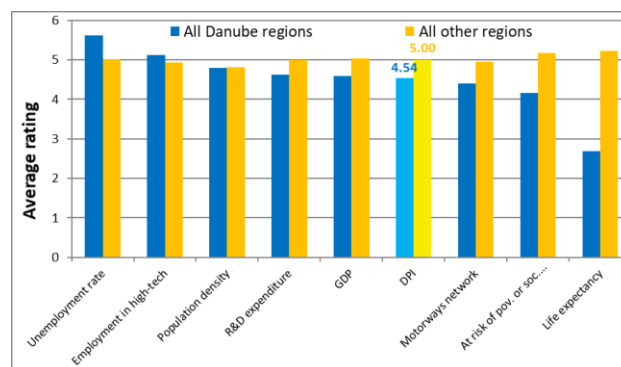


Fig. 2: Comparison between the Danube-adjacent and the other regions' average ratings for the different DPI indicators

Given all that, not surprisingly the average DPI rating for the Danube regions is lower than that for all the regions covered by the study – 4.54 to 5.00. The detailed analysis of the average ratings for each of the eight DPI indicators shows that the Danube regions have advantage only in Unemployment rate and Employment in high-tech sectors, while they

significantly lag behind in terms of life expectancy (Fig. 2).

Encompassing 8.87% of the whole studied area (EU + Norway, Switzerland, and Serbia), the Danube region (as defined in our study) is where 9.43% of the total population lives and only 6.78% of the total GDP is produced. That supports the thesis for economic underdevelopment of the Danube region.

Comparison between the Danube-adjacent NUTS2 regions

The DPI for the Danube-adjacent NUTS2 regions varies in a wide range – from 2.49 to 7.46 (Fig. 3). Out of 27 studied Danube-adjacent NUTS2 regions, only two could be classified as regions with European importance (having DPI over 7), three of them are with supranational importance (characterized with DPI between 6 and 7), while at the same time the DPI result for thirteen regions is under 4, thus signifying serious underdevelopment (Table 2).

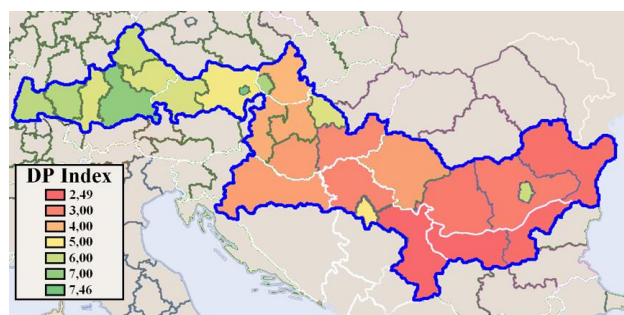


Fig. 3: The DPI results for the Danube-adjacent NUTS2 regions

Table 3: Most and least developed Danube-adjacent regions according to DPI

Wien	Austria	7.46	Sud-Vest Oltenia	Romania	2.87
Oberbayern	Germany	7.06	Sud-Est	Romania	2.69
Bratislavský kraj	Slovakia	6.48	Severen tsentralen	Bulgaria	2.61
Tübingen	Germany	6.35	Severozapaden	Bulgaria	2.51
Freiburg	Germany	6.22	Region Južne i Istočne Srbije	Serbia	2.49

At country level, the socio-economic development of the Danube-adjacent regions is very high in Germany, Austria, and to some extent in Slovakia (respectively 6.13, 6.11, and 5.24 average DPIs). Hungary, Croatia, Serbia and Romania have averages between 3.5 and 4, while in Bulgaria the Danube-adjacent regions are in severe crisis clearly attested by the lowest average DPI result – 2.56. To find out the influence of the different indicators for the final DPI ratings, we should analyse each of them separately.

In terms of Regional GDP (measured in PPS per inhabitant) Danube-adjacent regions of Germany

Table 2: Classification of the Danube-adjacent NUTS2 regions based on the DPI results

group	Nº of NUTS2	in countries
over 7	2	Austria, Germany
6 to 7	3	Slovakia, Germany
5 to 6	7	Germany, Romania, Austria, Hungary
4 to 5	2	Serbia, Slovakia
3 to 4	7	Hungary, Croatia, Romania, Serbia
under 3	6	Romania, Bulgaria, Serbia

Despite belonging to the semiperiphery in our general European development model (just because they are spatially isolated from the core area), Vienna and Bratislava are among the regions with the highest DPI results (Table 3). The list of the top five most developed regions is filled out with three German regions – Oberbayern, Tübingen, and Freiburg. On the other hand, the least developed NUTS2 are situated in Serbia, Bulgaria, and Romania, with the bottom two regions severely lagging behind (Table 3). Only the capital regions in Eastern and Central European countries have results that are closer to those of the Western European NUTS2 – Bucuresti-Ilfov in Romania (5.88), Közép-Magyarország in Hungary (5.58), and Beogradski region in Serbia (4.91). The results not only demonstrate convincingly the significant inequalities at NUTS2 level, but also outline eloquently the East-West polarization.

(6.49) and Austria (6.45) have a rating higher than the total for the last two countries (Bulgaria and Serbia, respectively 2.56 and 2.78). The third position is firmly occupied by Slovakia (5.95), while the other three countries – Hungary, Croatia, and Romania have ratings between 3.53 and 3.76.

Considering the Unemployment rate, again far ahead are the German and the Austrian regions (rated 7.12 and 6.42). With very good performance (over 5) are characterized Slovakia, Hungary, Serbia, and Romania. The last place in this case is for Croatia (2.47), lagging slightly behind Bulgaria (3.37).

The best position in terms of Employment in high-tech sectors is for Slovakia (7.14), followed by Germany (6.28) and a little further back by Austria and Hungary – with ratings above 5. Croatia and Romania have averages of over 4, while the ratings for Bulgaria and Serbia are the lowest – respectively 3.49 and 2.74.

The analysis of the Total intramural R&D expenditures (as % of GDP) reveals stunning discrepancies. While the German and the Austrian Danube-adjacent regions reach ratings of 7.48 and 6.65, all the other countries fall heavily behind having ratings below 4, with Romania and Bulgaria – even lower than 3. Similar discrepancies are also typical considering the indicator Life expectancy at birth, which demonstrates to a great extent the differences in the overall living conditions between Western and Eastern Europe.

In terms of People at risk of poverty or social exclusion the leading trio of Germany, Slovakia, and Austria clearly stands out (respectively 7.11, 6.28, and 5.90). The ratings of Croatia and Hungary are 3.65 and 3.51 respectively, while the other three countries are lagging behind with particularly alarming being the situation in the Danube-adjacent regions of Bulgaria (0.60), where half of the population is exposed to such a risk.

The average ratings for the other two DPI indicators (Motorways network and Population density) are more balanced, however in both cases the Austrian NUTS2 regions occupy the first position, while the Bulgarian – the last one. The results of the whole empirical analysis, scrutinizing the role of the different DPI indicators in the separate countries, are summarized in Figure 4.

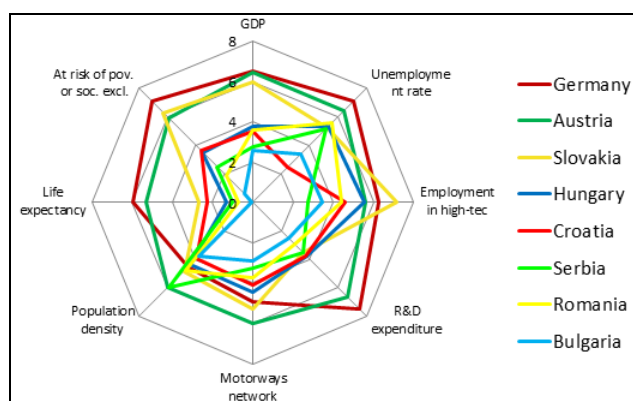


Fig. 4: Danube-adjacent regions' average ratings for the different DPI indicators (by countries)

Analysis of the development within the countries

Our "second level" of analysis is focused on comparing the development of the Danube-adjacent regions against that of the other NUTS2 within a

particular country. The general results are presented in Fig. 5. We find out that in all the studied countries, with the only exception of Bulgaria, the Danube-adjacent regions are characterized with better DPI results. Undoubtedly, one of the main reasons is that the capital regions of Austria, Slovakia, Hungary, Croatia, Serbia, and Romania fall within the Danube region. In a view to provide more details about the socio-economic role and the importance of the Danube River, we scrutinize the DPI and its components on country by country base.

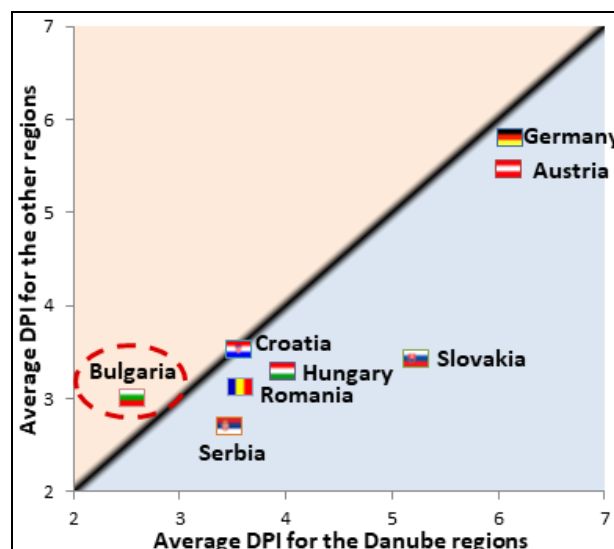


Fig. 5: Comparison between the Danube-adjacent and the other regions' DPI results within the countries

The only indicators where the Danube-adjacent regions of Germany defer to the other NUTS2 are Motorways network and Population density. The coincidence of these NUTS2 regions with some of today's most advanced German territories can be explained with the development of the country after World War II. Nowadays the main socio-economic disparities still remain primary connected with the wealth and income inequalities between former East and West Germany (divided for more than 40 years). For a long time the major economic power was concentrated in the northern parts of the former West Germany where were situated the major ports and stocks of minerals, but that lead to old-industrial specialization (ineffective at later stages), economic and social problems in the 70s and 80s, and need of economic restructuring. On the other hand, the southern regions developed in different way – because of their remoteness from the sea coast and the lack of rich mineral resources, up to World War II these regions were peripheral, characterized with economic indicators below the national averages and with less developed transport infrastructure. The preparations for the war however

lead to rapid industrialization and utilization of the Danube Alpine tributaries' hydropower potential. Last but not least, after the 50s development of modern knowledge-intensive sectors was initiated. Today the Danube states of Bavaria and Baden-Württemberg are among the leaders in a number of social and economic indicators.

Although registering a bit higher GDP per capita and greater transportation density, the Danube-adjacent regions of Austria have disadvantages considering some other indicators, such as the Unemployment rate, Life expectancy at birth, and People at risk of poverty or social exclusion. One of the main reasons for the significant concentration of population, transport, and economy along the Danube (almost 60% of the population and the produced GDP) is naturally determined – about 2/3 of the Austrian territory, mainly the southern and western areas, are part of the Alps. The dominance of the Danube-adjacent regions in Austria is to a large extent due to the key role of the capital Vienna, while at the same time many of the cross-border regions of Upper and Lower Austria continue to experience difficulties. Moreover, taking into account for example solely economic indicators (such as GDP per capita), we can disclose certain West-East disparities (richer western provinces such as Salzburg, Tyrol, and Vorarlberg, at the expense of Burgenland, Lower Austria, and Styria).

Slovakia is the country with the greatest difference in terms of complex development between its Danube-adjacent (with average DPI of 5.24) and other (3.43) NUTS2 regions. All the DPI indicators have larger values for the Danube-adjacent regions – in some cases even more than twice higher: GDP per capita; Employment in high-tech sectors; Motorways network; Population density. Regardless of the over-10-year membership in the EU and all European measures and cohesion instruments, disparities between the rich metropolitan region and the other parts of the country continue to worsen. As a result Bratislava has advantages in many indicators even over some Western European NUTS2 regions, while the central and the eastern regions (Stredné Slovensko and Východné Slovensko) are among the least developed in our research.

The Danube-adjacent regions in Hungary have an average DPI result of 3.99 compared to 3.29 for the rest NUTS2. All their indicators have higher values with the only exception being Employment in high-tech sectors. Identifying the regional importance of the Danube on the base of the DPI results, however, is a difficult task because the river passes through five of the seven Hungarian NUTS2 regions. The only two non-Danube regions (Észak-Magyarország and Észak-Alföld) cover the most north-eastern and least developed parts of the

country. One of the reasons for their underdevelopment could be sought in the specifics of the historical processes – while eastern Hungary was part of the Ottoman Empire, the western territories belonged to the richer Habsburg monarchy. The sound differences remained largely unchanged throughout the socialist period and even after the political changes in the late 80s the restructuring processes and the economic growth in eastern and north-eastern Hungary were the slowest.

In the case of Croatia, which has only two NUTS2 regions, we can see the greatest convergence of values and DPI results. Again, it is difficult to estimate the impact of the Danube River because it performs mainly border functions, while a number of territorial disputes with Serbia still exist. The greater advantages in favour of Kontinentalna Hrvatska are registered in terms of Employment in high-tech sectors, Total intramural R&D expenditure, and Population density. Once more we can indicate the belonging of the capital to the Danube-adjacent NUTS2 regions as a major reason for those results.

The passage of the river through the northern, more developed parts of Serbia logically leads to a reflection on the DPI results: 3.49 to 2.69 in favour of Danube-adjacent regions. The only indicators where Danube regions have disadvantage are Population density and Life expectancy at birth. The role and the importance of the Danube, however, are difficult to be determined by calculations at NUTS2 level because three of the four Serbian regions fall into the category "Danube regions" with only one left to be used as counterbalance in the comparative analysis (excluding the disputed area of Kosovo and Metohija).

Owing to the assignment of Bucuresti-Ilfov to the Danube NUTS2, similar is the situation in Romania: 3.59 to 3.12 DPI average ratings in favour of the Danube-adjacent regions. All the indicators (with the only exception of People at risk of poverty or social exclusion) are more favourable in these regions, with particularly large disparities registered in Motorways network (11 times higher) and Population density (4 times higher). However, aside from Bucuresti-Ilfov and Vest, the other three Danube-adjacent regions of Romania are among the least developed NUTS2 in all the studied countries. These regions are generally characterized with predominance of the agricultural sector, low stock of foreign direct investments, difficulties in restructuring of the economy, massive labour migration, and other negative socio-economic trends.

Taking into consideration that the Danube serves as a Bulgarian state border in the northern, underdeveloped parts of the country and that the metropolitan agglomeration does not fall into the

Danube NUTS2 group, the better average DPI result for the other regions (3.01 to 2.56) is no surprise, making (as mentioned above) Bulgaria the only exception in this comparative analysis. Moreover, the Danube-adjacent NUTS 2 regions practically lag behind in all eight DPI indicators. The problems in these areas started in the socialist period and then deepened after the political changes in Eastern Europe. As a result nowadays these peripheral for the country regions are among the poorest in the whole EU. The relatively weak utilization of the Danube and its potential is the reason why the river continues to perform basically boundary functions and why it is still more a natural barrier than a bridge for cross-border cooperation between Bulgaria and Romania.

Conclusion

Building author's methodology and index (DPI) to assess the complex socio-economic development in Europe, we provide solid evidences for the existence of significant discrepancies that spread far behind single indicators. After conceptualizing a thorough spatial development model at European level, the study emphasizes on the key role of the Danube region, whose territory falls within the three major zones of our model – centre, semiperiphery, and periphery. The in-depth analysis of the Danube-adjacent NUTS2 regions suggests that the traditional dichotomy "rich Western Europe – poor Eastern Europe" is also observed at this level. Concentrating on the development patterns within the separate countries, we discover that in seven of the eight studied cases (with Bulgaria being the only exception) the average DPI results for the Danube regions are higher than those for the other NUTS2 in the given country. That is to say that the Danube regions are extremely important for the development of the countries and have huge potential in serving as "motors" of long-term sustainability. Moreover, the results provide clues that the Danube region itself could turn in the future into a key for the whole Europe economic zone. Our findings provide solid ground for building up adequate future policies and development strategies, as well as for overcoming some of the major problems standing on the way of the Danube region.

Author contribution

Hristo Dokov was primary responsible for the design of the methodological framework and for the processing of the statistical data, while Ivaylo Stamenkov was in charge of conducting literature overview and of interpreting the empirical results. Both authors contributed in the design of the

thorough spatial development model at European level, as well as in summarizing the final results and conclusions.

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