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The variation in the level of the socio-economic development of the NUTS-3 subregions in the European Union

A very important research problem is the specification of the level of the socio-economic development of the EU regions. Within the cohesion policy, one may differentiate between regions more and less advanced in terms of general development, including the worth of GDP per capita. Following that measure, one can establish the areas eligible for getting help from EU budget support programmes. The purpose of the article was to present the variation in the level of the socio-economic development of 28 EU countries within the 1,347 NUTS-3 units. The level of the development was established on a multilevel basis, subcategorising three factors of regional development: human capital, the natural environment and the economy. The article specifies the extent of the NUTS-3 unit general progression following the analysis of 31 indicative measures structured around publicly available Eurostat statistical data (as of 2019). The extent of the progression was demonstrated based on a synthetic measure revealing the taxonomic distance of a particular region from the assumed arrangement measuring the development. The research procedure consisted of five development levels, namely: the establishment of factors of the progression of regions, a choice of variable factors, a decrease in the multi-factor space, an identification in the extent of the social and economic progression of the researched units and a subcategorisation of the units on the scale of the social and economic progression structured around a ranking prepared using the analysis of a lowering synthetic measure. The research resulted in spatial variation of 1,347 NUTS-3 unit subregions in 28 EU states presented in terms of the level of the social and economic progression and the three subparts of the progression. The highest synthetic measure was noted in the areas including the capitals of the states included in the research and in a belt comprising the Irish subregions, Central England, the Benelux states, Western and Southern Germany, up until the Alpine subregion. Moreover, significant differences between the levels of the development within the respective states were presented. The results of the research may be a source of inspiration for EU institutions within the scope of the manner of specifying the richest and the poorest EU regions, whose purpose is to ensure the efficient introduction and conclusion of the cohesion policy in the programming periods specified.

Keywords: regional development, NUTS-3 units, developmental discrepancies, distance from the pattern, Hellwig's data reduction

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1. Introduction

Identifying the level of the socio-economic development as well as its changes is a very important research issue both in the theory of economics and in economic practice. The level of the development heavily influences the EU regional classification in terms of the better and worse developed regions, and the latter in turn impacts on the scope of the EU fund allocation in the regions, as well as the intensity of state aid made available in the respective territorial units (Matsuura 2015; Albulescu, Goyeau 2014; Nistor, Glodeanu 2014). Within the EU cohesion policy, the regions are classified as richer and poorer and based on that, territorial units eligible for EU aid funds are subcategorised. The abovementioned classification was, however, conducted solely based on GDP per capita of a particular region as well as relating its value to the EU average. The purpose of the report was to specify the level of the development of the EU regions, however taking into account of the larger number of indicators, not just the GDP per capita.

Researching the core, the cause and the consequences of the process of the level of the socio-economic development constitutes the subject of many scientific compilations (Dreyer et al. 2006; Mukhametzhan et al. 2020; Jašková, Havierniková 2020; Vučković et al. 2018; Orlova et al. 2018; Shikverdiev et al. 2019). The regions under scrutiny progressed in spatially diverse ways. The increasing discrepancies of regional development are one of the core issues of the modern economy, and the main goal of the EU cohesion policy is convergence, i.e. activities aimed at decreasing the discrepancies in the level of EU regional progression (Beugelsdijk et al. 2018; Martin, Sunley 1998; Charron et al. 2014).

The article examines the level of the socio-economic development of all 1,347 EU NUTS-3 unit subregions (as of 2019), analysed based on 31 indicative factors included within the three factors (subcomponents) of regional progression: human capital, the environment, as well as the economy. The results were obtained using widely accessible Eurostat data. The article was written in order to present the extent of the variation of 28 EU regions within 1,347 territorial units of the NUTS-3 level, i.e. the third level of Eurostat categorisation of units of territory in a statistical manner. The article presents the socio-economic situation of the EU subregions at a more detailed level than the one used by the European Commission within the cohesion policy, both in terms of the number of subjects of the research and the scope of the indicators taken into account. The variation between the level of development aimed for, and the actual one demonstrates the level of progression.

A review of the literature within the scope of the factors of regional development is presented first, followed by the methodology of the research, together with a description of the respective stages of the research procedure. Next, the obtained results of the research are examined extensively. In the final section, the conclusions as well as the recommendations within the scope of exhibiting the extent of the progression between regions are indicated.

2. Factors of regional development in the subject literature

The regional development may be considered both in the quantitative and in the qualitative dimension. Striving towards an increase in productivity may be considered to be quantitative activities, and stimulating the development of certain spheres of activity with the simultaneous lack of incentives for other spheres may pass as qualitative activities (see: Vučković et al. 2018). It is well worth noting that the quantitative dimension of development is economic development, hence it is a notion wider than growth, as apart from qualitative changes, it is accompanied by structural changes (Bystrova et al. 2015).

In the subject literature one may find numerous reviews of the concepts and theories of regional development, some attempting to systematise them, taking account of different criteria (Illeris 1993; Martin 2015). The article includes a review of concepts of regional development conducted in terms of the factors of the development based on two main trends in economics:

– neoclassical, according to the liberal doctrine, minimising the extent of the intervention of the state in business and treating the free market as a regulating force;
– neo-Keynesian, considering state interventionism as indispensable and the most important regulatory mechanism of the regional development.

A concept of regional development relating to Smith's and Ricardo's theories representing the classical school of economics, is the theory of comparative costs. Ricardo proved not only the falsehood of the Mercantilists' beliefs concerning international trade, who thought only one party of the transaction obtains benefits, but also supported Smith's arguments on the advantages of free international trade. Smith saw the benefits of both partners, if each, thanks to specialisation has a cheaper product at their disposal, created using a relatively lower labour input compared to their partner (Friedmann 1983). Therefore, the main assumption of the theory is that the comparison of the efficiency and the labour cost between two regions shapes the level of the development, which is co-operation and international exchange.

Another neoclassical concept is the theory of convergence, formulated by the Nobel prize winner, J. Tinbergen. The theory has an immediate relation with the comparative cost theorem, and its supporters claim trade exchange between the highly and the low developed countries may with time lead to a decrease in the variations in their level of progression, going as far as to make even the level of generated revenue minus tax in both samples. The exchange between countries, the capital increase and the technology advancement are also significant (see: Henrekson, Jakobsson 2003).

In the first part of the twentieth century, as opposed to the neoclassical concepts, theories emerged connected with Keynes' doctrine. The previous concepts focused on the supply aspect, while Keynes and his followers centred around the demand side of the equation. The demand concepts postulate different administrative

and management activities directed at creating or reinforcing the factors of the progress, such as: boosting export, improving the labour force competencies, supporting the development of entrepreneurship, investments in infrastructure and creating innovativeness (Li et al. 2019; Diebolt, Hippe 2019; Zemtsov, Smelov 2018; Florida 2002).

The importance of innovation in the process of the development between regions was emphasised by J. Schumpeter, leader of the Austrian School. In his opinion, progress is similar to the process of creative destruction (Emami-Langroodi 2018; De Castro et al. 2018). Innovativeness provides a structural transformation and growth on the one hand, as well as the destruction of previous socioeconomic structures that turned out to have been inefficient and maladapted to the changing reality on the other. Some such units are unprepared for such changes. Occasionally, some maladapted units or structures have to destroy themselves in order to make room for technological transformation.

A novel way of perceiving development, proposed by P. Romer, assumes the possibility of collecting the factors of development, meaning the option to achieve sustainable development, as well as maintaining and increasing the economic differences between the regions. A stable and long-lasting development is termed within the concept as an endogenous development. The main stimulating factors are: human capital, the financial capital and also the technological advancement of the economy. The theory states that the lesser developed regions may not close the gap in developmental differences in a manner different than by increasing their technological advancement and investing in human competencies (Baklanov 2020; Arranz et al. 2019; Rodionov et al. 2018; Benner 2003).

In line with the neoclassical trend, a contemporary model was also created of the so-called new economic geography, which combines three factors: transport cost, the benefits of an agglomeration and the cost of production flow resources (see: Krugman 1998). The model established that there is a possibility of the occurrence, and even of the intensifying, the differences between regions, which according to Grosse (2018) is an effect of the trend of accumulating the factors of development in the most developed capital regions of the metropolitan area. New economic geography along with the new theory of development have found a widespread use within the concept of the policy of endogenous regional development (see: Eshugova 2018). According to this theory, the economic development of a particular region depends on factors such as: the endogenous material capital, the human and social capital as well as the intraregional policy of the development. Regional development should be an internal effect, as well as managed by a region "from the bottom" (Gallego et al. 2010). The conditions for sustainable regional development should be created by an efficiently managed regional policy. Thus the concept rejects the neoclassical assumption of the "invisible hand of the market" to the benefit of neo-Keynesian state interventionism.

Regional development may take place in a spontaneous manner or in a directed manner. The latter is connected with shaping development through stimulating the factors of the regional development within the regional policy. The problem of regional policy is a subject of lively debate among the exponents of different fields of knowledge: economics, geography, law and political science. Defining the regional policy leads to some difficulty, especially in the context of the activities taken within the structural policy and the cohesion policy of the European Union (Milenković et al. 2021). The notions are very often interchangeable, as both the regional policy, the cohesion policy and the structural policy have the same purpose which is to decrease the economic and social differences between the EU regions (Moroshkina 2020). The European Commission (Smętkowski, Dąbrowski 2019) concluded that regional policy is a conscious and purposeful activity of the central bodies of the public authority directed towards regulating the interregional proportions of development. Structural policy is a notion used in the European Union virtually always within the policy of cohesion (Downes 1996).

According to Smętkowski (2015), regional policy in the economic dimension comprises all forms of state intervention which are directed towards a change in the spatial location of the business venture activity. Within such a perspective, it aims to correct the effects of the functioning of free market forces directed at ensuring economic development, along with a change in income redistribution (Pfirrmann 1995). From the general perspective, regional policy may be defined as activities striving towards maximising of the usability function, i.e. improving the economic situation of one or a few regions (Démurger 2001).

To summarise, regional policy is linked with the occurrence of variations in the level of the development of the respective regions. Uneven progress made by the regions resulting from the decisions of the investors, the workings of the mechanism regulating the market, and the factors connected with the geography, lead to different amounts of the registered income and the quality of life. The basic task of regional policy is thus the necessity to decrease the differences in scale of those phenomena (Liu et al. 2018).

Among the factors most frequently mentioned in the literature on regional development are: economic aspects and aspects related to human capital. Following the literature review, however, a research gap was identified in relation to including environmental aspects among regional development factors. This may be caused by the difficulty in identifying and insufficient indexing of environmental elements, therefore the author of this study decided to address the research gap and include environmental aspects in his considerations as one of the most important regional development factors. However, due to the limited availability of empirical data directly referring to the natural environment, the author is aware of certain imperfections related to the construction of a synthetic indicator.

3. Methodology

The article provides a confirmed hypothesis according to which the development of society and the economy, including the NUTS-3 unit subregion variation in the European Union, and its highest level of the said development is noted in the territorial units comprising the capitals of countries, and the lowest in the regions furthest from the capital units exhibited. The research comprises all NUTS-3 subregions subcategorised in 28 EU states as at the end of 2019 – 1,347 units in total.

A cross-sectional measure of distance from the assumed pattern was used. The research procedure was carried out simultaneously – both statically (based on the values of measures as of 2019) and dynamically (based on the change of the value of indicators in 2010-2019, i.e. a 10-year period with the most up-to-date data). The research procedure consisted of five stages:

(1) an identification of subparts – i.e. the factors contributing to the progression of the regions (the so-called subcomponents of the development),
(2) a choice of contributing factors – a construction of a matrix of geographical information,
(3) a decrease in the multi-factor space,
(4) a specification of the extent of the social and economic development of the researched units,
(5) a classification of the subregions on the scale of the socio-economic progress resulting from the data included in a ranking created according to the decreasing value of the synthetic measure.

In the first stage, a conducted review of literature comprising the concept of regional development demonstrates that the most significant subparts were established, i.e. the subparts constituting the progression of the respective areas. A factor influencing the progression might be a subpart, a property of the region or an event which puts the most pressure on the socio-economic development of a particular territorial unit (Khasanova et al. 2020; Naydenov 2019; Feldman 1999; Yun et al. 2017). In this article, the socio-economic development was characterised based on its three subcomponents: human capital, the natural environment, and the economy. The 'human capital' subcomponent was specified through the indicators presenting the population potential of a particular subregion, relating to the migration balance and the natural development, the level of education, the birth rate, and the age structure. Within the 'natural environment' subcomponent, the indicators concerning the use of land, the structure of farms, urban waste, the burden connected with road transport of goods, and the use of energy for heating and cooling the living quarters were also included. Within the 'economy' subcomponent, indicators concerning entrepreneurship were subcategorized, as well as the GDP, the structure of the employment and the scale of innovativeness measured as the number of trademarks and consumer goods obtained. All the factors of regional development mentioned above are interrelated. In striving towards the competitive development of a particular region, these factors should be included in its long-term strategy (cf. Cristina et al.

2021). According to Churski (2008), one may thus assume that regional development comprises both the dynamic processes occurring under the influence of specific factors which determine the character, the direction as well as the speed of the socio-economic changes, and also the changes purposefully directed at realising the tasks within the regional policy. In the research, publicly available Eurostat data were used. The author understands the inadequacies and incompleteness of the structure of the respective indicators characterising the factors of the development. Specific characteristics could be built more precisely, however all the available public data taken into account may determine the level of the development of the respective subcomponents of the development. It is well worth considering a wider catalogue of indicators, e.g. from other sources.

Table 1

Indicative factors analysed in the establishment of the respective area development

The indicative factor of development	**Indicative factors**
Human capital (11 variables)	the growth rate counted per 1,000 inhabitants (s); the ratio of migration per 1,000 inhabitants (s); the share of people with higher education in the total population (s); the percentage of individuals at working age in the general population (s); the percentage of individuals at pre-production age in the general population (s); *the percentage of people at non-working age in the general population (d);* the ratio of people at non-working age against one hundred individuals at working age (d); *the number of people at non-working age per 100 people at pre-working age (d);* the birth rate in total (s); the population median age (d); the average age of women when giving birth (d)
The natural environment (10 variables)	the area of farming land and the green areas in the area in total (s); the percentage of farmers owning farms under the age of 35 in the number of farm owners in total (s); the percentage of farms under 5 hectares in the number of farms in total (d); road transport of products in tonnes measured against 1,000 inhabitants (d); the noting of minor offences and crimes against the natural environment measured against 1,000 inhabitants (d); the electrical energy exploitation for the purpose of lowering the temperature of the living areas (as the average in the EU) (d); *the electricity use for heating the living areas (as the average in the EU) (d);* municipal waste in relation to1 inhabitant (d); municipal waste disposed of measured against 1 inhabitant (s); accommodation per 1,000 inhabitants (s)
The economy (10 variables)	microenterprises in the economic entity number in total (s); the creation of enterprise coefficient (s); the number of information sector employees in the general workforce (s); the percentage of farming employees in the total number of the employed (d); the percentage of professional service sector employees in the general workforce (s); *the share of the employed in the financial sector in the total number of the employed (s);* the percentage of the employed in services in the general workforce (s); *consumables in relation to 1m inhabitants (s);* the number of trademarks per 1m inhabitants (s); Gross Domestic Product per capita (as the EU average) (s)

Notes: (s) – stimulant, (d) – destimulant, *italics* – rejected indicators.

Source: own research.

The subsequent part of the study involved geographical data obtained from 31 indicating factors (Table 1), highlighting the level of development of the NUTS-3 parts in 2019 and changes related to its three subparts: human capital, the environment and the economy. Next, Pearson's correlation coefficients were included among all the final indicators researched separately for 2019, and separately for their change in 2010-2019. It is important for the indicators selected for a synthetic measure of distance from the assumed model of the development to be achieved, not to be correlated with each other. Thus, the information capacity of the indicators is varied.

The obtained Pearson's correlation coefficient matrices were the foundation for the reduction of a departure variable decrease by means of Hellwig's method, whose purpose was to seclude the indicative features, i.e. those indicators to be included in the further research procedure (Balcerzak 2016). In Hellwig's indicative measure decrease method, the correlation coefficients between different variables were manipulated for the purpose of the final calculation. The main indicative feature had the highest correlation of the value sum of the absolute correlation coefficients with the other features (then called the central feature). Next, the variables for which the value of the correlation coefficient was bigger than the central value indicated formed against the pattern below specified, were eliminated (Nowak 2018):

$$r^* = \sqrt{\frac{\left(t^*\right)^2}{n-2+\left(t^*\right)^2}} \tag{1}$$

where: r^* – the central value of Pearson's coefficient measuring linear correlation [**= 0.35**], t^* – the t-Student statistic (at $p = 0.05$), n – departing indicative measures (variables) [= **31**]

Next, the varying measures were cancelled which were statistically significant for the diagnostic feature (termed as the satellite factors). At each subsequent stage, there was a reduction of the correlation matrix by a significant feature as well as the lesser significant features. Hellwig's method was used again by the achievement of new decreased value correlation matrices until the set of features is exhausted or isolated features were separated (Hauke, Kossowski 2011). The procedure of variable reduction was conducted eight times: with respect to the level of the general socio--economic development, and for the level of the development of each of the three subparts of the development both in the static dimension (for the data for 2019), as well as the dynamic dimension (for the data for 2010-2019).

At the following stage of the research procedure, a model and an anti-model of the social and economic progression were specified. The model considered the highest standardised values of the respective diagnostic features, and an anti-model – their minimum values (Spychała 2020). At the subsequent stage, the diversion of every thus examined subregion of the NUTS-3 level from the desired model of development formed against the data comprising the pattern specified below was established (Reiff et al. 2016):

$$d_{i0} = \sqrt{\sum_{j=1}^{m}(z_{ij} - z_{0j})^2}, \quad (2)$$

where: d_{i0} – the diversion of the i^{th} subregion from the desired model of development, z_{ij} – the standard value of the j^{th} indicative measure (feature) for the i^{th} subregion, z_{0j} – the standard value of the j indicative measure (feature) for the pattern of the development.

At the last stage of the research procedure, a synthetic measure being an indicator of the level of the development in a given subregion was devised for each territorial unit of the NUTS-3 level. The value of the synthetic measure was calculated for the total level of socio-economic development and separately for each of the three factors of development. The synthetic measure was calculated based on the following pattern:

$$v_i = 1 - \frac{d_{i0}}{d_0}, \quad (3)$$

where v_i – a synthetic measure of the level of the i^{th} subregion development, d_{i0} – the diversion of the i^{th} subregion from the established model of development, d_0 – the diversion of the model from an anti-model of development.

A synthetic measure of the extent of the researched development took on figures from 0 to 1, noting that the higher its value, the higher the level of the development of the researched area. Against the values of the synthetic measures counted, a set of the ranked 1,347 subregions of the NUTS-3 stage in the EU countries was established, and subsequently divided into five groups:

1. group – extremely high (20% of the areas exhibiting the biggest value of the synthetic measure values within the ranking 1-269);
2. group – high (the next 20% of the areas within the ranking 270-539);
3. group – medium (territorial units ranked within 540-808 including their lowered position resulting from a particular synthetic measure);
4. group – low (areas within the ranking 809-1,078);
5. group – very low (20% of the subregions with the lowest value of the synthetic measure within the ranking 1,079-1,347).

Regarding the research conducted dynamically, areas of the NUTS-3 level for which the measure registered the highest value figures (20% of the studied areas) were subcategorised into a set of a very big change in the level of the development of a specific phenomenon, and the units for which the measure took the lowest values (20% of the researched subregions), classified into the group at a relatively low change in the level of development of a specific area of research.

In Figures 1 and 2 and in Tables 2 and 3, the research outcomes are presented. Table 2 shows the NUTS-3 level units of the highest and lowest values of the synthetic measure within the respective factors of the social and economic development counted separately for 2019, while Table 3 shows the NUTS-3 subregions of extreme figures

Table 2

The highest and the lowest values of the synthetic measure within the specific factors of regional development in 2019

The highest figures of the synthetic measure (2019)			The lowest figures of the synthetic measure (2019)		
Item	**The NUTS-3 area**	**Value**	**Item**	**The NUTS-3 area**	**Value**
Human capital					
1	Seine-Saint-Denis (FR)	0.581	1347	Stuttgart, Stadtkreis (DE)	0.139
2	Barking and Dagenham and Havering (UK)	0.569	1346	Esslingen (DE)	0.142
3	Val-d'Oise (FR)	0.568	1345	Böblingen (DE)	0.151
4	Thurrock (UK)	0.566	1344	Evrytania (EL)	0.325
5	Mid-East (IE)	0.566	1343	Zamora (ES)	0.360
The natural environment					
1	Hautes-Alpes (FR)	0.596	1347	Florina (EL)	0.147
2	Savoie (FR)	0.582	1346	Seine-Saint-Denis (FR)	0.334
3	Primorsko-notranjska (SL)	0.551	1345	Darlington (UK)	0.341
4	Koroska (SL)	0.547	1344	Byen København (DK)	0.348
5	Kerkyra (EL)	0.542	1343	Arr. de Bruxelles-Capitale (BE)	0.356
The economy					
1	Camden and City of London (UK)	0.642	1347	Vaslui (RO)	0.027
2	Westminster (UK)	0.554	1346	Kardzhali (BG)	0.029
3	Luxembourg (LU)	0.329	1345	Razgrad (BG)	0.031
4	Tower Hamlets (UK)	0.291	1344	Neamt (RO)	0.033
5	Groot-Amsterdam (NL)	0.244	1343	Silistra (BG)	0.035
The level of the social and economic progression in general					
1	Camden and City of London (UK)	0.518	1347	Esslingen (DE)	0.194
2	Westminster (UK)	0.489	1346	Böblingen (DE)	0.202
3	Luxembourg (LU)	0.423	1345	Stuttgart, Stadtkreis (DE)	0.214
4	Tower Hamlets (UK)	0.406	1344	Florina (EL)	0.217
5	Dublin (IE)	0.379	1343	Evrytania (EL)	0.237
6	Groot-Amsterdam (NL)	0.378	1342	Vidin (BG)	0.256
7	München, Landkreis (DE)	0.372	1341	Fokida (EL)	0.258
8	Kensington and Chelsea and Hammersmith and Fulham (UK)	0.366	1340	Alto Tâmega (PT)	0.262
9	Miasto Warszawa (PL)	0.364	1339	Terras de Trás-os-Montes (PT)	0.262
10	München, Kreisfreie Stadt (DE)	0.363	1338	Arta, Preveza (EL)	0.264

Source: own research.

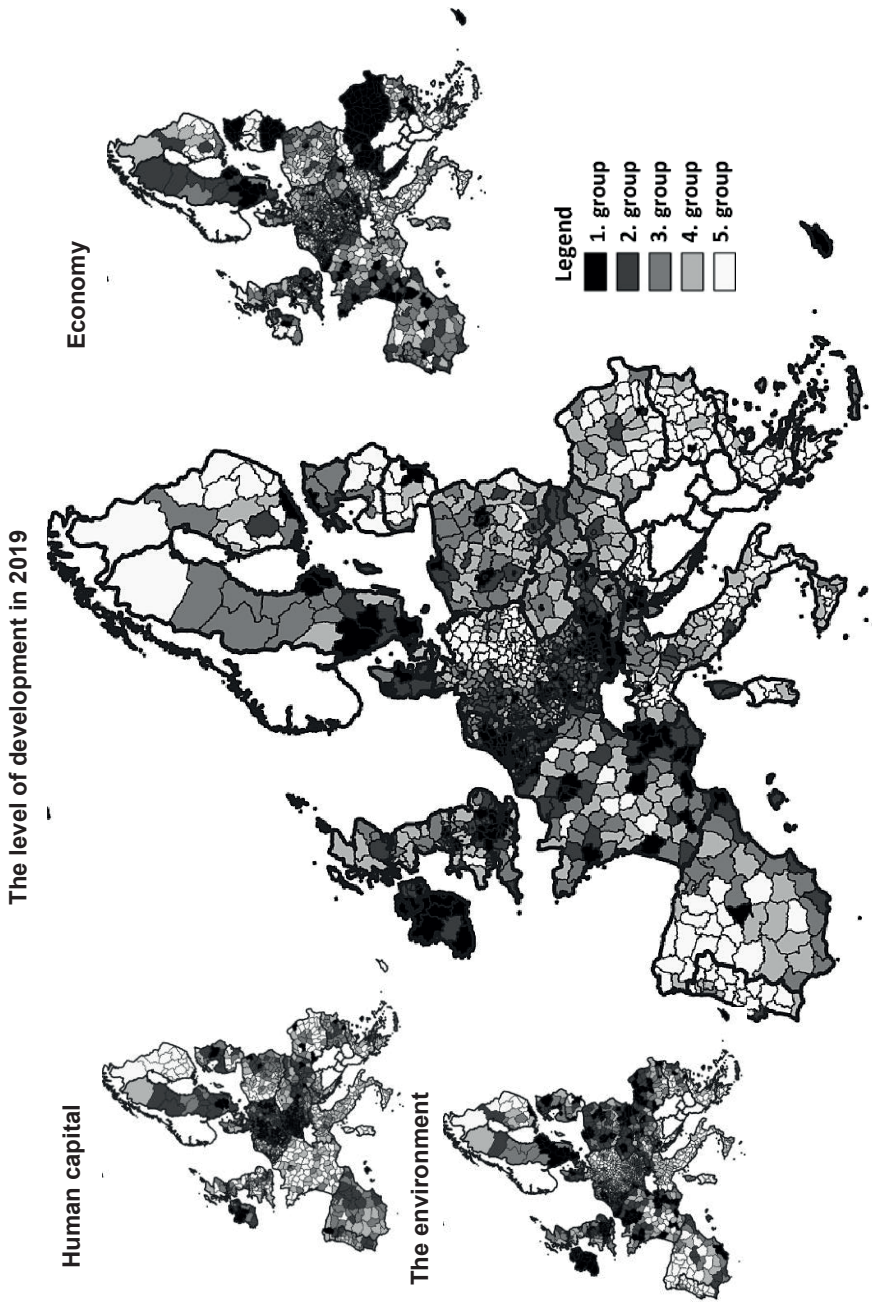
Table 3

Extreme figures of the synthetic measure within the specific factors of regional development in 2010-2019

The highest values of the synthetic measure (the period of 2010-2019)			The lowest values of the synthetic measure (the period of 2010-2019)		
Item	**The NUTS-3 area**	**Value**	**Item**	**The NUTS-3 area**	**Value**
Human capital					
1	Hagen, Kreisfreie Stadt (DE)	0.606	1347	Oost-Zuid-Holland (NL)	0.270
2	Gelsenkirchen, Kreisfreie Stadt (DE)	0.584	1346	Etelä-Savo (FI)	0.368
3	Salzgitter, Kreisfreie Stadt (DE)	0.581	1345	Kymenlaakso (FI)	0.373
4	Schweinfurt, Kreisfreie Stadt (DE)	0.581	1344	Kainuu (FI)	0.378
5	Ingolstadt, Kreisfreie Stadt (DE)	0.580	1343	Kanta-Häme (FI)	0.384
The natural environment					
1	Norrbottens län (SE)	0.422	1347	Florina (EL)	0.160
2	Kerkyra (EL)	0.395	1346	Menorca (ES)	0.212
3	Außerfern (AT)	0.393	1345	Ithaki, Kefallinia (EL)	0.230
4	Grevena, Kozani (EL)	0.389	1344	Fokida (EL)	0.233
5	Västerbottens län (SE)	0.381	1343	Byen København (DK)	0.237
The economy					
1	Camden and City of London (UK)	0.388	1347	Pieriga (LV)	0.155
2	Malta (MT)	0.357	1346	Bratislavský kraj (SK)	0.201
3	Westminster (UK)	0.356	1345	Zemgale (LV)	0.207
4	Ilfov (RO)	0.355	1344	Vidzeme (LV)	0.209
5	Wolfsburg, Kreisfreie Stadt (DE)	0.355	1343	Banskobystrický kraj (SK)	0.214
The level of the social and economic progression in general					
1	Norrbottens län (SE)	0.371	1347	Florina (EL)	0.255
2	Außerfern (AT)	0.369	1346	Pieriga (LV)	0.264
3	Cluj (RO)	0.361	1345	Fokida (EL)	0.264
4	Västerbottens län (SE)	0.361	1344	Thesprotia (EL)	0.279
5	Vas (HU)	0.359	1343	Oost-Zuid-Holland (NL)	0.281
6	Bucuresti (RO)	0.358	1342	Bratislavský kraj (SK)	0.283
7	Ingolstadt, Kreisfreie Stadt (DE)	0.357	1341	Banskobystrický kraj (SK)	0.284
8	Camden and City of London (UK)	0.356	1340	Ithaki, Kefallinia (EL)	0.285
9	Vilniaus apskritis (LT)	0.356	1339	Etelä-Savo (FI)	0.287
10	Gyor-Moson-Sopron (HU)	0.354	1338	Nitriansky kraj (SK)	0.287

Source: own research.

of the synthetic measure counted for the changes in the period 2010-2019. Figure 1 contains choropleth maps representing the spatial variation of the level of the socio-economic development of the NUTS-3 subregions located in the continental part of the European Union in 2019 (the UK excluded), as well as the changes of the level of development in 2010-2019. Figure 2 shows the division of the NUTS-3 subregions


The level of development in 2019
Economy
Human capital
The environment
Legend
1. group
2. group
3. group
4. group
5. group

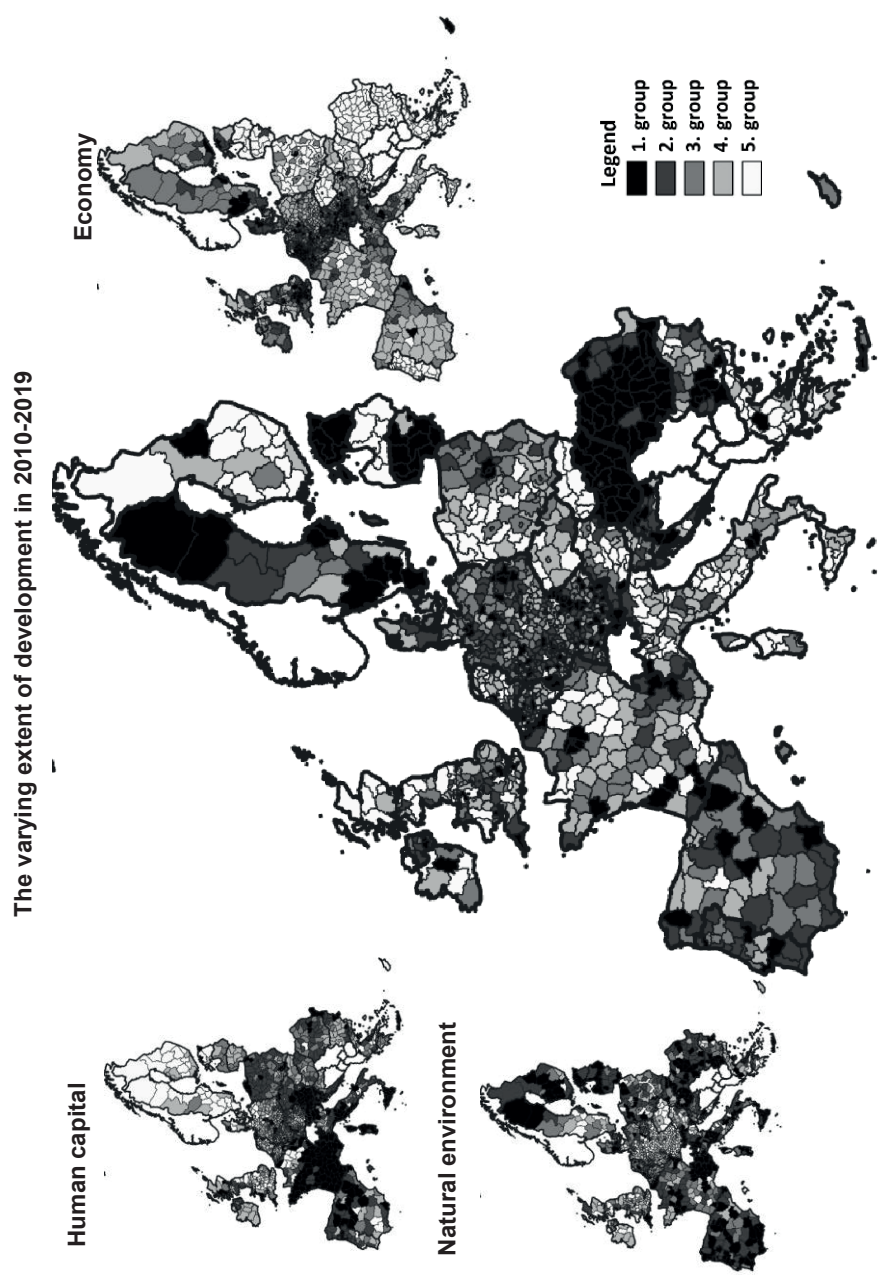


Fig. 1. Variation of the extent of regional development of the subregions in the EU countries

Source: own research.

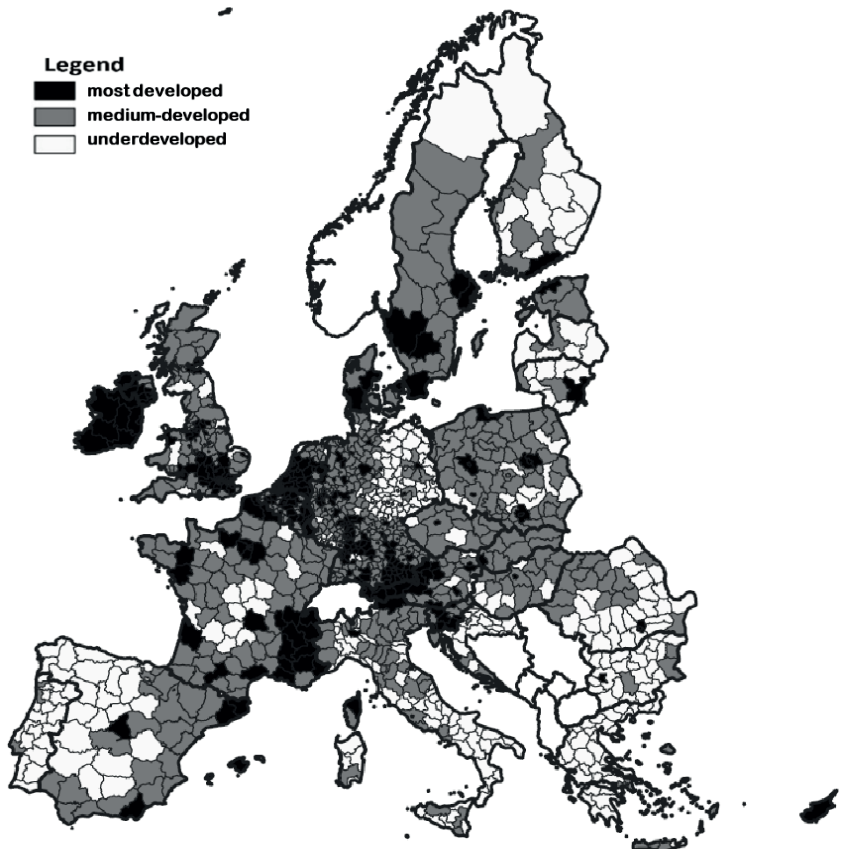


Fig. 2. The most developed, medium-developed and socio-economically underdeveloped subregions

Source: own research.

into the most developed (darkest colour), medium-developed and underdeveloped (lightest colour). The above classification was made on the basis of the average value of the total synthetic measure and its standard deviation.

4. Conclusions from the scientific examination of the selected respective factors of development

The research carried out for the purpose of this study resulted in the spatial variation of 1,347 NUTS-3 level subregions in 28 EU countries demonstrated with regard to the extent of socio-economic development, and the three subcomponents of the development (Figure 1). In the set of units examined, the value of the synthetic measure reflecting the level of the social and economic development in 2019 varied from 0.194 to 0.518 (Table 2). The value of the measure reflecting the variation in the social and economic rate of development of the researched subregions in the period

2010-2019 ranged from 0.255 to 0.371 (Table 3). A parallel variation was noted in the case of human capital (0.139–0.581 for 2019, and 0.270–0.606 for the change in 2010-2019), the natural environment (0.147–0.596 and 0.160–0.422, respectively), and in the economy (0.027–0.642 and 0.155–0.388, respectively).

It is thus worth noting that the highest variation in the specific areas was observed for the economy in 2019, and the biggest similarity of the researched units occurred in the case of the changes of the general level of the socio-economic development in 2010-2019. In the researched subregions, the biggest discrepancies within the scope of their economic development, while for human capital and the natural environment such big fluctuations were not registered.

Regarding the rate of development of the human capital subcomponent, the most significant values of the synthetic measure in 2019 were noted in the following subregions: Seine-Saint-Denis (FR – comprising the northern outskirts of Paris), Barking and Dagenham and Havering (the UK – forming part of the Greater London) and Val-d'Oise (FR – also located in the Île-de-France region), and the lowest – in the German subregions: Stuttgart, Esslingen and Böblingen. Their significant place within the ranking of the indicated NUTS-3 units was decided by: a high birth rate and a positive migration balance, a favourable age structure of the population, as well as a significant share of people with higher education. A low position of the respective units was decided by: the negative birth rate, and a very high share of people at the post-production age in the total number of people. In the group of the subregions of the lowest level of the development of human capital, there were the NUTS-3 units in which the ageing of the population may be observed. Apart from the German subregions (including specifically the ones located in the area of previous East Germany), one may thus subcategorise, among others, a high number of Portuguese, Spanish, Italian and Greek subregions. Considering the analysis conducted in the dynamic dimension, the biggest change in the level of the development of the human capital subcomponent in 2010-2019 was observed in the German subregions of Hagen, Gelsenkirchen and Salzgitter. Generally, the biggest improvement in the human capital in the researched years was noted in the German subregions, related to, among others, an increase in the level of the education of the population and also a relatively big improvement in the demographic structure (resulting from a very unfavourable starting position in 2010). The least significant variation in the rate of the development of the human capital impacting factor was noted in the areas: Oost-Zuid-Holland (NL), Etelä-Savo (FI) and Kymenlaakso (FI). The weaker position of the indicated NUTS-3 level units in the research on the change in the level of the development of human capital was influenced by: the falling birth rate, the increasing indicator of the demographic burden, and the significant deepening of the negative migration balance.

Regarding the factors impacting the condition of the environment, the highest value of the synthetic measure in 2019 was observed in the areas: Hautes-Alpes (FR), Savoie (FR) and Primorsko-notranjska (SL), and the lowest in Florina (EL), Seine-Saint-Denis (FR) and Darlington (UK). The position within the ranking of the NUTS-3

units was decided by: the number of accommodation places per 1,000 inhabitants, a significant share of land used for farming and the green spaces in the area in total, as well as the low share of road transport of goods. A high position within the ranking within the natural environment, involved tourist areas, located among others in South and Central France, in the Alpine region, in Austria, in Northern and Central Italy, on the Black Sea coast, by the Polish coast of the Baltic Sea and on the Mediterranean islands. A low ranking position was decided by: a low share of the area of farming land and the green spare in the area in total, a high number of offences and crimes connected with the natural environment per 1,000 inhabitants, and a heavy burden connected with road transport of products. When considering the dynamic development, the biggest improvement in the natural environment in 2010-2019 was observed in the following subregions: Norrbottens län (SE), Kerkyra (EL) and Außerfern (AT), and the lowest in Florina (EL), Menorca (ES) and Ithaki, and Kefallinia (EL). The lowest position of the studied subregions was decided by: an increase in urban waste generated per 1 inhabitant, a decrease in accommodation places, and an increase in electrical energy for cooling the living quarters. A high position within the ranking of the respective units was decided by: a decrease in the nuisance of road transport of products, a high increase in the share of the natural green areas in the total area (the biggest improvement was observed in the Austrian subregion of Außerfern), as well as a significant increase in the share of the treated waste.

Regarding the rate of development of the economy, the highest value of the synthetic measure in 2019 was observed in the British subregion forming part of the Inner London: Camden and the City of London and Westminster, as well as in Luxembourg (LU) – these NUTS-3 units showed the biggest number of patents registered per 1 mln inhabitants, the biggest share of the employed in the financial sector in the total number of the employed, as well as the biggest GDP per 1 inhabitant. The lowest value of the synthetic measure was observed in the following units: Vaslui (RO), Kardzhali (BG) and Razgrad (BG) (the biggest share of the employed in farming, the lowest number of patents per 1 mln inhabitants, as well as a very low GDP per capita). Thus the highest value of the synthetic measure within the scope of the economy was observed in the subregions located within the belt extending from the British capital region , through Benelux, South-West Germany, up to the Alpine region. The value of the measure decreased together with the increasing distance from the abovementioned area of the development of the economic level. For the dynamic set, the biggest improvement of the economy subcomponent in 2010-2019 was registered in: Camden and City of London (UK), Malta (MT) and Westminster (UK), and the lowest in the subregions of Pieriga (LV), Bratislavský kraj (SK) and Zemgale (LV). The position within the ranking of the NUTS-3 units in the dynamic version of the research was decided by: the percentage of the professional service sector employees in the general workforce, the share of the employed in the financial sector in the total number of the employed, an increase in the number of registered patents per 1 mln inhabitants, as well as the share of the employed in the information sector and in the communication sector in the total

number of the employed. Interestingly, in the group of the subregions in which the biggest increase in the economy subcomponent was registered, there was a majority of Romanian, Hungarian, Lithuanian, Estonian and Croatian units. Moreover, it is worth noting that the value of the synthetic measure within the economy reflects to a large extent the level of the general social and economic development of the EU areas under study.

5. Discussion – the overall level of the socio-economic development of the NUTS-3 regions in the EU member states

Summarising the results of the research conducted on the rate of the social and economic development of all 1,347 NUTS-3 areas in the EU countries, the following general remarks can be made. The rate of the overall development in 2019 was characterised according to 31 indicators subcategorised as the three indicative factors of the development: human capital, the natural environment, and the economy. The most significant indicative factor of the synthetic measure was registered in the subregions comprising the capitals of the respective countries: Camden and the City of London (UK), Westminster (UK) and Tower Hamlets (UK) as parts of London, Luxembourg (LU), Dublin (IE) and Groot-Amsterdam (NL). The statement to be verified, given at the start of the article, was confirmed. What is more, in the first thirty of the best developed NUTS-3 subregions in the European Union, 16 capital units were found – comprising the capitals of 11 countries (six units were parts of London), and the group of 20% of the best developed subregions numbered 22 out of 28 units, including the capitals of the respective EU countries (constituting 79% of their population). Including the dynamic compilation, the biggest improvement of the socio-economic development in 2010-2019 was observed in the following subregions: Norrbottens län (SE), Außerfern (AT) and Cluj (RO). Among the capital subregions, the top thirty places in the ranking were: Bucuresti (6th), Camden and the City of London (8th), Vilniaus apskritis (9th), Põhja-Eesti (17th position) and Luxembourg (30th). The group of 20% of the subregions demonstrating the biggest change in the level of the socio-economic development included 15 out of 28 subregions including the capitals of the respective EU countries (i.e. 54% of all the capital regions). Apart from those previously mentioned, the group also included: Warsaw (42th position in the ranking), Berlin (45th), Malta (60th), Sofia (64th), Dublin (83th), Stockholms län (92th), Grad Zagreb (93th), Groot-Amsterdam (97th), Área Metropolitana de Lisboa (162th) and Madrid (244th). The first half of the compilation also included Budapest (450the), Osrednjeslovenska (470th) and Hlavní mesto Praha (609th). Lowest positions among the capitals were taken by: Rome, Byen København, Arr. de Bruxelles-Capitale, Athens and Bratislavský kraj (1167th, 1196th, 1262th, 1304th and 1342th, respectively). Remarkably, the areas exhibiting a very high level of social and economic development were usually those units which experienced the biggest change in the rate of their development in 2010-2019 (and conversely). Apart from the capitals indicated, a group of the subregions of the

highest level of the development in 2019 included among others, units located in a belt extending from Ireland, through Central England, Benelux, Western and Southern Germany up to the Alpine regions (i.e. an area similar to the units characterised by the highest level of development of the economy), as well as the Danish, Southern Swedish and French-Italian border subregions. The group of units of the most significant alteration of the level of socio-economic development – outside of the capitals – included above all the subregions from the areas with a weaker level of socio-economic development in 2010, and which within the last 10 years made up for the developmental discrepancies and effectively caught up with the richer regions in terms of the level of the development (mainly the Romanian, Hungarian, Croatian and the Baltic states' regions). Conversly, the regions with the lowest rate of socio-economic development were the NUTS-3 units located on the outskirts and also away from the most advanced areas, including, most notably, the NUTS-3 units in Greece, Southern Italy, and the furthest overseas departments and dependent units, such as: Martinique, Guadeloupe, French Guyana, Ciudad de Melilla, Ciudad de Ceuta, the Azores and Madeira. One may thus conclude that – on the one hand – the current level of development of the respective subregions of the EU member states to a large extent depends on the means of activities undertaken within the last ten years, while on the other hand – the increasingly higher developmental discrepancies of the NUTS-3 subregions are noted. To the greatest extent, this applies to the level of socio-economic development in the economically strongest regions, being mostly capital subregions of the respective countries, and to the least extent – to the relatively weaker developed subregions, usually located away from the socio-economic centre of Europe, within the belt extending from London, through Benelux, up to the Alpine regions. Large developmental discrepancies may also be observed in the respective countries. In the examined areas of each subregion, there were regions both exhibiting a very high level of socio-economic development, and the units classified into the group of the 20% of the least developed NUTS-3 units in the respective states.

The conducted research analysis is specific to the related studies, and it was not possible to find another publication in which the level of the regional development of the EU was first of all conducted in a synthetic manner for all the 28 EU member states on the level of all 1,347 NUTS-3 subregions, and secondly, where a synthetic measure of development was used for that purpose prepared on the basis of Hellwig's data reduction procedure. The statements of other authors researching regional development in the EU, who use other procedures, are however similar. They also indicate the largest intensity of development of the capital regions, while the level of development usually decreases together with the distance from the most important regions. Similarly, analyses concerning the NUTS-2 unit regions by Eurostat, based on GDP per capita, classify the capital units among the richest regions. The abovementioned compilation thus validates the appropriateness of the achieved final criteria – the applied procedure notwithstanding – classifying a specific area into a more or less developed group in a correct manner.

Conclusions

To summarise, it is worth looking into the results relating to the respective countries (Table 4). The rate of the social and economic development varied greatly also in the respective countries, as shown in Table 4 (apart from the countries in

Table 4

The most and least advanced NUTS-3 subregions in the EU member states in 2019

Country	The most developed NUTS-3 region			The least developed NUTS-3 region		
	The name of the region	Value	Place	The name of the region	Value	Place
Belgium	Arr. de Bruxelles-Capitale	0.359	15	Arr. Veurne	0.309	737
Bulgaria	Sofia (stolitsa)	0.326	254	Vidin	0.256	1342
Czech Rep.	Hlavní mesto Praha	0.335	119	Karlovarský kraj	0.299	1021
Denmark	Byen København	0.352	26	Bornholm	0.292	1148
Germany	München, Landkreis	0.372	8	Esslingen	0.194	1347
Estonia	*Põhja-Eesti*	*0.353*	*23*	*Kirde-Eesti*	*0.309*	*738*
Ireland	Dublin	0.379	5	Mid-West	0.324	294
Greece	Andros, Thira, Kea, Milos…	0.320	391	Florina	0.217	1344
Spain	Girona	0.330	177	Ourense	0.267	1332
France	Hauts-de-Seine	0.352	24	Creuse	0.283	1261
Croatia	Grad Zagreb	0.321	370	Vukovarsko-srijemska zupanija	0.276	1307
Italy	Bolzano-Bozen	0.335	118	Medio Campidano	0.270	1324
Cyprus	*Kypros*	*0.338*	*90*	*Kypros*	*0.338*	*90*
Latvia	*Pieriga*	*0.315*	*552*	*Latgale*	*0.283*	*1268*
Lithuania	Vilniaus apskritis	0.328	217	Utenos apskritis	0.277	1305
Luxembourg	*Luxembourg*	*0.423*	*3*	*Luxembourg*	*0.423*	*3*
Hungary	Budapest	0.325	286	Békés	0.292	1142
Malta	*Malta*	*0.354*	*21*	*Gozo and Comino*	*0.313*	*592*
Netherlands	Groot-Amsterdam	0.378	6	Oost-Groningen	0.293	1124
Austria	Salzburg und Umgebung	0.349	34	Südburgenland	0.295	1079
Poland	Miasto Warszawa	0.364	9	Sandomiersko-jedrzejowski	0.291	1169
Portugal	Área Metropolitana de Lisboa	0.319	426	Alto Tâmega	0.262	1340
Romania	Ilfov	0.329	195	Teleorman	0.270	1325
Slovenia	Osrednjeslovenska	0.345	47	Pomurska	0.302	930
Slovakia	Bratislavský kraj	0.341	64	Trenciansky kraj	0.301	972
Finland	Helsinki-Uusimaa	0.343	53	Etelä-Savo	0.266	1333
Sweden	Stockholms län	0.359	12	Norrbottens län	0.294	1109
the UK	Camden and City of London	0.518	1	Eilean Siar (Western Isles)	0.289	1195

Notes: *italics* – countries in which only one or two NUTS-3 subregions are separate.

Source: own research.

Table 5

Average values of the synthetic measure in the subregions of the researched countries

Item	Belgium	Bulgaria	Czech Rep.	Denmark	Germany	Estonia	Ireland	Greece	Spain	France	Croatia	Italy	Cyprus	Latvia
Number of NUTS-3 subregions	44	28	14	11	401	5	8	52	59	101	21	110	1	6
The level of development in 2019														
General - the average value of the synthetic measure	0.323	0.283	0.307	0.323	0.313	0.320	0.338	0.287	0.304	0.316	0.292	0.298	0.338	0.297
Human capital - the average value of the synthetic measure	0.500	0.460	0.501	0.494	0.468	0.495	**0.549**	0.455	0.462	0.495	0.461	0.439	0.518	0.486
The natural environment - the average value of the measure	0.416	0.418	0.427	0.405	0.418	0.422	0.408	0.422	0.432	0.441	0.419	0.434	0.385	0.413
The economy - the average value of the synthetic measure	0.111	0.049	0.070	0.119	0.109	0.103	0.114	0.060	0.087	0.087	0.066	0.089	0.145	0.065
Transforming rate of development in 2010-2019														
General - the average value of the synthetic measure	0.320	0.321	0.316	0.318	0.324	0.340	0.320	0.310	0.322	0.320	0.326	0.315	0.321	0.292
Human capital - the average value of the synthetic measure	0.485	0.496	0.482	0.487	**0.531**	0.485	0.522	0.477	0.494	0.464	0.469	0.467	0.450	0.521
The natural environment - the average value of the measure	0.296	0.302	0.290	0.295	0.292	**0.316**	0.288	0.299	0.301	0.303	0.295	0.307	0.291	0.307
The economy - the average value of the synthetic measure	0.290	0.283	0.287	0.286	0.290	0.314	0.286	0.268	0.286	0.290	0.307	0.273	0.305	0.214

Item	Lithuania	Luxembourg	Hungary	Malta	Netherlands	Austria	Poland	Portugal	Romania	Slovenia	Slovakia	Finland	Sweden	the UK	EU
Number of NUTS-3 subregions	10	1	20	2	39	35	73	25	42	12	8	19	21	179	1347
The level of development in 2019															
General - the average value of the synthetic measure	0.293	**0.423**	0.305	0.334	0.330	0.321	0.312	0.287	0.298	0.322	0.313	0.298	0.316	0.324	0.311
Human capital - the average value of the synthetic measure	0.476	0.520	0.488	0.499	0.490	0.483	0.498	0.444	0.493	0.489	0.509	0.455	0.499	0.510	0.479
The natural environment - the average value of the measure	0.414	0.415	0.420	0.419	0.407	0.451	0.424	0.423	0.423	**0.479**	0.411	0.402	0.402	0.402	0.421
The economy - the average value of the synthetic measure	0.062	**0.329**	0.077	0.134	0.138	0.102	0.082	0.066	0.056	0.088	0.084	0.093	0.101	0.113	0.096
Transforming rate of development in 2010-2019															
General - the average value of the synthetic measure	0.337	**0.345**	0.343	0.326	0.315	0.321	0.319	0.325	0.338	0.319	0.292	0.310	0.328	0.320	0.321
Human capital - the average value of the synthetic measure	0.455	0.507	0.508	0.468	0.465	0.509	0.485	0.487	0.462	0.488	0.499	0.416	0.510	0.492	0.496
The natural environment - the average value of the measure	0.307	0.292	0.308	0.267	0.305	0.304	0.300	0.307	0.304	0.308	0.301	0.315	0.299	0.293	0.298
The economy - the average value of the synthetic measure	0.324	**0.342**	0.323	0.332	0.277	0.277	0.283	0.289	0.327	0.277	0.223	0.272	0.297	0.289	0.287

Source: own research.

which only one or two NUTS-3 subregions are separate, i.e. Cyprus, Luxembourg and Malta). The biggest developmental discrepancies measured by the value of the synthetic measure were registered in Great Britain. The largest discrepancies in socio-economic development measured by the position within the ranking of the best developed subregions were observed in Germany. The countries with a strong variation in the level of socio-economic development were: Greece, Italy, the Netherlands, France, Poland, Spain, Finland, Bulgaria and Romania, whose capitals mostly counted as 20% of the best developed subregions, and numerous NUTS-3 units were found in the last positions of the ranking. Taking into account the value of the synthetic measure, as well as the position of the respective NUTS-3 subregions within the ranking, the countries showing the lowest developmental discrepancies were: Ireland, Estonia, Latvia and Belgium.

In the results discussed here, the most commonly mentioned were the German, British and French subregions, therefore one may have an illusion that those features are the best (the least) developed. However, a higher frequency of the occurrence of the subregions from those countries results from the fact that in Germany there were 401 NUTS-3 units (30% among all those under study), in the United Kingdom – 179 subregions (13% of the researched group), and in France – 101 units (7%). This is related to the assumption that a NUTS-3 subregion must number – apart from certain extraordinary circumstances – at least 150,000 inhabitants, and at most 800,000 inhabitants, thus the majority of such units were created in the most densely populated EU states, and vice-versa.

Table 5 shows a different attitude to the specification of the level of development from the perspective of the respective countries. The level of socio-economic development was presented, as well as the changes in the NUTS-3 unit subregions of the EU member states, taking account of the average values of the synthetic measure of all the subregions in a particular country. The highest average value of the synthetic measure of the general level of socio-economic development and its changes, as well as the 'economy' subcomponent was registered in Luxembourg. This stems from the fact, however, that in Luxembourg only one NUTS-3 subregion was subcategorized, which at the same time is the third most developed EU subregion. Among the countries in which at least three NUTS-3 units were subcategorised, the highest average value of the synthetic measure of the general level of socio-economic development was registered were Ireland, the Netherlands, the United Kingdom, Denmark and Belgium, while the highest average of the synthetic measure of the changes of the rate of development was observed in Hungary, Romania and Estonia. The highest level of development of the 'human capital' component in 2019 was registered in Ireland, and the biggest change of the subcomponent in the period 2010-2019 was observed in the German subregions. The most significant value of the synthetic measure within the 'economy' subcomponent, among the member states of at least three NUTS-3 subregions in the static dimension, was observed in the Netherlands, and in the dynamic dimension – in Romania. Within the natural

environment, the highest value of the synthetic measure in the static dimension was registered in Slovenia, and the biggest improvement of the state of the environment in 2010-2019 was observed in Estonia. To sum up, it could be thus stated that in the analysis of the respective NUTS-3 subregions, dominated German, British and French units due to their largest number. Taking account of the average value of the respective synthetic measures, the best results were registered for Irish, Dutch and Romanian regions. The abovementioned considerations, the conducted research and the final figures arrived at, may therefore be a stimulus for further studies, including those of future development and shaping the cohesion policy at the subsequent stages.

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