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SMART SPECIALISATION, CREATIVITY AND INNOVATION AS THE BASIS FOR THE CONSTRUCTION OF THE HARMONIOUS GROWTH PATH OF THE EUROPEAN UNION MEMBER STATES[*]

Abstract

The purpose of the paper is to construct harmonious development paths for the countries of the EU by applying the apparatus of multidimensional statistical analysis for pillars facilitating smart growth assessment. The three pillars of smart growth are smart specialisation, creativity and innovation. Numerous indicators allowing for their quantification were defined, which allowed for the construction of aggregate measures on each smart growth pillar, with linear arrangement and assessment of changes occurring in the European Union countries to follow. The concept of harmonious smart growth was illustrated as the balance present between smart specialisation development, creativity and innovation. The path of harmonious smart growth was constructed and an individual growth benchmark for each EU member state was identified. The analysis covered the year 2011.

Keywords: smart growth, harmonious development path, smart specialisation, creativity, innovation.

1. Introduction

The importance of traditional competition factors for European Union member states has fallen significantly and therefore the intensification of activities focused on implementing modern growth potential, such as smart specialisation, creativity

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and innovation, have become necessary. In response to this challenge the European Union in 2010 adopted the Growth Strategy Europe 2020 (*Europe 2020 Strategy...* 2010), identifying the objectives for helping member states not only to overcome the economic crisis successfully, but also to ensure smart, sustainable growth enhancing social inclusion. Smart growth defined in the EU development strategy for the period 2010–2020 identifies the larger role of knowledge and innovation as the driving forces of future development. Smart growth is stimulated by more effective investments in education, research and innovation. The concept of smart growth refers to numerous former theoretical concepts and models of regional growth, for example: regional innovation systems (Cooke *et al.* 1997), innovation environments – *milieu innovateur*, learning regions (Florida 1995, Morgan 1997) and innovation clusters (Porter 1998).

The idea of a harmonious growth path can be used in the construction of smart growth programming by assuming that the balance between smart growth pillars constitutes one of the basic determinants responsible for its stability and durability[1]. The purpose of the paper is to construct harmonious growth paths for EU countries by applying the apparatus of multivariate statistical analysis for the pillars facilitating the assessment of smart growth. The following three pillars of smart growth have been identified: smart specialisation, creativity and innovation. Additionally, numerous indicators allowing for their quantification have also been defined, and allowed for the construction of aggregate measures on each smart growth pillar with linear arrangement, identifying the individual growth models and the construction of the smart growth harmonious path for the European Union member states.

2. The Concept of Smart Growth Harmony

The concept of smart growth harmony[2] was illustrated as the balance present between smart specialisation growth, creativity and innovation. It was accepted that internal balance means preserving an equal distance between aggregate measures quantifying the level of particular smart growth pillar development in a given country and values of these measures for the benchmark region. The following pillars of smart development constitute the basis for the construction of a harmonious growth path for EU countries by applying multivariate statistical analysis methods:

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[1] The proposals for the construction of harmonious (optimal or proportional) growth paths are discussed, among others, in the studies by S. Bartosiewicz (1976) and D. Strahl (1982, 1992, 2010).

[2] The concept of harmonious development of regional innovation developed by D. Strahl (2010) has been modified in this study.

– pillar I – smart specialisation,
– pillar II – creativity,
– pillar III – innovation.

Each smart growth pillar represents a complex phenomenon observed based on objects-countries and described by means of the selected diagnostic characteristics. Aggregate measures were applied in order to quantify and measure the three smart measures. The construction of aggregate measures was preceded by the normalisation of diagnostic characteristics constituting the identifiers of growth referring to the particular smart growth pillars.

Normalisation with zero minimum[3], expressed by formulas (1) and (2) for stimulant and destimulant characteristics respectively, was applied to normalise the smart growth identifiers.

$$z_{ij} = \frac{x_{ij} - \min_i x_{ij}}{\max_i x_{ij} - \min_i x_{ij}}, \tag{1}$$

$$z_{ij} = \frac{\max_i x_{ij} - x_{ij}}{\max_i x_{ij} - \min_i x_{ij}}, \tag{2}$$

where:

z_{ij} is a normalised value of j-th identifier in i-th country,
x_{ij} is the value of j-th identifier in i-th country.

The method of averaged standardised sum was used as the aggregating function for normalised values of the diagnostic characteristics describing the smart growth pillars:

$$SM_i = \frac{1}{m} \sum_{j=1}^{m} z_{ij}, \tag{3}$$

where m is the number of diagnostic characteristics describing a particular complex phenomenon (smart growth pillar).

An aggregate model of smart growth i-th object takes the following form:

$$RI_i = [SMIS_i, SMK_i, SMI_i], \tag{4}$$

where:

$i = 1, 2,…, N$ is the number of an object-country,
$SMIS_i$ is an aggregate measure of smart specialisation,
SMK_i is an aggregate measure of creativity,
SMI_i is an aggregate measure of innovation.

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[3] See (Kukuła 2000, pp. 79, 90).

An object-country presents the state of internal balance if the following relation occurs:

$$SMIS_i = SMK_i = SMI_i. \tag{5}$$

The smart growth identifiers normalised by applying normalisation with the zero minimum method take values in the range of [0, 1] and therefore aggregate measures for particular pillars of smart growth are characterised by the following property:

$$SMIS_i, SMK_i, SMI_i \notin [0, 1]. \tag{6}$$

Therefore, the global benchmark of smart growth and the leading element on the harmonious growth path of the objects being studied is represented by the following point:

$$P_o^1 = [1, 1, 1]. \tag{7}$$

The path of harmonious growth is illustrated by a straight line crossing the following points:

$$P_o^0 = [0, 0, 0]. \tag{8}$$

$$P_o^1 = [1, 1, 1]. \tag{9}$$

Placing an i-th object on the path of harmonious smart growth consists in specifying an individual benchmark of smart growth in line with the following formula:

$$z_i^* = \max(SMIS_i, SMIK_i, SMI_i). \tag{10}$$

A smart growth pillar characterised by the maximum aggregate measure value is the leading one in a given EU country.

The internal balance measure of i-th object-country is an average difference of the following aggregate measure values: smart specialisation, creativity and innovation:

$$MRW_i = \frac{1}{3}\left(|SMIS_i - SMK_i| + |SMIS_i - SMI_i| + |SMK_i - SMI_i|\right). \tag{11}$$

The moment in which an object reaches the state of complete equilibrium between smart growth pillars (internal balance measure equals zero) represents the moment of harmonious smart growth.

3. The Information Basis and Stages of the Research

The statistical information indispensable for the construction of the smart growth harmonious path in the European Union space come from the Eurostat database. The study included 27 EU member states while the time range of the research covered 2011.

The following research procedure was applied:

1. The indicators for smart growth pillars were selected.

2. The aggregate measures for the EU countries' smart specialisation, creativity and innovation growth in 2011 were constructed.

3. The harmonious smart growth path of the EU states in 2011 was constructed by identifying:

– the individual benchmarks of smart growth for the EU member states,

– the leading pillars of smart growth,

4. The possibilities for carrying out the harmonious smart growth were identified, as was the construction of the EU states' internal balance measures.

For the purposes of the study smart growth is, again, a complex phenomenon based on three pillars defined as smart specialisation, creativity and innovation.

Smart specialisation concerns the role of the high and medium technology sector in the employment structure. Creativity emphasises the quality of human capital and readiness to improve qualifications. Innovation here refers to the amount of R&D funds invested in the region, as well as the effects of innovation activities in the form of registered patent applications.

The following identifiers were used for the level assessment of smart specialisation, creativity and innovation growth in the EU states:

1) pillar I – smart specialisation:

HMHTM – employment in high and medium high-technology manufacturing as a share of total employment (in %),

KIS – employment in knowledge-intensive services as a share of total employment (in %);

2) pillar II – creativity:

TETR – tertiary education employment as the a of total employment (in %),

LLL – life-long learning of population aged 25–64 as a share of the total population (in %),

HRST – human resources in science and technology, employment in occupations related to the creation, development, dissemination and application of scientific and technical knowledge as a share of total employment (in %);

3) pillar III – innovation:

GOERD – gross domestic expenditure on R&D as a percentage of GDP,

BEERD – business enterprise expenditure on R&D as a percentage of GDP,

EPO – number of patent applications in the *European Patent* per 1 mln of employment.

The selection of smart growth identifiers was of a substantive nature and also to a great extent determined by the availability of statistical data.

4. Harmonious Smart Growth Path of the European Union Countries in 2011 – The Results of Empirical Research

Table 1 presents the values of aggregate measures for smart specialisation, creativity and innovation growth in the European Union countries in 2011, the ranking of countries and individual values of smart growth models.

Germany, The Czech Republic and Sweden exhibited the highest level of smart specialisation growth, while Finland, Denmark and Luxembourg were the most creative and Germany, Finland and Sweden showed the highest level of innovation. The states showing the least smart specialisation were Romania, Latvia, and Cyprus; Romania, Italy and Portugal illustrated the least creativity; and Malta, Cyprus and Greece showed the lowest level of innovation. Poland ranked 18th for growth in each of the three distinguished smart growth pillars.

Fig. 1, which presents aggregate measures arranged by the decreasing values of individual smart growth models, also illustrates the disproportions occurring between the particular pillars of smart growth in the EU member states. As one can observe, these countries present a distinctive diversification of both intra- and inter-regional smart specialisation and innovation growth.

Table 2 shows the basic descriptive parameters of aggregate measures on the growth of particular pillars, allowing for the detailed assessment of their distribution. The highest variation measured by the range and variation coefficient was characteristic for the EU countries in terms of innovation pillar (range 0.7486, variation coefficient 55.45%), followed by the creativity pillar (range 0.6636, variation coefficient 28.52%) and the smart specialisation pillar (range 0.5286, variation coefficient 25.40%). The lowest value of aggregate measure was recorded in 2011 in Malta for the innovation pillar (as low as 0.0793). Germany had the highest value of aggregate measure – 0.8279 – which it scored for the innovation pillar.

The median of aggregate measure values for the EU states proved similar for creativity and smart specialisation (0.5436 and 0.5131 respectively), while a slightly lower median value was characteristic for the innovation pillar (0,3169).

Aggregate measures of smart specialisation and creativity presented moderate left skewness, while the states featuring measure values higher than the median predominated. The skewness coefficient specified for innovation aggregate

Table 1

Aggregate Measure Values of Smart Specialisation, Creativity and Innovation
in 2011 in the EU Countries by Decreasing Values of Individual Smart Growth Models

Country	Aggregate measure of smart specialisation		Aggregate measure of creativity		Aggregate measure of innovation		Individual smart growth benchmark
	Value	Position	Value	Position	Value	Position	Value
Germany	0.7611	1	0.4808	15	0.8279	1	0.8279
Finland	0.6725	4	0.8095	1	0.8121	2	0.8121
Denmark	0.6539	5	0.7968	2	0.5528	6	0.7968
Luxembourg	0.4768	17	0.7735	3	0.5269	7	0.7735
Sweden	0.6731	3	0.7663	4	0.7215	3	0.7663
United Kingdom	0.5646	11	0.7074	5	0.3299	13	0.7074
Czech Republic	0.6952	2	0.3685	19	0.4063	11	0.6952
Netherlands	0.5532	12	0.6529	6	0.4868	9	0.6529
Ireland	0.5131	14	0.6518	7	0.2773	16	0.6518
Estonia	0.3685	20	0.6438	8	0.3654	12	0.6438
Belgium	0.6227	7	0.6391	9	0.4386	10	0.6391
Slovakia	0.6386	6	0.2871	24	0.1755	20	0.6386
Cyprus	0.2642	25	0.6204	10	0.0804	26	0.6204
Slovenia	0.5901	8	0.5456	13	0.5782	5	0.5901
France	0.5880	9	0.5436	14	0.5843	4	0.5880
Lithuania	0.2927	23	0.5825	11	0.1668	23	0.5825
Hungary	0.5824	10	0.3257	21	0.2568	17	0.5824
Spain	0.3982	19	0.5779	12	0.3169	14	0.5779
Italy	0.5457	13	0.2705	26	0.2943	15	0.5457
Austria	0.4831	15	0.4162	17	0.5211	8	0.5211
Malta	0.4797	16	0.3204	22	0.0793	27	0.4797
Latvia	0.2600	26	0.4461	16	0.1505	24	0.4461
Poland	0.4014	18	0.3868	18	0.2330	18	0.4014
Greece	0.2821	24	0.3499	20	0.1243	25	0.3499
Portugal	0.3230	21	0.2823	25	0.1673	22	0.3230
Bulgaria	0.3153	22	0.3109	23	0.1838	19	0.3153
Romania	0.2325	27	0.1459	27	0.1695	21	0.2325

Source: ahe author's compilation based on Eurostat database.

measures showed a slight right skewness. The highest skewness intensity of aggregate measure values occurred for creativity while the lowest occurred for innovation.
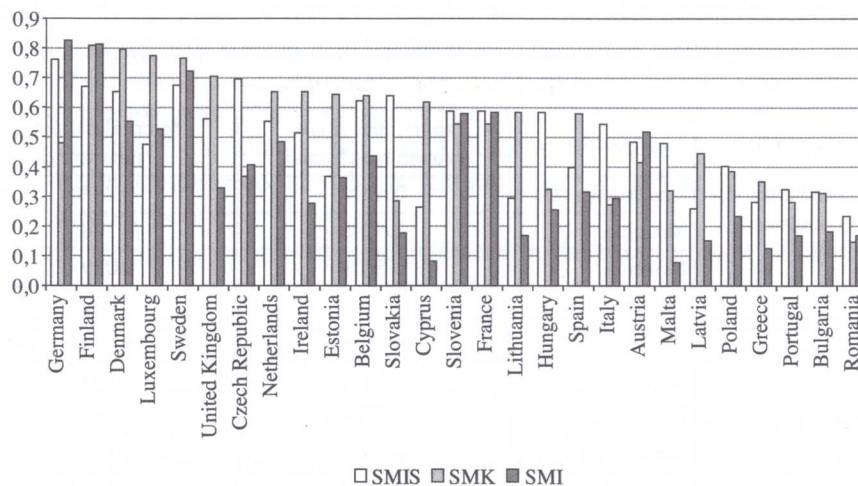

Fig. 1. Aggregate Measure Values of Smart Specialisation (SMIS), Creativity (SMK) and Innovation (SMI) in 2011 in the EU Countries by the Decreasing Values of Individual Smart Growth Models

Source: the author's compilation based on the data presented in Table 1.

Table 2

The Descriptive Parameters of Aggregate Measures for Smart Specialisation, Creativity and Innovation of the EU Countries in 2011

Descriptive parameters	Aggregate measures		
	Smart specialisation	Creativity	Innovation
Min	0.2325	0.1459	0.0793
Max	0.7611	0.8095	0.8279
Range	0.5286	0.6636	0.7486
Median	0.5131	0.5436	0.3169
Quartile variation coefficient (%)	25.40	28.52	55.45
Skewness coefficient based on quartiles	−0.2837	−0.3277	0.1782

Source: the author's compilation based on the data presented in Table 1.

Table 3 shows the classification of EU countries regarding the leading pillar type, the values of individual growth models and internal balance measures of

particular pillars. Within the framework of each of the distinguished groups the EU countries were arranged by decreasing values of the individual growth models.

Table 3

The Leading Pillars, Individual Growth Models and Internal Balance Measures in the EU Countries in 2011

Leading pillar	Country	Individual smart growth benchmark	Internal balance measure
Smart specialisation 11 EU countries	Czech Republic	0.6952	0.2178
	Slovakia	0.6386	0.3088
	Slovenia	0.5901	0.0297
	France	0.5880	0.0296
	Hungary	0.5824	0.2171
	Italy	0.5457	0.1834
	Malta	0.4797	0.2670
	Poland	0.4014	0.1123
	Portugal	0.3230	0.1038
	Bulgaria	0.3153	0.0877
	Romania	0.2325	0.0577
Creativity 13 EU countries	Denmark	0.7968	0.1626
	Luxembourg	0.7735	0.1978
	Sweden	0.7663	0.0621
	United Kingdom	0.7074	0.2517
	Netherlands	0.6529	0.1108
	Ireland	0.6518	0.2497
	Estonia	0.6438	0.1855
	Belgium	0.6391	0.1336
	Cyprus	0.6204	0.3600
	Lithuania	0.5825	0.2771
	Spain	0.5779	0.1740
	Latvia	0.4461	0.1971
	Greece	0.3499	0.1504
Innovation 3 EU countries	Germany	0.8279	0.2314
	Finland	0.8121	0.0930
	Austria	0.5211	0.0700

Source: author's compilation based on data presented in Table 1.

As the analysis of information presented in Table 3 indicates, innovation was the leading pillar of smart growth for only three countries – Germany, Finland, and Austria. In case of Germany and Finland the values of innovation growth measures exceeded those of aggregate measures defined for all smart growth pillars of all the other countries. Additionally, they also exceeded, by far, the median value specified for this pillar (median 0.3169).

Creativity was the leading pillar of smart growth for thirteen countries. With reference to eleven countries included in this group the value of aggregate measure was higher than the median value of 0.5436. Denmark, Luxembourg, Sweden and Great Britain demonstrated the highest level of creativity, while Greece and Latvia clearly showed the worst.

Smart specialisation growth predominated in the smart growth of eleven EU member states, including Poland. In six of those countries the value of aggregate measure for smart specialisation growth exceeded the median values (median 0.5131). The Czech Republic and Slovakia exhibited the highest level of growth, while Romania, Bulgaria and Portugal came in lowest.

None of the twelve new EU accession countries demonstrated growing innovation. Creativity was the leading category for four of the twelve, and smart specialisation was the foremost pillar for the other eight.

The most harmonised smart growth, as expressed by the internal balance measure values (see formula 11), occurred in Romania (0.0577), Austria (0.0700), Bulgaria (0.0877) and Finland (0.0930) – the countries presenting an extensively diversified level of smart growth. The largest disproportions in the growth of particular pillars were observed in Cyprus (0.3600) and Slovakia (0.3088).

Table 4 presents deviations from the path of harmonious growth specified for each EU country by means of differences between aggregate measure values of the leading pillar and the remaining smart growth pillars.

In the countries where smart specialisation constituted the leading pillar of smart growth the largest deviations from the harmonious growth path, exceeding the value of 0.3, were recorded for innovation growth in Slovakia (0.4631), Malta (0.4004) and Hungary (0.3256), and for creativity growth in Slovakia (0.3515) and The Czech Republic (0.3267). In the group of countries characterised foremost by growth in creativity the distinctive deviations from harmonious growth occurred in terms of delays in growing the innovation pillar in Cyprus (0.5400), Lithuania (0.4157), Great Britain (0.3775) and Ireland (0.3745) and Cyprus (0.3562) for the smart specialisation pillar. Among the countries featuring innovation growth foremost a significant delay in the growth of the creativity pillar was observed only in Germany. In this case the deviation from an individual smart growth model (aggregate measure of innovation growth) presented at a level of 0.3470.

Table 4

Deviations from the Path of Harmonious Smart Growth in 2011

Country	Deviations from the path of harmonious growth		
	Smart specialisation	Creativity	Innovation
Czech Republic	leading pillar	0.3267	0.2889
Slovakia	leading pillar	0.3515	0.4631
Slovenia	leading pillar	0.0445	0.0119
France	leading pillar	0.0444	0.0037
Hungary	leading pillar	0.2567	0.3256
Italy	leading pillar	0.2752	0.2514
Malta	leading pillar	0.1593	0.4004
Poland	leading pillar	0.0146	0.1684
Portugal	leading pillar	0.0407	0.1557
Bulgaria	leading pillar	0.0044	0.1315
Romania	leading pillar	0.0866	0.0630
Denmark	0.1429	leading pillar	0.2439
Luxembourg	0.2966	leading pillar	0.2466
Sweden	0.0931	leading pillar	0.0448
United Kingdom	0.1427	leading pillar	0.3775
Netherlands	0.0997	leading pillar	0.1661
Ireland	0.1387	leading pillar	0.3745
Estonia	0.2752	leading pillar	0.2783
Belgium	0.0164	leading pillar	0.2005
Cyprus	0.3562	leading pillar	0.5400
Lithuania	0.2898	leading pillar	0.4157
Spain	0.1797	leading pillar	0.2609
Latvia	0.1861	leading pillar	0.2956
Greece	0.0677	leading pillar	0.2255
Germany	0.0668	0.3470	leading pillar
Finland	0.1396	0.0026	leading pillar
Austria	0.0380	0.1049	leading pillar

Source: the author's compilation based on the data presented in Table 1.

Fig. 2 illustrates the ranking of the EU member states on the path of harmonious growth in 2011.
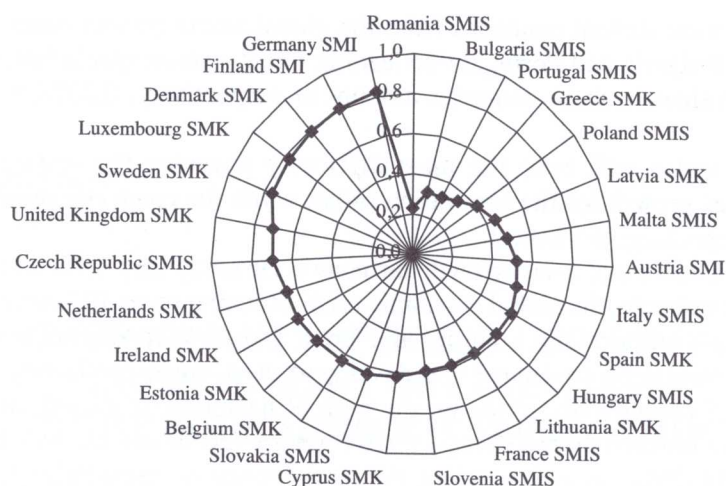
Fig. 2. The Path of Harmonious Smart Growth in the European Union Countries in 2011

Source: the author's compilation.

All this attests to the diversification of the EU countries in terms of individual smart growth models. As the lowest ranking states, Romania, Bulgaria and Portugal presented a relatively low level of socio-economic development, with smart specialisation their dominant growth pillar. Germany and Finland are the leaders in terms of innovation, while Denmark, Luxembourg and Sweden are ranked present the highest level of creativity growth. Poland ranks 23rd on the path of harmonious growth and features dominant growth in smart specialisation.

5. Conclusions

The conducted analysis and assessment of smart growth harmony in European Union countries leads to the following conclusions:

1. In 2011 the EU member states showed the greatest diversity in terms of the third smart growth pillar – innovation (55.45%), while the first pillar – smart specialisation – showed the least diversity (25.40%).

2. In 2011 creativity was the leading smart growth pillar in the majority of EU countries (13 EU).

3. Slovenia and France were characterised by the highest internal balance of smart growth, Cyprus and Slovakia the lowest.

4. Germany (the leading pillar – innovation SMI = 0.8279), Finland (the leading pillar – innovation SMI = 0.8121) and Denmark (the leading pillar – creativity SMK = 0.7968) are the countries closest to the global benchmark of smart growth.

5. The most distant countries from the global smart growth benchmark are Romania, Bulgaria and Portugal (the leading pillar – smart specialisation, SMIS indicator values in these countries amount to, respectively: 0.2325, 0.3153 and 0.3230).

6. EU states will have the most difficulty covering the distance to the harmonious growth for the innovation pillar, while the creativity pillar will be, relatively speaking, the easiest.

7. The guideline of smart growth harmony is currently very difficult to achieve due to, for example, the global economic crisis affecting many EU countries.

The study of harmony, stability and smart growth diversification in the EU countries should be continued and developed. It is worth conducting dynamic analyses of changes occurring on the path of harmonious growth in the time perspective covered by the *Europe 2020* Strategy (2010) and the new budgeting period 2014–2020, as well as refine the spatial range of research by performing analyses of smart growth harmony for NUTS 2 regions.

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