
Impact of EU Funds on the Level of Regional Socio-Economic Development: The Case of Poland*

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Abstract:

Purpose: The paper presents an investigation how the amount of EU funds invested in individual Polish regions contributed to a change in the socio-economic development level.

Design/Methodology/Approach: The study applied the zero unitarisation and five different methods of assigning weights to input variables. The TOPSIS method was applied to study the level of the socio-economic development in the regions, whereas the correlation between the amount of financial assistance received from the EU and the socio-economic development level was analysed by means of the Kendall rank correlation coefficient and p-value.

Findings: The results of the conducted research indicate that there was no relationship between the amount of subsidies received by individual regions and changing the position in the socio-economic development ranking in the years 2004-2018.

Practical Implications: The implementation of the proposed methodology of studying the impact of EU funds on regional socio-economic development could also be implemented in other EU member states, and that could serve as the basis for generating further conclusions, which will make it possible to focus EU resources on specific areas where they can bring desired outcomes.

Originality/Value: So far, we have not encountered any studies focused on analysing the relationship between the amounts of EU financial assistance and their impact on socio-economic development in such a broad perspective as we propose.

Keywords: Cohesion policy, regional policy, economic governance, social governance.

JEL codes: R11, P48, R12, F02.

Paper type: Research article.

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1. Introduction

Reduction in regional disparities is a major concern for governments in most countries, as large regional inequalities represent serious threats to the economic and political stability of a country (Shankar and Shah, 2009). The European Union (EU) provides grants to disadvantaged regions of member states to allow them to catch up with the EU average. NUTS2 regions with a per capita GDP level below 75% of the EU average (e.g., Poland, which is classified as “less developed”) qualify for structural funds transfers from the central EU budget (Becker *et al.*, 2010). What is particularly relevant in this context is that the cohesion policy has various social (fostering equality), political (honouring enlargement agreements) and economic (creating conditions that allow regions adversely affected by the single market to prosper) rationales. It also supports the EU’s inclusive, smart, green and sustainable development priorities. In the literature, there is no conclusion on the impact of the cohesion policy, partly because of major methodological and data complications (Mathieu-Collin *et al.*, 2019).

So far, studies were based on structural regional differences in per capita income, unemployment, and interregional migration (Abraham, 1996). Ferrer (2009) presented the milestones in the EU’s approach to the regional policy, and then GDP growth (annual average % change) by NUTS 2 regions in 1995 – 2004 and compared them with the EU27 average. Summing up his analyses, he confirmed a positive impact of structural funds on all the analysed regions. According to Shankar and Shah (2009), these policies have at best a mixed record of success. In their studies, they verified the approaches to reducing regional inequalities - free market vs. state intervention, and those reducing regional inequalities – centralised vs. decentralised approach, via reviewing the literature and analysing the research results in the context of those four aspects.

Becker *et al.* (2010) assessed the causal effect of per capita GDP growth of treated regions in the EU using a regression-discontinuity design for the programme evaluation. They studied the initiatives related to purchasing power parity (calculating the growth of GDP per capita as purchasing power parity) and the impact on employment, applying the aforementioned quasi-experimental design based on regression analysis. They found some effects on the GDP growth, but not on employment. Maynou, Saez, Kyriacou and Bacaria (2016) verified the impact of Structural and Cohesion Funds to the Gross Domestic Product per inhabitant growth of receiving regions (Maynou *et al.*, 2016). Di Cataldo and Monastiriotis have constructed a measure of specialisation (spending on one’s own area of advantage) and two measures of needs-effort misalignment (horizontal and vertical), they found clear evidence of a positive relationship between EU grants and regional growth in UK (Di Cataldo and Monastiriotis, 2020). Coppola, Destefanis, Marinuzzi and Tortorella analyzed the effects of cohesion policies on the gross domestic

product (GDP) per capita of the Italian administrative regions and found a positive impact of European Union funds (Coppola *et al.*, 2020).

Kyriacou and Roca-Sagalés (2012) examined the impact of the structural and cohesion funds on regional disparities within EU countries over the 1995-2006 period, employing the Feasible General Least Squares (FGLS) estimator. They also studied human capital based on the average years of schooling of the population aged 25 and over. Their results showed that the structural and cohesion funds helped to reduce regional disparities within EU member states during the 1994 - 1999 and 2000 - 2006 programming periods. Simultaneously they found that one cannot speak of a solid consensus in the empirical contributions, some studies report a positive impact on regional growth (Becker *et al.*, 2010a; Dall'erba 2005; Mohl and Hagen 2010; Ramajo *et al.*, 2008).

Others found no effects in terms of regional convergence (Esposti and Bussoletti, 2008; Dall'erba and Le Gallo, 2008). Still others found that structural spending improved the national economic convergence across the EU (Beugelsdijk and Eijffinger, 2005). Misiąg *et al.* (2013) in the study entitled *Ocena efektywności wykorzystania pomocy finansowej Unii Europejskiej jako instrumentu polityki spójności społeczno-gospodarczej oraz poprawy warunków życia* [Assessment of the effectiveness of utilisation of EU financial assistance as an instrument of the socio-economic cohesion policy and of life conditions improvement] examined the impact of the EU budget funds on the rate of GDP growth, the impact of EU funds on the indicator showing to what extent the main objective of the National Strategic Reference Framework had been achieved, and the impact of the EU budget funds on other socio-economic development indicators, demonstrating the level of diversification of the individual indicators in Poland (minimum, maximum and mean values were presented for each indicator) for the 2004 – 2011 period.

Tomova *et al.* (2013) relied on average socio-economic development indexes (SEDI) and government debt to potential GDP. According to Tomaszewicz (2014), the EU funds were to contribute to dynamic regional growth and high hopes were attached to them. The first studies based on the HERMIN model (applied to study the effects of structural funds on the basic macroeconomic indicators in the acceding countries) suggested that their impact on the economy would be considerable. In that study, the author presented the change of GDP per capita over time and concluded that the effects were much smaller than expected. Pieńkowski and Berkowitz (2015) analysed 23 studies regarding the Cohesion Policy growth effects, among which 20 were based on GDP growth per capita. They concluded that most studies showed a positive but small impact of EU structural funds on regional growth, especially in less developed regions. In her article regarding the impact of EU funds on business activity development, Szymańska (2017) presented the idea of the European

Social Fund and the objectives of the Integrated Regional Operational Programme. Fischer and Pfaffermayr (2018) examined the impact of migration on income growth among European NUTS 2 regions and found a positive effect on the average income convergence speeds within the European Union.

Dudzińska *et al.* (2018) studied the socio-economic development of rural areas within two Polish regions, applying 19 variables broken down into 4 categories: human capital, social, economic and environmental capital indicators characterising rural areas. Becker *et al.* (2018) considered the following outcomes: average annual PPP-adjusted GDP-per-capita growth, average annual employment growth, average annual total investment intensity (gross fixed capital formation relative to GDP) and average annual public investment intensity (gross fixed capital formation of the public sector relative to GDP).

Crescenzi shows the results of the analyzes according to which the sources of structural disadvantage are more spatially concentrated than the funds devoted to compensating this disadvantage and reveals a weak association between socio-economic disadvantage and European Union funding (Crescenzi, 2009). Mathieu-Collin *et al.* (2019) examined the effects of the cohesion policy and underlined that in addition to the effects of economic growth there were other important factors such as social inclusion and the environment protection. They analysed sample programmes of individual countries and their assumptions, estimating ‘unexplained economic growth’ by controlling for the influence of various region-specific factors and then analysing its relationship with about two dozen project-specific characteristics. They found a significant influence of:

- the initial level of GDP (PPS) per capita in 2003,
- the capital income ratio in 2003,
- the percentage of employment in the tertiary sector in 2003,
- the growth in population between 2000 and 2003,
- population density in 2003,
- quality of governance in 2010,
- the percentage of 25-64 year olds with tertiary education in 2003,
- R&D personnel as percentage of total employees in 2003, and
- the growth of tertiary sector employment in 2003 - 2015.

Other variables, which were tested, but were not significant, included:

- business demographics,
- health indicators,
- a model to establish whether a region is rural.

Mathieu-Collin *et al.* (2019) quoted more than 1,000 papers dealing with various aspects of effectiveness, convergence, inequality, governance and many others, however, most of them are limited to the theory, sometimes

indicating the amounts of the EU funds received by the individual regions. Crescenzi *et al.* (2020) concluded that EU funds mitigated the growing Euroscepticism across the European Union (EU) only where they were coupled by tangible improvements in local labour market conditions, the ultimate objective of this form of EU intervention.

Based on the analysis of the aforementioned studies, two major conclusions may be drawn. Firstly, the researchers addressing the impact of the EU funds often limited themselves to analysing a range of documents such as the structure and assumptions of individual policies and programmes. Secondly, most of the analyses focused on calculating only the value of GDP per capita and its change over time. It is understandable, as it may be coherent with the criterion of granting funds by the EU.

According to the authors of this article, the level of socio-economic development is a complex issue, therefore it should be studied using complex indicators that are adequate to a given region. In our opinion, even though Misiąg *et al.* (2013) applied an interesting set of variables in their analyses, their weakness is that each of them was analysed separately, without constructing an indicator or analysing the correlations between the level of the received financial assistance and the socio-economic development. Also, the approach taken by Dudzińska (2018) seems interesting, and it is the most coincident with ours (apart from the fact that it focuses on a group of typically rural indicators).

The purpose of this research study is to verify how the amount of EU funds invested in individual Polish regions (16 voivodeships) contributed to a change in the socio-economic development level. The analyses were made based on sixteen indicators covering the years 2004-2018, which provided us with a total of 3840 input data. The study applied the zero unitarisation method to standardise the values, five different methods of assigning weights to input variables (method of balanced level of priority of individual variables, method based on standard deviation of standardised variables, method based on entropy of variables, the CRITIC method and method of minimising the distance from the reference pattern).

The TOPSIS method was applied to study the level of the socio-economic development in the regions, whereas the correlation between the amount of financial assistance received from the EU and the socio-economic development level was analysed by means of the Kendall rank correlation coefficient and p-value. So far, we have not encountered any studies focused on analysing the relationship between the amounts of EU financial assistance and their impact on socio-economic development in such a broad perspective as we propose,

therefore, it is possible for us to assume that our work is innovative in this respect.

The rest of this paper is organised as follows: Section 2 is to explain the concept of regional development and the basic assumptions and development of the EU regional policy. Next, Section 3 describes the ways of interpreting the concept of regional socio-economic development as well as the measures used in its quantification. Section 4 contains a description of research methods applied by us, and Section 5 presents the results of our studies. In the final section, we conclude with a summary of our results and point to future research opportunities.

2. Regional Development and EU Regional Policies

Processes of socio-economic and regional development are quite often addressed in academic studies, strategies of local self-government units, or political speeches. They are of interdisciplinary nature and they are described by a host of definitions, the wording of which depends on the context and the area of science from which they derive. In order to refine the concept of regional socio-economic development, first it is necessary to quote the most relevant (in the context of this study) definitions of its individual constituents. The concept of a region as a research tool boils down to separating homogeneous areas where a certain feature or a set of features are observed, which are relevant from the point of view of the research problem in question (Chojnicki and Czyż, 1992). Dutkowski (2008) defined a region as an area that is distinctly different from the neighbouring ones in terms of the researched phenomenon or process, whereas Klasik (1974) specifies it as a historically developed, specific “whole” of a geographical, social and economic space, predicated on its own spatial structure. For the purposes of this study, an assumption was taken that a region is the highest territorial unit within the state. This concept is consistent with the EU policy that identifies regions in Poland with Polish (16) voivodeships (NUTS 2). Policies pursued at the regional level are aimed at ensuring a possibility of development and high living standard to the inhabitants (OECD Regional Outlook, 2016; 2016).

Although a regional policy is primarily a national responsibility, its transnational European dimension is justified by at least two important reasons. First of all, a regional policy should be conducted within the EU due to the fact that the level of social and economic development of individual member states varies greatly and that there are even greater disparities in development between their regions (seeking to reduce disparities in levels and opportunities for development on the European continent justifies the European dimension of a regional policy). The second reason pertains to the creation of a single European market in which the less developed regions are at a disadvantage and are not able to fully compete with the richer regions. Thus, the policy aims at

increasing the competitiveness of underdeveloped, underinvested or degraded regions (Obrębalski, 2012). Since its origin, the EU has paid close attention to social and economic cohesion (The evolution and impact of EU Regional and Rural Policy) to reduce (the EU) regional socio-economic imbalances.

Domański (2012) underlined that the EU regulations apply the principle that vital development processes take place at the regional level, therefore the EU earmarks a considerable part of its budget for regional development, and it also runs research projects on economic development of the regions. According to Rudnicki (2000), the EU regional policy is a thematically structured action introduced by the decision-making centre, which aims (through a set of legal and financial instruments) to remove disparities in the economic and social development of regions in the EU and to ensure sustainable growth of all its areas while maintaining its internal economic and social cohesion.

Głąbicka (2003) defined the European regional policy as a set of actions taken by the European Community's decision-making centre to reduce disparities in economic, social and spatial development and to achieve cohesion between the regions through redistribution of financial resources in the integrated Europe. At the beginning of the integration process, regional disparities and their adverse consequences on the political, economic, social and cultural spheres were recognised (Leszkiewicz, 2012). One of the most crucial issues addressed in the discussions about regions concerns convergence in the EU and whether this will lead to a reduction in disparities in the development of regions in the future, or whether polarisation processes will lead to permanent differentiation and even an increase in disparities. Elimination of developmental disproportions is one of the main objectives of the EU regional policy, which is accomplished through the allocation and concentration of non-repayable financial aid in areas requiring support (Chądzyński *et al.*, 2007).

The EU regional policy involves not only elimination of divergence effects, but also their prevention by stimulating the spread effects. It is therefore justified to selectively support regional development on a sectoral and territorial basis, adopting a holistic approach to avoid the adverse effects of divergence (Ziomek, 2008).

The EU regional policy has been pursued practically since 1956, when the Treaty of Rome was prepared. It was then that the regional scope was indicated as one of the three main common courses of action for Member States (Pietrzyk, 2000). The preamble to the 1958 Treaty of Rome states that the countries establishing the European Economic Community do so “desiring to deepen the solidarity between their peoples (...) determined to promote economic and social progress for their peoples, taking into account the principle of sustainable development and within the context of the accomplishment of the internal

market and of reinforced cohesion and environmental protection, and to implement policies ensuring that advances in economic integration are accompanied by parallel progress in other fields” (Official Journal of the European Union, 2012).

Under the Programme of Community Action for 1962-1965 in 1968, the General Directorate for Regional Policy was established. At the Paris Summit in 1972, the European Regional Development Fund (ERDF) was established in order to eliminate disparities within the European Community caused by predominance of agriculture, industrial changes and structural unemployment. The Single European Act signed by all the countries of the Community in February 1986 emphasised the importance of a regional policy within the Community. “In particular, the Union shall aim at reducing disparities between the levels of development of various regions and the backwardness of the least favoured regions” (Official Journal of the European Union, 2007, Article 174).

In 2008, the European Commission presented a Green Paper on territorial cohesion (2008), setting out the measures necessary to turn territorial diversity into a Community strength. It provides for a more balanced and sustainable development throughout the Community, which should be conducive to optimal use of resources and bring benefits arising from the reduced concentration and pressure on the resulting cost increases.

The Commission White Paper on the Future of Europe (European Commission, 2017a) sets out five sample scenarios for the future of Europe. The United Kingdom’s withdrawal from the European Union entails the loss of a major contributor to the financing of the Union policies and programmes. Accordingly, it will be necessary to identify possible areas in which savings may be made and priorities may be determined more effectively (Communication, 2018). Among the many different options for improving the effectiveness of the cohesion policy and increasing the impact of its investments the following proposals were identified, *inter alia*, rendering the cohesion policy more flexible to better address the new challenges and increased level of co-financing of the national cohesion policy to align these levels with the different countries and regions more efficiently, and increase the sense of responsibility and duty (European Commission, 2017b).

The 2021-2027 cohesion policy framework takes greater account of action at a local level – it supports the development of local growth strategies by municipal, local or other territorial authorities which should be responsible for or involved in the selection of EU funded projects. At the same time, the funds operated under the cohesion policy will continue to invest in all the regions and there will still be three categories of regions (less developed regions; transition regions; more developed regions). The method of assigning the funds will still be to a large extent based on GDP per capita, but it will also take into account

other criteria (youth unemployment, low level of education, climate changes and measures connected with taking in and integrating migrants) so as to better reflect the situation in the field. The most distant regions will continue to use the specific support of the EU (European Commission, 2020).

To sum up the above considerations, the regional policy has been and still is partially based on the idea that growth is generated by opening up the less developed regions to trade while developing the infrastructures required to participate in the European common market (The evolution and impact of EU Regional and Rural Policy, 2009). An important issue that focuses the discussions on the regions regards convergence in the EU and whether or not in the future it will lead to decreasing the inequality in the regions development or whether the polarisation processes will lead to permanent diversity, and even a growing disproportion (contrary to the assumptions of the EU regional policy) (Chądzyński *et al.*, 2007). Ziomek (2008) pointed out that in running the EU regional policy the focus should be on stimulating the spread effects of development rather than on liquidating any results of divergence.

In this context, the following questions arise; how to measure the level of regional inequalities, which aspects of regional development should be taken into account, and predominantly, on which defining assumptions this should be based.

3. Regional Socio-Economic Development

The Polish regional policy, based on a compensatory model of the EU economic cohesion, requires continuous improvement both in the forms of its implementation and with regard to its scale and set of instruments. It is currently based on the creation of social and economic space as well as the preparation of development programmes on the basis of strategic objectives and operational programmes (Spsychalski, 2006).

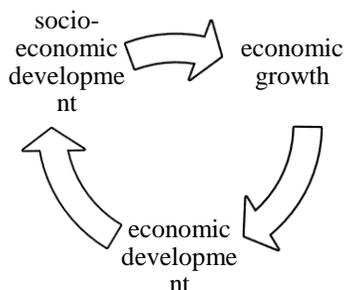
In this context, the socio-economic development comprises the totality of changes encountered by the economy and the society. When defining the concept, it should be noted that the literature on the subject consistently differentiates between the concepts of economic growth and economic development. Development, in the simplest terms, is understood as a process of positive changes comprising both quantitative growth and qualitative progress, where the quantitative aspect encompasses the concept of economic growth, while the qualitative aspect regards transformation of socio-economic structures, as a result of which they acquire new characteristics (Klóska, 2015).

According to Stanny (2012), in economic sciences the concept of development was most often empirically connected with an increase in Gross National

Product, however, this is only a one-dimension measure which does not take into account the complexity and the multiple-criteria nature of the concept – economic development does not take place in isolation from social development that is described as a multi-stage process of social changes, aimed at satisfying the needs, as a result of which there is a steady increase of certain variables that are relevant for the given society or communities.

Salecka (2018) asserted that the result of development is the continuous improvement of people's living conditions, which is manifested by changes in the system of social relations, the social structure, the public's preferences, social criteria and principles of activity, behaviour patterns, attitudes and awareness facilitating improvement of people's coexistence and co-operation, and sharing by them the effects of economic development. The United Nations Development Programme (UNDP) defines social development as a process of expanding people's choices which lead to long and healthy life, gaining knowledge and maintaining decent living standards (Kubiczek, 2014). Socio-economic development comprises the totality of changes undergone by the economy and the society. Parysek (2018) emphasised that this is a multi-level and long-lasting process, nevertheless it seems that despite the complex and structured nature, it can be interpreted also in terms of changes of concrete properties of the individual constituents of the socio-economic system, i.e., its distinguished elements that are decisive for the developed structures. Analysing this phenomenon, it is possible to notice that (in accordance with Maslow's hierarchy of needs) the condition necessary for any socio-economic development is economic development – the public in the first place must meet their basic needs which grow and implicate socio-economic development, whereas economic development is determined by the economic growth which at the same time is a derivative of the socio-economic development (Figure 1).

Figure 1. Socio-economic development as a determinant and derivative of economic growth and economic development



Source: Own study.

Over the recent decades, many studies addressed the theory and determinants of regional and socio-economic development, both in a broad perspective and in concrete areas comprising, *inter alia*, the financial aspects of development, educational conditions of development, impact of technical effectiveness on the individual socio-economic indicators, globalisation processes, innovativeness or methods and tools for managing the regional development (Aivazian *et al.*, 2018; 2018; Florida *et al.*, 2008; Herbst, 2007; 2012; Klasik and Kuźnik, 2017; Klóska, 2015; Nowakowska, 2015; Zakrzewska-Półtorak, 2012).

The older studies generally applied the traditional measures of economic development, based on the national accounts systems (GDP, GNP, NNP), as the approximate, general indicator of the social development and across-the-board progress level, while GDP per inhabitant still tends to be the basic and universally applied measure of the socio-economic development (Obrębalski, 2013). Pater, Harasym and Skica (2015) pointed out that economic development measured with GDP per inhabitant does not account for numerous aspects other than economic growth, including structural, social or ecological changes. The measures developed in the 1970s and 1980s were based on national accounts systems, which were to account for the qualitative aspects, thus eliminating the drawbacks of applying only GDP per inhabitant. The major ones included, Measure of Economic Welfare (MEW), Net National Welfare (NNW), Index of the Economic Aspects of Welfare (EAW), green GDP and net domestic product, Index of Sustainable Economic Welfare (ISEW), and Genuine Progress Indicator (GPI). Still, none of those measures was perfect.

Consequently, researchers started to devise synthetic indicators of socio-economic development, among which the greatest popularity is enjoyed by the Human Development Index (HDI) and its derivatives, such as e.g., Human Poverty Index (HPI), Gender-Related Development Index (GDI), Gender Empowerment Measure (GEM) (Kubiczek, 2014). Makkonen (2011) quoted studies completed in the 2000s, (Ebersberger, 2005; Florida *et al.*, 2008), which showed that education, knowledge, R&D and innovations were becoming more important factors affecting economic growth and regional development.

Kubiczek (2014), summing up the overview of socio-economic development indicators, pointed out that numerous attempts had been made in order to devise a synthetic measure which takes into account all the identified aspects of development, however, the attempts were discontinued due to the inability to standardise and identify the totality of determinants affecting the socio-economic development level. Kubiczek also emphasised that not all countries were interested in standardising the measures of development, as such indexes often demonstrated a lower level of the given country's development, thus adversely affecting its image. Despite that, international organisations present

findings of various research studies that contain comparisons on an international scale.

In the OECD analysis in the area of Research and Development Statistics, titled *Gross domestic expenditure on R&D by sector of performance and socio-economic objective*, the data are broken down into five categories of socio-economic factors (“Gross domestic expenditure on R&D by sector of performance and socio-economic objective,” 2020), environment, energy, industrial production and technology, agriculture, education. OECD also presented the tool, *Regional Well-Being: A Closer Measure of Life*, which makes it possible to measure the well-being level in a concrete region and to compare it with 402 other regions on the basis of eleven key themes related to inhabitants’ life quality.

According to OECD, in order to better understand how the society functions, it is necessary to go beyond GDP level measurement and other economic statistics (OECD, 2018). The set of ratios illustrating the regional well-being level consists of three categories (material conditions, life quality and subjective level of well-being). An interesting set of development indexes is used by Eurostat to monitor the implementation of goals of the EU Sustainable Development Strategy in the thematic area of socio-economic development. The set is based on 12 indicators demonstrating activities in 3 categories: economic development, competitiveness, innovations and eco-effectiveness and employment (Table 1 in Appendix).

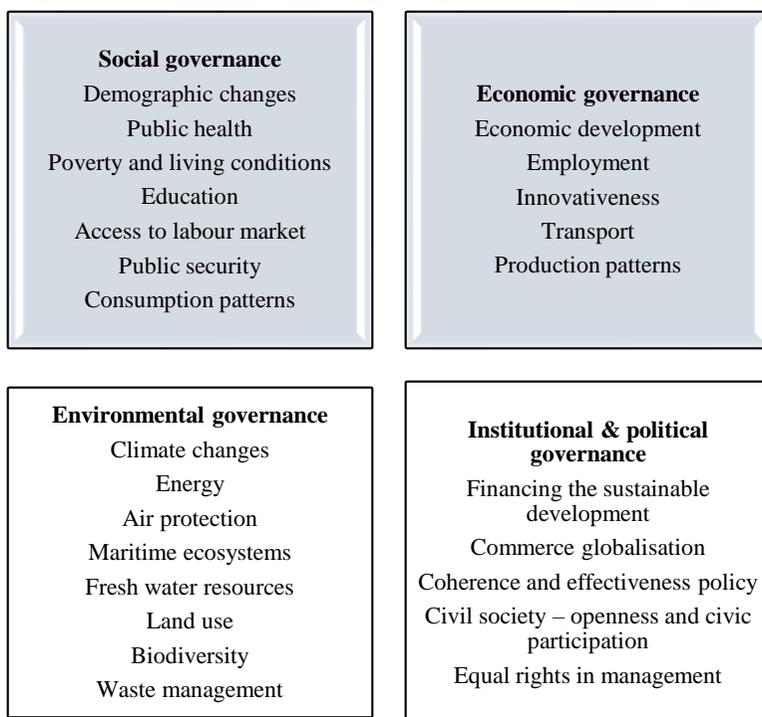
A broad set of indicators of Poland’s sustainable development was proposed by the Central Statistical Office of Poland in the study *Wskaźniki zrównoważonego rozwoju Polski 2015 [Indicators of sustainable development of Poland]* (GUS, 2015). They were assigned to four types of governance: social, economic, environmental, and institutional & political, within which specific thematic areas were distinguished, which comprise the concrete indicators (Figure 2).

The individual regions in Poland prepare their development strategies which lead to the socio-economic development, and they often comprise a SWOT analysis of the region, the vision and development objectives (for more details please refer to e.g., Samorząd Województwa Mazowieckiego, 2014; Sejmik Województwa Pomorskiego, 2012; “Strategia rozwoju społeczno-gospodarczego województwa warmińsko-mazurskiego do roku 2025,” 2013; Wydział Zarządzania Strategicznego i Urząd Marszałkowski Województwa Zachodniopomorskiego, 2017).

In the study entitled “Innovation and Regional Socio-Economic Development – Evidence from the Finnish Local Administrative Units” (2011), Makkonen proposed a set of 14 variables that describe innovations and socio-economic development: patents granted, number of inhabitants, net population change, percentage of people of working age, unemployment rate, non-working

population compared with working population, number of women compared with men, percentage of population with higher education, percentage of densely populated areas, gross domestic product per capita, gross value added, gross income, percentage of small and/or inadequate housing, average cost of housing (€/m²).

Figure 2. *Thematic areas of indicators of Poland's sustainable development, according to the Central Statistical Office of Poland*



Source: *Own study based on (GUS, 2015).*

As opposed to any tangible capital, human capital is accumulated for a very long time, i.e., any noticeable changes in human capital resources take place over decades rather than several years. It is acquired both in the process of formal education and (what is no less important) practice during occupational work (Bukowski *et al.*, 2008). The literature on the subject emphasises that a population is a carrier of specific needs, and at the same time it generates labour force which will meet those needs (Kupiec, 2011). Human capital is a factor that affects the long-term economic growth rate in various profiles – investing in human capital results in internal effects in the form of increased labour productivity, and also external effects in the form of increased productivity of material capital, therefore it may be deemed to be the key element of the

contemporary economy, which stimulates the productivity in the economies where it is found (Korenik, 2008).

Undoubtedly, the proportion between the working population and the post-working age population affects the efficacy of the socio-economic functioning on the regional and national scale.

According to Markowska-Przybyła (2017), social capital differs from region to region, which is connected with factors of historical nature, and thus persistent and difficult to change, it is related to effectiveness of regional economies. In turn Jańczuk (2013) asserted that enterprises striving to maximise their profits search for locations offering lower costs (aiming to obtain lower production costs and consequently to attain a competitive advantage) and relocate their activity from more expensive (i.e. more developed) to cheaper (i.e., less developed) locations. In this way, they stimulate economic growth in less developed regions, and at the same time they contribute to the socio-economic growth of the regions. This leads to spatial deconcentration, i.e., evening out the level of socio-economic development across regions.

As Ziemiańczyk (2010) rightly concluded, complex phenomena, which undoubtedly include socio-economic development, are very difficult to assess in an objective and unambiguous manner. Zimny (2016) underlined that reliable and trustworthy measurement of socio-economic development requires careful selection of appropriate measures that include objective and subjective measures. In his analyses, Czyżycki (2012) pointed out that preparing any types of rankings, and putting them in any sort of order in terms of socio-economic development, is to a certain extent subjective. The final results of any study are to a large extent affected not only by the initial selection of diagnostic variables, but also by the research methodology (including standardisation of the variables).

4. Methodological Aspects of Measuring the Regions' Socio-Economic Development

Ranking the regions from “the best” to “the worst” takes place on the basis of a value that describes the individual regions (a synthetic variable, a synthetic measure of development), received via a function that aggregates information included in the assumed diagnostic variables. The main stages of the procedure aimed at obtaining the synthetic variable include (Kukuła, 2000; Walesiak, 1996):

- selection of diagnostic variables, factually connected with the overarching criterion, in accordance with which the particular objects (voivodeships) will be ranked;

- eliminating the individual denominations of the variables and standardising their orders of magnitude so as to achieve comparability between the variables;
- weighing the standardised diagnostic features, i.e. individual variables are assigned weights that specify their significance for the general criterion, compared to other features;
- selection of the aggregation formula as the basis for determining the value of the synthetic measure of development.

However, due to the lack of a universal and timeless, generally binding system of adequate indicators and unambiguous principles of selecting the diagnostic variables, the selection is conditioned predominantly by the possibility of obtaining comparable data and the need to meet the factual and formal requirements (Johann, 2005; Słaby, 1994). Proper selection of measures should account for the spatial, temporal and factual scope of the assessment, as well as – first and foremost – its objective.

The selection of diagnostic variables may be facilitated by applying (especially in the case of the factual scope) some ready-made sets of such measures, developed by competent, trusted organisations. These could be, for example, Organisation for Economic Co-operation and Development (OECD), or Central Statistical Office of Poland (Główny Urząd Statystyczny, GUS), which have developed appropriate measures of regional and local development.

In view of the purpose of this study and the results of the literature review, the following measures have been selected to be the variables that describe the development:

- in the area of social development:
 - rate of natural increase per 1,000 population (X_1),
 - net migration of working-age people for permanent residence per 10,000 of the working age population (X_2),
 - deaths of people aged under 65 per 1,000 population in this age group (X_3),
 - average monthly gross pay (business entities employing above 9 people) (X_4),
 - participation of children in pre-school education centres per 1,000 children aged 3-5 years (X_5),
 - share of the long-term (more than 1 year) unemployed in the total unemployed population (X_6),
 - registered unemployment rate (X_7),
 - number of outpatient clinics per 10,000 population (X_8),
 - total crimes confirmed by the Police per 1,000 population (X_9),

- rates of detectability of delinquents in ascertained crimes by the Police (X_{10}),
- traffic accident fatalities per 100,000 registered vehicles (X_{11});
- in the area of economic development:
 - investment outlays in enterprises (current prices; without business entities employing fewer than 9 people) per 1 working-age inhabitant (X_{12});
 - entities of the national economy, newly entered in the REGON register, per 10,000 of the working-age population (X_{13});
 - physical persons running business activity per 100 of the working-age population (X_{14});
 - entities of the national economy, entered in the REGON register, per 1,000 of the working-age population (X_{15});
 - length of local public roads per 100 km² (X_{16});

In order to assure comparability of the variables, the zero unitarisation method (Kukuła, 2000) was applied, which makes it possible to standardise the variables within the [0,1] range via using:

- in the case of LTB factors ($X_1, X_2, X_4, X_5, X_8, X_{10}, X_{12}, X_{13}, X_{14}, X_{15}, X_{16}$) - the formula:

$$z_{ij} = \frac{x_{ij} - \min_i x_{ij}}{\max_i x_{ij} - \min_i x_{ij}} \quad (1)$$

- in the case of STB factors ($X_3, X_6, X_7, X_9, X_{11}$) - the formula:

$$z_{ij} = \frac{\max_i x_{ij} - x_{ij}}{\max_i x_{ij} - \min_i x_{ij}} \quad (2)$$

The weight values for the individual diagnostic variants (w_j) have been determined by means of the following methods:

1. method of balanced level of priority of individual variables:

$$w_j^1 = \frac{1}{m} \quad (3)$$

where m means the number of diagnostic variables ($m=16$);

2. method based on standard deviation of standardised variables (Diakoulaki *et al.*, 1995):

$$w_j^2 = \frac{\sigma_j}{\sum_{k=1}^m \sigma_k} \quad (4)$$

3. method based on entropy of variables, consisting in (Wang and Luo, 2010):

- standardisation of the variables in accordance with the formula:

- in the case of LTB factors:

$$z_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}}} \quad (5)$$

- in the case of STB factors:

$$z_{ij} = \frac{(x_{ij})^{-1}}{\sqrt{\sum_{i=1}^m (x_{ij})^{-1}}} \quad (6)$$

- determining the value of entropy (E_j) and diversification level (d_j):

$$E_j = -\frac{1}{\ln(m)} \cdot \sum_{i=1}^m z_{ij} \ln z_{ij} \quad (7)$$

$$d_j = 1 - E_j \quad (8)$$

- determining the weights:

$$w_j^3 = \frac{d_j}{\sum_{k=1}^m d_k} \quad (9)$$

4. the CRITIC (*Criteria Importance through Inter-criteria Correlation*) (Diakoulaki et al., 1995) method, which requires standardisation of the variables as per formulas (3) and (4), followed by determining the standard deviation σ_j for each standardised variable and correlation coefficients r_{ij} between all the variables. The values of the individual weights are determined on the basis of formula (10):

$$w_j^4 = \frac{C_j}{\sum_{k=1}^n C_k} \quad (10)$$

where

$$C_j = \sigma_j \cdot \sum_{k=1}^m (1 - r_{ik}) \tag{11}$$

5. method of minimising the distance from the reference pattern (Ma *et al.*, 1999), which assumes determining such weight values for the individual variables, which will minimise the distance defined as:

$$\sum_{i=1}^n \sum_{j=1}^m (z_0^+ - z_{ij})^2 w_j^2 \rightarrow \min \tag{12}$$

where

$$z_0^+ = \begin{cases} \max_i z_{ij} & \text{in the case of LTB factors} \\ \min_i z_{ij} & \text{in the case of STB factors} \end{cases} \tag{13}$$

whereas z_{ij} are determined in accordance with formulas (1) and (2).

The solution of assumption (12) is determining the values of the individual weights on the basis of the following formula:

$$w_j^5 = \frac{\frac{1}{\sum_{i=1}^m (z_{ij} - z_0^+)^2}}{\sum_{k=1}^m \left(\frac{1}{\sum_{i=1}^m (z_{ik} - z_0^+)^2} \right)} \tag{14}$$

The values obtained via methods 1 – 5 meet the two major assumptions connected with weights of the diagnostic variables, namely positivity ($w_j > 0$) and summability to one ($\sum_{j=1}^m w_j = 1$).

To study the level of the socio-economic development of the regions, the TOPSIS (*Technique for Order Preference by Similarity to Ideal Solution*) (Hwang and Yoon, 1981) method was applied, which is based on the Euclidean distance, according to which a ranking of objects is made on the basis of C_i values determined by means of the formula:

$$C_i = \frac{d_i^-}{d_i^+ + d_i^-}, \tag{15}$$

where

$$d_i^+ = \sqrt{\sum_{j=1}^m w_j (z_{ij} - z_0^+)^2}$$

$$d_i^- = \sqrt{\sum_{j=1}^m w_j (z_{ij} - z_0^-)^2}$$
(16)

$$z_0^+ = \begin{cases} \max_i z_{ij} & \text{in the case of LTB factors} \\ \min_i z_{ij} & \text{in the case of STB factors} \end{cases}$$

$$z_0^- = \begin{cases} \min_i z_{ij} & \text{in the case of LTB factors} \\ \max_i z_{ij} & \text{in the case of STB factors} \end{cases}$$
(17)

$$z_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}}$$
(18)

In order to specify the impact of the EU funds invested in the individual Polish voivodeships on the change in the level of socio-economic development, taking into account the information found at www.mapadotacji.gov.pl, a ranking of voivodeships was prepared to reflect the value of the EU financial assistance per capita received in connection with implementing the investment projects co-financed with community funds in a given voivodeship, broken down into specific investment areas. Using the Kendall rank correlation coefficient, (*Encyclopaedia of Measurement and Statistics*, 2007) we checked the compliance of the received ranking with the change in the position in the ranking that describes the socio-economic development of the individual voivodeships in the years 2004-2018, assuming that any statistically significant value of the coefficient indicates a significant impact of the EU funds on the regional development in Poland. Some remarks regarding the applicability of the Kendall rank correlation coefficient in studying correlations between two data sequences may be found, inter alia (Couso, Strauss, and Saulnier, 2018; Puth, Neuhäuser, and Ruxton, 2015).

5. Research Results

Analysing the changes in values of individual diagnostic variables over the years 2004-2018, based on Welch's t-test (Lu and Yuan, 2010), it is possible to find that in the case of the variables that describe the rate of natural increase per 1,000 population (X_1), net migration of working-age people for permanent residence per 10,000 of the working-age population (X_2) and deaths of people

aged under 65 per 1,000 population in this age group (X_3), they did not change to a statistically significant degree. In the other cases, p-value for the two-sided Welch's t-test ranged from 1.16E-14 for the X_4 variable (average monthly gross pay) to 1.17E-02 in the case of the variable describing the X_{14} variable (number of physical persons running business activity per 100 of the working-age population). The selected numerical characteristics describing the changes in the levels of the diagnostic variables adopted for the research study are presented in Table 2.

Table 2. Basic numerical characteristics describing the changes in the selected variables that reflect the socio-economic development of Polish regions in 2004 - 2018.

	2004	2018	2004	2018	2004	2018	2004	2018	2004	2018
	mean		min		max		median		S(X)	
X1	-0.10	-0.96	-3.08	-3.50	2.07	1.80	-0.09	-1.40	1.35	1.57
X2	-5.27	-7.21	-28.60	-37.40	35.80	38.30	-8.10	-11.70	15.82	21.79
X3	3.31	3.20	2.57	2.50	4.46	4.00	3.34	3.20	0.42	0.40
X4	2321.60	4497.43	2081.76	4028.33	3227.04	5888.90	2221.33	4381.11	273.93	446.89
X5	395.86	859.69	295.04	786.00	593.61	935.00	380.75	853.00	82.28	38.31
X6	49.76	38.51	45.12	30.90	54.33	45.40	49.82	37.40	2.46	4.40
X7	18.99	6.54	13.80	3.20	27.20	10.40	18.60	6.20	3.92	1.93
X8	3.13	5.81	2.00	4.00	4.00	7.00	3.00	6.00	0.48	0.63
X9	35.02	19.36	20.93	11.39	45.33	25.76	35.23	18.55	6.11	3.91
X10	59.82	74.47	45.30	64.60	71.90	82.40	62.65	75.70	8.55	5.26
X11	35.66	9.78	24.50	6.72	57.00	13.59	35.05	9.66	6.89	1.73
X12	2844.31	7218.75	1841.00	4586.00	5321.00	12601.00	2762.50	6675.00	821.30	1835.95
X13	94.00	160.56	69.00	117.00	125.00	225.00	91.00	148.00	16.80	29.87
X14	11.10	12.83	8.51	9.84	14.47	16.65	11.15	12.53	1.58	2.03
X15	142.92	177.66	108.33	132.50	183.15	253.80	141.38	170.90	21.34	33.32
X16	123.74	137.25	78.70	86.70	202.60	207.10	118.20	134.85	32.22	32.14

Source: Own work.

In addition to the change in the value levels of individual variables over the analysed period, their significance in the study of the socio-economic development in the individual Polish regions was also subject to change. If the same level of significance had been assumed for all of the variables, the weight value in each period would have been established at the same level, i.e., $w_j^1=1/16=0.0625$. In fact (depending on the assumed method of assigning weights), their values ranged from 0.0288 in the case of variable X_4 in 2004 when applying the method of minimising the distance from the reference pattern (w_j^5), up to the level of 0.1492 in the case of variable X_8 in 2006 and applying the CRITIC method (w_j^4).

Generally, based on the completed research studies, we can conclude that the variables that have above-average significance in the study of the socio-economic development of the Polish regions are those that reflect the natural increase per 1,000 population (X_1), deaths of people aged under 65 per 1,000 population in this age group (X_3), share of the long-term (more than 1 year) unemployed in the total unemployed population (X_6), number of outpatient clinics per 10,000 population (X_8), total crimes confirmed by the Police per 1,000 population (X_9), rate of detectability of delinquents in ascertained crimes by the Police (X_{10}) and traffic accident fatalities per 100,000 registered vehicles (X_{11}).

As for the other variables, the weight values obtained by means of various methods indicate that their significance for the socio-economic development of the analysed regions was below average. Table 3 (in Appendix) presents detailed information describing the development of weight values for all the variables adopted for the study, obtained by means of various methods, in 2004 (at the beginning of the study period), 2007 and 2014 (at the end of the particular EU financial perspectives) and in 2018 (at the end of the study period). In studies on regional development, adopting a specific system of weighing, the diagnostic variables may have a significant impact on the obtained research results (Czyżycki, 2018), therefore the further studies take into account the mean weight levels obtained by means of formulas (3), (4), (9), (10) and (14).

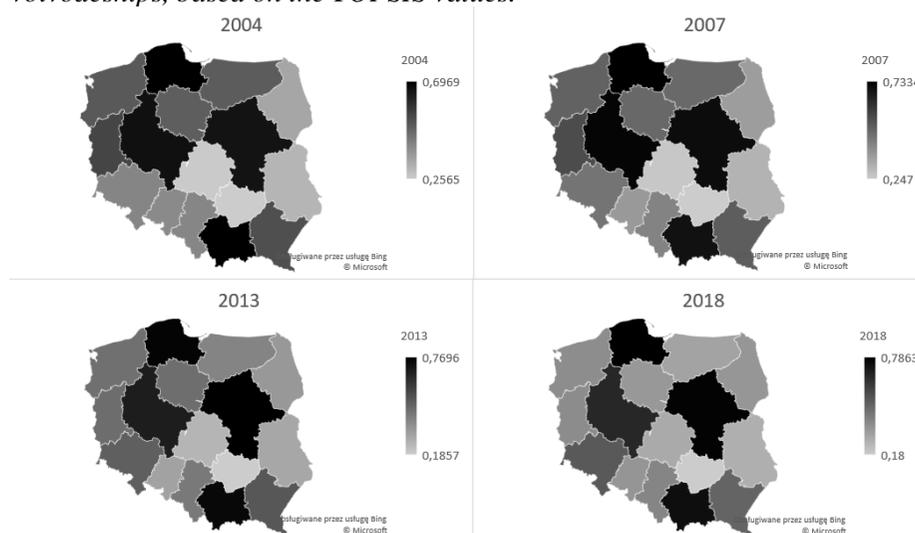
Averaged weight values of the adopted diagnostic variables over the individual years are presented in Table 4 (in Appendix). Taking into account the average weight values in the individual years, based on the TOPSIS method, we ran an analysis of changes in the socio-economic development level in the particular voivodeships in the years 2004-2018. On that basis, it was possible to distinguish three groups of regions:

- four regions which in different configurations and in each period took the four top places in the socio-economic development ranking (Pomorskie, Mazowieckie, Małopolskie, and Wielkopolskie);
- three regions which alternately took the last three places in the ranking (Świętokrzyskie, Łódzkie, and Lubelskie)
- the remaining nine voivodeships, which in terms of socio-economic development were placed in the middle of the ranking.

The exact numeric values that describe the development of the individual regions are presented in Table 5 (in Appendix), whereas the graphical presentation of that information can be found in Figure 3.

Generally, we can conclude that in terms of socio-economic development the biggest positive changes took place in the Dolnośląskie region, which in the analysed period advanced from the 10th place in 2004 to the 5th position in 2018. The Śląskie voivodeship in turn moved four places up, Mazowieckie, Opolskie and Podlaskie – two places up, and Łódzkie – one place up. The region that showed the worst performance was the Warmińsko-mazurskie voivodeship which moved down in the socio-economic development ranking from the 8th place in 2004 to the 13th place in 2018, also, the Kujawsko-pomorskie and Lubuskie voivodeships which moved down by two places.

Figure 3. Socio-economic development level in the individual Polish voivodeships, based on the TOPSIS values.



Source: Own work.

Before attempting to specify the impact of the EU funds on the socio-economic development of the individual regions in Poland, it is necessary to point out that in the years 2004-2018 the total of 212,297 investment projects were completed in Poland, totalling over PLN 652 bn, and they were supported by EU funds amounting to nearly PLN 376 bn. If we decide that the research study should include only the projects that have been completed in full within a single voivodeship, it is necessary to take into account 198,166 projects totalling over PLN 590 bn and co-financed by the EU with the amount of nearly PLN 340 bn.

In the years 2004-2018, the investment projects that were co-financed with EU funds to the greatest extent included those connected with transport, company development and environmental protection. However, depending on the specific nature of the given voivodeship, the investment projects were implemented within different scopes in various areas of the individual regions, and the detailed information on the subsidy per inhabitant is presented in Table

6 in Appendix. The best results in this respect were achieved by the following voivodships; Warmińsko-mazurskie, where the completed investments were co-financed with EU funds in the amount of PLN 9,763 per inhabitant, Podkarpackie, where the subsidy amount was PLN 9,035 per inhabitant, and Mazowieckie with the amount of PLN 8,565. The smallest amount of subsidy per inhabitant was obtained by the Małopolskie voivodship – PLN 5,289, Kujawsko-pomorskie – PLN 5,610 and Opolskie – PLN 5,698.

Table 7 presents the results of the research on the relationships between the change of the region's position in the socio-economic development ranking and the value of subsidy per inhabitant, obtained from EU funds in the individual areas. Analysing the relationship between the amount of the co-financing obtained by the individual regions and the change of the position in the ranking that describes the socio-economic development over the years 2004 - 2018, it is not possible to indicate any impact of such funds (both in aggregate and per inhabitant) on accelerated socio-economic development of a given voivodship (the Kendall rank correlation coefficient was 0.0348, and p-value = 0.8508).

Table 7. *The relationship between the change of the region's position in the socio-economic development ranking and the ranking of subsidies per inhabitant, obtained from EU funds to implement investment projects in the individual areas*

	Kendall rank correlation coefficient	p-value
administration	0.3482	0.0600
research, development, innovations	0.1567	0.3973
safety	0.0174	0.9251
power engineering	-0.0696	0.7068
culture and arts	0.4178	0.0240
science and education	0.0522	0.7778
environmental protection	-0.0522	0.7778
health care	0.0174	0.9251
labour and social integration	-0.3656	0.0483
revitalisation	-0.1741	0.3470
business development	-0.2437	0.1879
telecommunications and e- services	0.0174	0.9251
transport	0.1219	0.5103
tourism	-0.0870	0.6382
international cooperation	0.1273	0.4917

Source: Own work.

Nevertheless, when the received subsidies were disaggregated into the individual investment areas, it was possible to observe a statistically significant correlation with a moderately positive impact on the above-average development of the regions where investments in the area of culture and arts (p-value = 0.0240) and administration (p-value = 0.0600) were implemented to a larger extent. However, a puzzling finding is the moderately negative impact of investments completed in the area of labour and social integration on the rate of socio-economic development of individual regions. Table 7 presents detailed information on the value of the Kendall rank correlation coefficient describing the relationship between the change of the region's position in the socio-economic development ranking and the ranking of subsidies per inhabitant, obtained from EU funds in the individual areas.

6. Discussion and Conclusions

EU funds constitute a significant determinant of the socio-economic development of Polish regions. They ensure not only a stable and reliable source of financing any growth-promoting initiatives, but due to the increasing control exerted by the community institutions over efficient utilisation of public funding, they contribute to a rational choice of investments to be financed. The purpose of the presented analyses was to verify how the amount of EU funds invested in the individual Polish regions contributed to the change in the socio-economic development level.

On that basis, three groups of regions were distinguished in terms of the socio-economic development: the regions which in different configurations and in each period took the four top places in the socio-economic development ranking, the regions which alternately took the last three places in that ranking, and the remaining regions which were placed in the middle of the ranking. The analysis of the dependencies between the amount of the subsidies received by the individual regions and the change in ranking that describes the socio-economic development over the years 2004-2018 has shown that there were no correlations between those values, which may confirm the suggestions found in the introduction that the effects of support in the form of EU funds are smaller than expected.

Simultaneously it is possible to point out to the areas where investments unambiguously contributed to a significant, most often positive change in the rate of their development. On the one hand, the changes were an expected outcome of the investments that were co-financed with the community funds, which in a simple and direct manner were reflected in the values of the adopted diagnostic variables, which in turn determined the values of the synthetic variables underlying the rankings.

On the other hand, the values of the synthetic variables were also changing as a result of the movements in importance of the individual diagnostic variables describing their changing significance for the regions' development over the studied period. The determined weight values may be used to identify the preferred (from the point of view of the regional socio-economic development) areas where specific investment projects should be implemented. However, it is necessary to note that in the case of large investment projects that are implemented over time, due to the above mentioned change in importance of the variables describing the regional development, the significance of a given project for the development of a given region may be totally different at the moment of its completion, compared to the moment the decision on the project implementation was made. The "weighing" process may in this regard be a procedure that supports the decision-making process, and finally the decision and accountability for it always lies with the decision-makers.

In conclusion, when studying the impact of EU funds, one should not focus merely on analysing the documentation, assumptions of specific programmes, disbursed amounts of financial assistance or GDP per capita and its changes over time. Due to the complexity of the concept of regional socio-economic development, it should be analysed by means of complex indicators. According to the authors, application of the TOPSIS method for the purposes of creating a ranking of regions makes it possible to obtain possibly the most objective classification.

The proposed methodology of studying the impact of EU funds on regional socio-economic development could also be implemented in other EU member states, and that could serve as the basis for generating further (maybe more radical) conclusions, which will make it possible to focus EU resources on specific areas where they can bring desired outcomes.

Appendix

Table 1. Socio-economic development indicators applied by Eurostat

Headline indicators	Operational indicators	Explanatory indicators
	Economic development	
Real GDP per inhabitant	Investments	GDP per capita
	Disposable income of household per capita	Net national income
		Household savings
	Competitiveness, innovations and eco-effectiveness	

Labour productivity increase	Eco-innovation indexes R&D expenditure Relative price and cost index Turnover from innovation Energy intensity of the economy
<hr/> Employment <hr/>	
Employment rate Young people neither in employment nor in education and training	Employment rate as per employment level Employment rate across regions Unemployment rate Labour cost to labour productivity ratio

Source: *Zimny (2016).*

Table 3. Weight values for the individual diagnostic variables, depending on the applied

	2004				2007				2013				2018			
	w ² _j	w ³ _j	w ⁴ _j	w ⁵ _j	w ² _j	w ³ _j	w ⁴ _j	w ⁵ _j	w ² _j	w ³ _j	w ⁴ _j	w ⁵ _j	w ² _j	w ³ _j	w ⁴ _j	w ⁵ _j
X	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	626	621	693	796	586	619	626	921	622	621	663	811	688	625	708	598
X	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	588	626	480	420	595	626	499	452	617	626	476	492	670	628	484	481
X	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	537	619	598	955	539	618	666	892	565	620	742	763	621	622	767	740
X	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	572	638	480	288	549	637	458	321	559	638	481	335	559	633	458	347
X	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	659	631	619	381	638	633	599	393	611	621	550	716	599	623	512	665
X	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	640	623	726	603	716	621	733	860	689	627	753	571	707	626	831	582
X	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	700	622	690	832	631	620	551	914	555	619	449	922	624	622	456	744
X	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
8	579	620	787	785	665	636	935	420	743	626	170	690	492	619	628	062
X	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	599	621	530	813	593	620	571	851	622	622	574	646	634	622	652	785
X	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
10	769	626	108	634	694	625	033	580	599	620	938	903	688	624	249	749
X	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	507	619	449	204	651	621	578	824	698	626	583	636	586	621	518	816
X	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	565	629	442	349	559	626	453	431	555	626	433	447	533	626	454	425
X	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	718	627	639	495	726	627	623	524	695	633	570	447	644	627	527	495
X	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	636	626	548	502	603	623	502	559	680	625	534	601	694	627	539	531
X	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	682	625	562	530	657	624	520	584	628	625	482	535	640	629	488	456
X	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	622	627	649	415	599	625	653	475	562	625	602	485	622	625	730	525
mi	0.0															
n.	507	619	442	288	539	618	453	321	622	621	663	811	492	619	454	347
m	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.0	0.1	0.1						
ax	769	638	108	204	726	637	033	921	617	626	476	492	707	633	249	062
.																

determination method.

Source: Own work.

Table 4. Average levels of weights determined on the basis of $w_j^2-w_j^5$ for the individual diagnostic variables covering the 2004 – 2018 period.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	mi n.	max.
X1	0.0 684	0.0 674	0.0 672	0.0 688	0.0 664	0.0 648	0.0 650	0.0 677	0.0 690	0.0 679	0.0 665	0.0 657	0.0 651	0.0 649	0.0 655	0.0 648	0.0 690
X2	0.0 528	0.0 527	0.0 523	0.0 543	0.0 541	0.0 550	0.0 543	0.0 541	0.0 541	0.0 553	0.0 545	0.0 549	0.0 562	0.0 557	0.0 566	0.0 523	0.0 566
X3	0.0 677	0.0 662	0.0 654	0.0 679	0.0 699	0.0 669	0.0 674	0.0 660	0.0 652	0.0 672	0.0 676	0.0 675	0.0 659	0.0 647	0.0 688	0.0 647	0.0 699
X4	0.0 494	0.0 497	0.0 482	0.0 491	0.0 494	0.0 495	0.0 497	0.0 495	0.0 498	0.0 503	0.0 496	0.0 496	0.0 496	0.0 493	0.0 499	0.0 482	0.0 503
X5	0.0 573	0.0 579	0.0 555	0.0 565	0.0 561	0.0 573	0.0 594	0.0 604	0.0 614	0.0 625	0.0 641	0.0 626	0.0 611	0.0 609	0.0 600	0.0 555	0.0 641
X6	0.0 648	0.0 619	0.0 633	0.0 732	0.0 685	0.0 731	0.0 656	0.0 670	0.0 652	0.0 660	0.0 647	0.0 686	0.0 675	0.0 670	0.0 687	0.0 619	0.0 732
X7	0.0 711	0.0 695	0.0 668	0.0 679	0.0 704	0.0 670	0.0 654	0.0 655	0.0 640	0.0 636	0.0 602	0.0 614	0.0 615	0.0 615	0.0 611	0.0 602	0.0 711
X8	0.0 693	0.0 772	0.0 909	0.0 664	0.0 737	0.0 836	0.0 847	0.0 796	0.0 792	0.0 807	0.0 802	0.0 825	0.0 730	0.0 737	0.0 700	0.0 664	0.0 909
X9	0.0 641	0.0 631	0.0 678	0.0 659	0.0 635	0.0 597	0.0 650	0.0 642	0.0 615	0.0 616	0.0 654	0.0 630	0.0 629	0.0 640	0.0 673	0.0 597	0.0 678
X10	0.0 784	0.0 826	0.0 786	0.0 733	0.0 748	0.0 681	0.0 715	0.0 713	0.0 748	0.0 765	0.0 859	0.0 731	0.0 836	0.0 838	0.0 827	0.0 681	0.0 859
X11	0.0 695	0.0 668	0.0 626	0.0 668	0.0 659	0.0 678	0.0 646	0.0 613	0.0 677	0.0 636	0.0 603	0.0 689	0.0 679	0.0 702	0.0 635	0.0 603	0.0 702
X12	0.0 496	0.0 499	0.0 508	0.0 517	0.0 511	0.0 540	0.0 531	0.0 540	0.0 517	0.0 515	0.0 489	0.0 510	0.0 547	0.0 522	0.0 509	0.0 489	0.0 547
X13	0.0 620	0.0 598	0.0 589	0.0 625	0.0 612	0.0 611	0.0 604	0.0 647	0.0 619	0.0 586	0.0 582	0.0 567	0.0 554	0.0 581	0.0 573	0.0 554	0.0 647
X14	0.0 578	0.0 573	0.0 559	0.0 572	0.0 577	0.0 557	0.0 575	0.0 591	0.0 596	0.0 610	0.0 598	0.0 595	0.0 598	0.0 597	0.0 598	0.0 557	0.0 610
X15	0.0 600	0.0 595	0.0 584	0.0 596	0.0 585	0.0 586	0.0 570	0.0 575	0.0 564	0.0 567	0.0 556	0.0 552	0.0 553	0.0 549	0.0 553	0.0 549	0.0 600
X16	0.0 578	0.0 587	0.0 575	0.0 588	0.0 590	0.0 578	0.0 594	0.0 582	0.0 585	0.0 568	0.0 585	0.0 597	0.0 606	0.0 594	0.0 625	0.0 568	0.0 625
mi n.	0.0 494	0.0 497	0.0 482	0.0 491	0.0 494	0.0 495	0.0 497	0.0 495	0.0 498	0.0 503	0.0 489	0.0 496	0.0 496	0.0 493	0.0 499		
m ax	0.0 784	0.0 826	0.0 909	0.0 733	0.0 748	0.0 836	0.0 847	0.0 796	0.0 792	0.0 807	0.0 859	0.0 825	0.0 836	0.0 838	0.0 827		
.																	

Source: Own work.

Table 5. The TOPSIS values in the individual Polish voivodeships, covering the 2004 – 2018 period.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Dolnośląskie	0.4099	0.4355	0.4485	0.4560	0.4616	0.4591	0.4952	0.4839	0.4899	0.4990	0.5121	0.5166	0.5252	0.5034	0.5208
Kujawsko-pomorskie	0.4930	0.4970	0.4859	0.4844	0.4799	0.4746	0.4518	0.4887	0.4789	0.4561	0.4554	0.4321	0.4120	0.4143	0.3356
Lubelskie	0.3069	0.3230	0.3167	0.3066	0.2675	0.2696	0.2840	0.2885	0.3275	0.2920	0.2802	0.3014	0.2821	0.2679	0.2665
Lubuskie	0.5482	0.5413	0.5418	0.5524	0.5093	0.5101	0.5029	0.4996	0.5447	0.4574	0.4828	0.4230	0.4423	0.4543	0.3712
Łódzkie	0.2604	0.2574	0.2408	0.2588	0.2835	0.2693	0.2580	0.2374	0.2561	0.2509	0.2576	0.2685	0.2745	0.2680	0.2818
Małopolskie	0.6967	0.6903	0.6775	0.6930	0.6898	0.7213	0.7280	0.7432	0.7487	0.7455	0.7417	0.7393	0.7463	0.7440	0.7461
Mazowieckie	0.6562	0.6764	0.6935	0.7051	0.7053	0.7004	0.7431	0.7455	0.7711	0.7696	0.7774	0.8010	0.7834	0.7706	0.7760
Opolskie	0.3989	0.4047	0.3728	0.3675	0.3612	0.3577	0.3321	0.3444	0.3744	0.3071	0.3462	0.3178	0.3464	0.3066	0.3430
Podkarpackie	0.5256	0.5195	0.5153	0.5115	0.4735	0.4738	0.4855	0.5180	0.5474	0.5212	0.5080	0.4588	0.4812	0.5034	0.4886
Podlaskie	0.3391	0.3684	0.3363	0.3592	0.3478	0.3212	0.3417	0.3480	0.3704	0.3333	0.3470	0.3356	0.3450	0.3573	0.3404
Pomorskie	0.6969	0.7080	0.7116	0.7334	0.7321	0.7454	0.7480	0.7554	0.7685	0.7587	0.7644	0.7653	0.7822	0.7953	0.7863
Śląskie	0.4066	0.4137	0.4126	0.4200	0.4112	0.4176	0.4281	0.4094	0.4152	0.4221	0.4004	0.3947	0.3976	0.3877	0.3896
Świętokrzyskie	0.2565	0.2624	0.1971	0.2470	0.2278	0.2408	0.2035	0.2061	0.2174	0.1857	0.1674	0.1892	0.1962	0.1693	0.1800
Warmińsko-mazurskie	0.4977	0.5071	0.4826	0.4825	0.4421	0.4595	0.4416	0.4555	0.4495	0.3916	0.4280	0.3608	0.3227	0.3614	0.3009
Wielkopolskie	0.6634	0.6991	0.6797	0.7219	0.6990	0.6961	0.6990	0.7087	0.7176	0.6862	0.7060	0.6861	0.7081	0.7046	0.6694
Zachodniopomorskie	0.5057	0.5134	0.4836	0.5005	0.4601	0.4583	0.4330	0.4344	0.4583	0.4480	0.4441	0.4248	0.4225	0.4068	0.3670

Source: Own work.

Table 6. Amounts of subsidies for the completed investment projects in the individual Polish voivodships, co-financed with EU funds in 2004 - 2018, by investment area (PLN per inhabitant, as at 30.11.2017)

	administration	research, development, innovations	safety	power engineering	culture and arts	science and education	environmental protection	labour and social integration	revitalisation	business development	telecommunications and e-services	transport	tourism	international cooperation	other
Dolnośląskie	165.99	337.34	307.55	426.12	190.87	568.67	165.76	527.65	171.08	941.20	217.18	2930.77	180.29	38.41	587.55
Kujawsko-pomorskie	118.03	447.99	37.36	199.59	85.69	356.24	181.91	594.05	239.89	977.34	260.77	1614.43	107.09	0.00	389.81
Lubelskie	129.44	707.53	20.48	214.35	59.02	423.26	169.13	733.73	152.80	1054.66	374.60	2990.76	344.25	21.15	732.13
Lubuskie	122.93	374.06	38.65	336.84	15.84	470.55	90.36	591.30	172.06	825.87	212.49	2569.41	236.50	50.89	418.39
Łódzkie	116.24	454.49	24.96	184.55	111.11	312.50	117.42	583.08	157.91	927.65	153.90	3384.84	110.51	0.00	527.47
Małopolskie	104.69	709.55	103.62	83.64	280.98	332.28	57.65	459.06	92.95	753.54	238.82	1537.95	88.30	48.40	398.09
Mazowieckie	386.14	655.36	28.19	140.84	181.66	443.87	156.51	466.36	75.78	890.19	502.37	4152.67	65.13	2.76	417.31
Opolskie	145.86	631.26	420.28	67.63	107.34	351.93	93.81	556.67	191.32	885.37	239.33	1297.78	259.61	12.81	437.18
Podkarpackie	157.93	988.51	114.45	394.50	89.00	556.85	201.36	710.89	134.63	894.26	434.81	3366.01	140.05	53.35	799.30
Podlaskie	176.44	665.79	41.73	201.82	176.01	494.99	164.08	586.74	21.50	1139.50	508.25	2287.69	320.08	14.81	627.90
Pomorskie	91.68	412.65	263.01	295.78	111.87	404.40	89.95	507.63	279.11	811.49	197.65	3742.09	120.99	0.31	753.56
Śląskie	149.42	386.42	7.05	167.69	115.79	249.35	42.49	460.85	294.96	640.72	166.62	2698.12	124.26	27.88	464.63
Świętokrzyskie	256.77	516.30	5.02	384.47	36.95	579.40	235.50	879.27	245.51	964.06	330.73	2575.61	316.06	0.00	514.23
Warmińsko-mazurskie	153.25	315.04	202.86	193.07	57.19	502.81	43.87	819.88	332.18	1154.23	426.74	4430.22	517.04	0.00	614.97
Wielkopolskie	127.55	398.66	60.85	130.57	79.32	267.20	127.23	489.94	84.49	1037.45	286.73	2185.77	72.39	0.00	512.27
Zachodniopomorskie	90.00	361.78	65.98	800.09	183.21	235.19	196.62	590.55	260.49	990.72	147.79	1990.48	166.33	51.67	694.53

Source: Own study based on www.mapadotacji.gov.pl [10.02.2020].

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