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Modelling and Analysis of Socio-Economic Development of the European Union Countries through the DP2 Method

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Abstract: - Further positive social and economic development (SED) requires modelling and analysis for evaluating its results to ground directions for future development. The purpose of the paper is to study the problem of estimating of SED, to form the methodology for modelling its results and to create an aggregated econometric indicator within the framework of unified conceptual approach for the European Union (EU) countries. To achieve this goal, it is necessary to solve the following objectives: to determine the essence of the concept of SED, to study traditional approaches to measure SED, to give an overview of the DP2 modelling

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method, to discover and structure the elements of SED in the EU countries and to argue a conceptual approach to modelling its outcomes. The study is based on the method of mathematical modelling in economics based on Distance P2 method. Econometric modelling, as well as regression analyze, was used to develop a synthetic indicator DP2 for evaluating SED of the EU countries. Also, the research process was based on analysis, synthesis and the system approach for information processing, as well as on the method of comparative and statistical analysis, quality and quantity analysis. The results of the deep research showed that there is no unified approach to modelling SED. The Distance P2 method was first proposed to measure SED at the national level exactly for the EU. The methodology for measuring SED specifically for the EU countries based on the conceptual approach was developed and substantiated. Based on the proposed methodology and taking into account the special characteristics of the region studied - the social and economic DP2 indicator for the EU countries was created. This study proposes to build a synthetic indicator DP2 to model results of progress in SED, especially in the EU. The practical implications of the synthetic indicator DP2 for modelling and analysis of SED of the EU countries can be a prospect for further research. Applied aspect of these studies is advising the EU's public policy with the aim of advancing. Using the DP2 synthetic indicator of SED for the EU countries will identify and substantiate the main directions for developing the country's domestic policy to improve the quality of life of the populations. Also, the results of the study can be used for advisory purposes to develop and optimize the EU development strategy 2020-2030. The value and originality of the paper lie in further application of the methodology of modelling the SED of the EU countries through synthetic indicator DP2. This will expand opportunities for increasing the national economy's efficiency, that is highly important in terms of increased international competition.

1 Introduction

The issue of development, both social and economic, has remained relevant throughout the history of mankind. During the long evolution of this problem, both the content of social and economic development (SED) and its conceptual approaches were changing. Early attempts to measure human development were focused more on its estimation in terms of economic factors.

In the second half of the 20th century, international organizations appeared. Their main feature was that they operate outside the jurisdiction of a particular country. This gave a big push to extrapolating the problem of social, economic and human development. This was reflected in the reports of the organizations such as the World Bank (WB) and the United Nations (UN) [32].

Amartya Sen is considered to be the father of the theory of human development. In 1998 he was awarded the Nobel Prize in Economics for his work on welfare economics. Among other works, one of the most outstanding was the Collective Choice and Social Welfare (1970) [1]. So, in the 80s of the last centuries, the idea of human development is gaining popularity in the world community. At the same time, a wider view of the development problem begins to prevail.

The problem of social and economic and, in particular, human development becomes part of public discourse when a team of scientists – led by economist Mahbub ul Haq – as part of the United

Nations Development Program (UNDP) publishes its first Human Development Report in 1990 [31]. It is Mahbub ul Haq who is considered the founder of the modern concept of human development. The report proposed an original methodology for measuring human development, which takes into account both economic and social factors. This method made it possible to assess human development both at the national level and supranational. This concept began to gain its popularity so rapidly that today more than 100 countries around the world publish annual reports on human development at the state level [2]. This concept made a significant contribution to the development of economic science. From this moment on, the development completely stops to be considered solely as an economic indicator.

The last few decades, a wide concept of human development has transformed into some conceptual directions, such as quality of life, happiness, well-being and SED. Among others, it is the SED that is the area of our research. Human capital is a determining factor in the SED of any country [3]. Geographically, the study focused on the European Union (EU). The EU is a unique form of union that has elements of the interstate, supranationalism and multi-party parliamentary democracy. All these factors only complicate the SED problem, taking it to the new level – beyond the responsibility of one country.

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Currently, the EU has a rather high level of SED, but at the same time, today every seventh citizen of the EU is at risk of poverty. Moreover, for less protected groups of the population (such as elderly people and children) this indicator is even more negative [4]. And while the urgency of the problem continues to grow – the issue of creating the one complex indicator and unified measuring method of SED still open.

Over the past few decades, a huge amount of scientific and practical works has been devoted to the study of the features of SED. Special attention was paid to the problems of its measuring, in particular, to the methods and models. These issues were covered in the many works of Ukrainian and International researchers.

The fundamental analysis of the theoretical background based on these scientific works is the basis of our paper. For our study, it was extremely necessary to analyse and compare different methodologies and methods to measure SED. This analysis will be presented in the next section of the paper, as well as a brief description of the problem in corresponding studies.

The purpose of the paper is to study the problem of SED measurement, to form a valid methodology for modelling its results and to create a synthetic indicator within the framework of unified conceptual approach for the EU countries.

To achieve this goal, it is necessary to present the structure of the content that will be developed in the following sections: determine the essence of the SED concept, study traditional approaches to measure SED, give an overview of the DP2 modelling method, discover and structure of the SED elements in the EU countries and argue a conceptual approach to modelling its outcomes.

2 Theoretical background

2.1 Measuring SED: Literature Review and Problem development

The concept of SED should be considered in the context of three levels: macro-, meso-, and micro-level. Macro-level covers the world community and national states. Meso-level – regions within the state; communities and associations. Micro-level – the processes occurring in the everyday life of individual organizations, groups and individuals. The purpose of such development is that people live a long, healthy and happy life, due to the socio-ecological-oriented innovation economy development [5], [6], [7].

In this article, we conduct the research solely on the macro-level, in the context of country comparisons. At the same time, the SED will be seen in the context of the multidimensional approach to the development: as structural and qualitative changes in the economy, factors of growth and development, science and innovation, education, environment, transport, quality and standard of living of the society and human capital. However, it is important to note that in addition to internal factors, international investment (in particular: investment income and foreign capital categories) is an important component of SED represented by economic growth, especially for developing countries [8], [9], [10].

As previously mentioned, since the time of Pigou, the only economic indicators of material goods and services were traditionally used to measure both human development and SED [11]. It is GNP per capita that has long remained the main indicator of development. Welfare measurements with only one indicator of income caused controversy among academic economists and their colleagues in related social sciences. So, in the evolution of economic science, this approach has been found defective.

Donald McGranahan, Eduardo Pizarro, Claude Richard (1985) analysed the shortcomings of the traditional "money" method and identified the potential of alternative approaches [12]. This research was part of a long-term study of alternative methods for evaluating SED at the intuition of The United Nations Research Institute for Social Development (UNRISD). Thus, this study gave a result that became the first step to rethinking the classical approach.

Habibullah Khan (1991) made a special contribution to the development of the problem of SED measurement. In his papers, Khan analysed various approaches to development measurement over the past decades, dividing them into two groups: based on income and social indicators approaches. The main achievement obtained was the results of a correlation analysis, which showed a close relationship between the GNP per capita and aggregated social indices [13]. This finding once again confirms the adequacy of measuring development not only from the point of economic growth but also through social achievements.

Vasily Kolesov (2008) in his fundamental work examined actual aspects of measuring SED based on the classical approach to the concept of human development. The author paid special attention to the importance of social development factors, in particular, to living standards, inequality, education,

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health and housing life expectancy [2]. The main
focus of his research was the role of the state and its
policies in the SED of the nation.

Adam Szirmai (2015), a Dutch scientist of
Hungarian descent, formed a new stage in the
development of research on SED problems. His
study, devoted to the changes of SED in developing
countries, was based on the interdisciplinary
approach. The obtained results opened a new
perspective on the problem from the standpoint of
such sciences like history, political science,
sociology and anthropology [14].

For nearly 100 years, the study of SED remains a
debatable issue. The inexhaustibility of this topic
leaves great potential for further scientific research.
At present, there is no unified approach to measure
SED in economic literature. Among other
methodologies, the most authoritative is the
generally recognized approaches developed by
various international organizations and companies.

2.2 International Methodologies and Methods to measure SED

Traditionally, GDP per capita is the most used
indicator to measure SED, for example, the EU use
it to assess progress in regional development. In
recent decades, from Amartya Sen's approach [1] to
human development, it is considered necessary to
include more dimensions in the measurement of
development in the form of social and economic
indicators. Sometimes they are integrated into a
weighted synthetic indicator, and sometimes not
(without weighting).

Thus, in addition to the main indicator of SED –
GDP per capita, – there are two groups of methods
which are the most popular in modern international
practice to measure results of SED in different
countries: 1st – based on a system of individual
indicators and 2nd – in the form of complex
indicators, known as synthetic indexes.

There is a huge amount of complex assessment
methods and aggregated indices of SED. Among
others, the most commonly used measurement and
evaluation methods are developed by major
international organizations and companies in their
fields. These are organizations such as the United
Nations Organization (UN) [32], Organization for
Economic Co-operation and Development (OECD)
[33] and The Economist Intelligence Unit [34].

The complexity of the studied category of SED
and continuous expansion of its content leads to the
idea that there is a definite connection between SED
and the achieved quality of life within it. So, the
quality of life and human development is the result

of the achieved level of SED. This makes it possible
to measure SED through these interrelated
categories.

2.2.1 Human Development Index

Among the comprehensive indicators, perhaps the
most famous and most cited is the Human
Development Indices (HDI), developed by the
United Nations Development Program (UNDP)
[32]. Today many economists are successfully using
this indicator to measure SED [15]. The aggregated
HDI indicator, developed for comparing countries
by the level and quality of life, consists of three
separate indices [32]:

a) Length of Life (LEX) – means life
   expectancy at birth in years for health
   dimension;
b) Knowledge (EDN) – mean and expected
   years of schooling for knowledge dimension;
c) A decent standard of living (PCY) – means
   gross national income per capita at constant
   prices (2005 PPP US $) for the dimension of
   a standard of living.

The arithmetic average of three separate indices
makes up the index of human development - Human
Development Indices. The index does not confine
only to the economic level but takes into account the
conditions that are created for demographic
reproduction, cultural development and welfare of
the population. It is based not only on the volume of
material goods consumption but also on the
opportunities for human development provided by
healthcare and education.

This index corresponds to its task of comparing
the countries by their level of SED [16]. Therefore,
today it is one of the most popular indicators for
measuring SED in different countries of the world.
The main disadvantage of this indicator is a small
set of included indicators which cannot fully and
objectively judge the SED of a county as an overall
development result.

2.2.2 Better Life Index

The next aggregate indicator that is popular in the
world practice of measuring SED - is the Better Life
Index, developed and annually calculated by OECD
[33]. The member countries of the OECD use 11
parameters to determine the quality of life: health;
education; employment and quality of working life;
income; leisure and recreation; living conditions;
happiness and life satisfaction; state of the
environment; personal safety; civil rights; social
opportunities and social activity [33].

A conceptual understanding of development is
taken as the basis in the process of selecting

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indicators for assessing SED in OECD countries. Thus, within the framework of the Better Life Index methodology, social development is a complex multilateral process for which the growth of material wealth is not the primary goal and not the main result, but rather a tool for creating better living conditions.

2.2.3 Quality-of-life Index

Another option for measuring is the Quality-of-life index. It was developed by the reputable British company Economist Intelligence Unit in 2005 [34]. This aggregated indicator is based on a methodology linking the results of studies on a subjective assessment of life with objective determinants of SED in these countries. The index consists of 9 parameters, including material well-being, health, employment, political environment, social sphere, personal life, security, climatic conditions and gender equality [34].

Of course, an obvious disadvantage of the Quality-of-life index is a narrow-angle estimation of SED, that doesn't include any economic component. It is social indicators that determine this index more. It can be summarized, that the Quality-of-life index is based principally on social indicators.

2.2.4 Comparison of methodologies and methods

For a visual comparison of different methodologies and methods described in the previous part of the paper – a comparative table of international indicators to measure SED is given below. Table 1 clearly shows the volume and content of categories that are the components of each synthetic indicator discussed above.

Table 1. Comparison of international indicators of SED by its structural components

Categories / Indices	Human Development Indices (UN)	Better Life Index (OECED)	Quality-of-life Index (The Economist Intelligence Unit)
Income	•	•	•
House		•	
Job		•	•
Social life		•	•
Education	•	•	
Environment		•	•
Political environment & civil rights		•	•
Health	•	•	•
Life satisfaction		•	
Safety		•	
Leisure		•	
Climate			•
Gender equality			•

Source: developed by the authors

To summarize the Table 1, we can state that different aggregated evaluation methods of SED (including the quality of life) consist of completely different structural components. The most commonly used are income and health (basic needs). The rarely used components are happiness and life satisfaction, security, leisure, gender equality and climate.

Moreover, each synthetic index is built based on its own unique methodology. So, there is no unified set of components for constructing an aggregate indicator in order to measure SED In different countries. Each individual index takes into account its own set of SED indicators, but it is important to emphasize that each of these sets is incomplete to one degree or another.

We can conclude that all of the above presented synthetic indexes were originally developed for use in world practice. The set of indicators selected for compiling a particular index is universal for every country (according to the authors of the methodologies). Thus, in these complex indicators, regional characteristics of the development of various countries are not taken into account, when evaluating their SED.

3 Research Methodology

3.1 Description of Method

Before presenting the approach proposed for modelling and measuring SED in the region of the EU and creating a synthetic aggregated index, it is necessary to give a complete overview of the mathematic method underlying the modelling of the index and argue its relevance.

For our study, we will use a synthetic indicator DP2 based on the Distance Method of Pena (also known as the P2 distance measurement method or the DP2 method). This method was developed by Professor Pena [17] for inter-spatial and inter-temporal comparisons. It was further continued and supplemented by Zarzosa [18], that has been applied for research in similar fields by Somarriba

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and Pena [19], Nayak & Mishra [20] and Zarzosa [21]. Later, Rodríguez, Holgado, Salinas [22], [23], [24] first used the P2 distance method for work with SED at the regional level.

This modelling method gives us the opportunity to analyse a large set of data. Indicator built by aggregation procedure based on econometric P2 distance measurement method allows you to compare the countries studied based on a wide range of variables due to one synthetic indicator - DP2 indicator. Thus, we can compare countries not by one indicator, but by a whole set of indicators synthesized into one index.

The essence of the Pena (1977) method is to measure the distance between each study area and one imaginary reference base. The reference base is a theoretical territory that has the most negative results for each individual indicator of which the indicator consists. So, the DP2 indicator calculates the distance of each studied territory to this imaginary territory. For this imaginary territory the value of DP2 = 0.

Synthetic DP2 indicator as a distance from country j according to the Pena method [17] defined as follows (1):

$$DP_2(j) = \sum_{i=1}^{n}\left\{\left(\frac{d_{ij}}{\sigma_i}\right)\left(1 - R_{i.i-1,\ldots,1}^2\right)\right\}, \quad (1)$$

with $R_1^2 = 0$, where $d_{ij} = |x_{ij} - x_{i*}|$; $i = 1,2,\ldots,n$; $j = 1,2,\ldots,m$;
- j is the country;
- i is the variable;
- n is the number of variables;
- m is the number of countries;
- x_{ij} is the value of the ith variable in the jth country;
- σ_i is the standard deviation of the ith variable;
- $R_{i.i-1,\ldots,1}^2$ is the coefficient of determination in the regression X_i over X_{i-1}, X_{i-2},…,X_1, that is already included.

In the process of modelling, we calculated the linear regression based on the variables used in the DP2 model. On its basis, we can measure the part of the variance of each individual variable [25]. This variance is measured by the determination coefficient (2).

$$R_{i.i-1,\ldots,1}^2 \qquad (2)$$

The factor $\left(1 - R_{i.i-1,\ldots,1}^2\right)$ is a correlation factor [17] through which the added information partially contained in the previous indicators is partially excluded. Thus, due to the correlation mechanism

duplication of information is avoided by including only new information [19].

It is important to describe the mathematical properties of the DP2 indicator. The DP2 synthetic indicator satisfies all the standard properties that the aggregated indicator should have, that has been proven in the papers of Zarzosa [18] and Pena [26].

The main advantage of this method over other methods lies in the fact that in addition to the standard properties, the model solves several important problems, such as:
a) arbitrary weighting - by weighting according to the inverse standard deviation [18];
b) heterogeneity of variables expressed in different measures – by dividing by standard deviation [25];
c) duplication of information – through the correlation factor (described above).

Despite the fact that the DP2 method was published by prof. Penna in 1977 [17], it has not got popularity, since it was published only in Spanish. This method attracted the attention of researchers in 2009 when prof. Somarriba and Pena [19] published the first English-language paper, where the quality of life of the EU citizens was measured using the DP2 method.

Today, DP2 has been widely used by scientists from around the world to measure welfare, quality of life, and other similar concepts, such as poverty, both at the regional and national levels. The use of the DP2 method to measure economic and social development is more recent. The most significant work in this area using the DP2 indicator belongs to Rodríguez, Holgado and Salinas [22], [23], [24] whose experience allows us to use effectively the DP2 synthetic indicator for SED measuring.

3.2. Methodological steps to construct the DP2 indicator

To measure SED with an objective approach, it is necessary to build an aggregate indicator. To construct a synthetic indicator based on the DP2 method for measuring SED in the EU countries, it is necessary to determine the main methodological steps (see Figure 1).
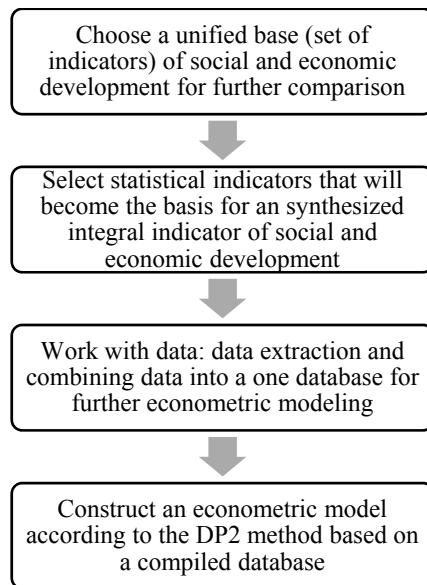
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**Figure 1. Methodological steps of creating DP2
synthetic indicator**

Source: developed by the authors

A special feature of integral indicators is that
their absolute value can be adequately estimated
only when considering their base of indicators
(criteria). In this regard, the choice of a base and its
set of indicators is one of the fundamental issues in
constructing a synthetic indicator of SED. These
aspects will be described more detailed below.

Taking into account the special characteristics of
the research area, a conceptual approach to
modelling SED based on the DP2 modelling method
specialized for the EU countries was proposed.

3.3 Selecting indicators within a conceptual approach

3.3.1 The importance of a Conceptualized Approach

The transformation of approaches to modelling and
analysis of SED is explained by the fact that the old
criteria – material security and basic needs – began
to fade into the background for highly developed
countries. On the other hand, in developing
countries, where they remained super-relevant, the
incomparability of priorities, indicators, and
estimates obtained continue to grow.

A special feature of the current stage of the
world economy development is the high
differentiation of countries within these groups. The
separation of national economies only in three
groups: developed, developing and transition
economies is no longer reflect today's economic
realities. The need to classify countries according to

their regional characteristics is relevant. At the same
time, there is a growing tendency to conceptualize
approaches to measure SED.

Returning to the problem of modelling SED in
the EU countries, it is necessary to adapt the DP2
methodology to the specific features of the
development of the studied regions. The
determining aspect is the base (set of indicators) for
comparing countries SED in unified research
concept. So, there is a need to develop a conceptual
approach for modelling and measuring SED in the
EU countries.

In general, we can evaluate the dynamics of SED
in the EU as positive. Over the past decade from
2000 to 2014, the classic mono-indicator of SED –
GNP per capita has gradually grown with an annual
average of + 0.9% [35]. However, like any other
mono-indicator, GDP per capita is not complete for
measuring SED in every EU country.

So, below we will propose a conceptual approach
to modelling and evaluating SED in the EU
countries. In particular, a unified research concept
and base with a set of specific indicators for
modelling will be presented and explained.

3.3.2 Base of Indicators for modelling

Modelling SED – is a multidimensional process,
which is considered in terms of many different
social and economic goals. Even if it is only about
measuring economic development, it is usually
analysed along with social development to obtain a
comprehensive evaluation.

Since the methodology proposed to model and
evaluate the development of the EU countries, it is
important to choose the one special set of indicators
– relevant and giving an adequate assessment for
each of all the 28 EU countries.

The EU policy and its development strategy,
helped us to define a general research concept with
the group of indicators which allow us to measure
and evaluate SED in the EU countries. The SED of
all the EU member states is being implemented
within the framework of the general and unified
economic policy of the EU. This policy was
presented in the Lisbon Strategy and continued in
the Europe 2020. The importance of a development
strategy is that it determines a successful foreign
economic policy [27].

The Lisbon Strategy, a ten-year development
strategy, was launched in March 2000. Its main
priority was to achieve EU competitiveness with the
following indicators: a fast-growing and knowledge-
based economy; sustainable economic growth; high
employment and job security, as well as social
cohesion. Thus, the Lisbon Strategy was focused on

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3 main areas of development: economics, social sphere, ecology and sustainability – as one general concept [35].

At the end of the Lisbon Strategy, in 2010 Europe 2020 was launched. The Europe 2020 was a logical continuation of the previous strategy, but revised and transformed according to the current realities. EU's new ambitious development goals are defined in the framework of the concept «smart, sustainable, inclusive growth» [35].

Thus, the SED of the EU countries during this period should be measured in the context of common goals and development directions within the framework of the current strategy Europe 2020. Indicator requirements should include authenticity, structural coverage and the ability to reflect changes. So, a set of indicators for measuring SED of the EU was chosen in the context of 3 main goals within the framework of its strategies:

- Smart growth – business, science, education;
- Sustainable growth – transport, environment;
- Inclusive growth – social inclusion, poverty and health.

As a result, we got a unique conceptual base with a set of specific indicators (see Table 2) for modelling and analysis SED in the EU countries based on the aggregated indicator DP2. As mentioned earlier, this set of indicators most accurately reflect the SED of the EU countries, taking into account all the specific features of this region and its development goals and directions.

It is very important to emphasize that the set of indicators presented below in Table 2 will be used in our research as evaluation criteria for the EU countries SED in the form of one aggregated DP2 indicator.

Table 2. The base of Indicators for modelling SED in the EU (according to the objectives of European Strategy 2020)

Objectives EU 2020 Strategy	Dimensions	Indicators	Units
Smart growth	Competitiveness and business environment	GDP per capita in PPS	
		Employment rates of age group 20-64	%
		Unemployment rates of age group 25-74 (-1)	%
		Unemployment rates of young people (less than 25 years) (-1)	%
	Research & Development	Patent applications to the EPO per million inhabitants	unit
		Research & Experimental Development expenditure as % of GDP	%
	Education	Tertiary educational attainment of age group 25-64 (%)	%
		Early leavers from education and training (from 18-24 years) (-1)	%
Sustainable growth	Transport	Victims in road accidents per million inhabitants (- 1)	unit
		Freight transported by road by region of loading (-1)	TKM
	Environment	Municipal waste generated per inhabitant (-1)	Kg/cap.
		Share of energy from renewable sources	%
Inclusive growth	Social inclusion, poverty and health	People at risk of poverty or social exclusion of total population (-1)	%
		Life expectancy at birth	year

Source: developed by the authors

3.4 Special features and uniqueness of the proposed methodology

When selecting indicators for measuring a group representing each goal of the SED of the EU, similar works of Rodríguez, Holgado and Salinas [22], [23], [24] were analysed and redone. The studies presented in these papers are geographically localized in the EU and are aimed at measuring SED. However, each of the above-mentioned works examines the SED at the regional level while our purpose is to assess the SED of each EU country as a whole. Moreover, in these works, the set of indicators selected to represent each of the groups were compiled most recently in 2015 and do not reflect the economic reality of the EU today. Today they should be updated.

In order to adapt the aggregated indicator DP2, to be suitable and adequate for assessing the modern SED of the EU countries - a set of indicators for creating a synthetic index was deeply analysed and

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recompiled under the current economic realities of the EU. The changes were made, in particular, for a group of environmental indicators, as well as for the economic competitiveness and business environment.

Among other indicators, the Research & Development expenditure (R&D) to GDP is the most significant one in the obtained econometric model. At the moment, a study on the inequalities in the SED in the former socialist countries of the EU is being conducted [28]. The study is based on our methodology for modelling SED in the EU countries through the DP2 index.

According to the current research results already presented [28], this indicator is more significant in the DP2 index of the EU SED according to the correlation coefficients, the correction factor, the coefficient of discrimination of Ivanovic [29]. At the same time, the innovative potential, based on R&D expenditure, is a determining factor in the EU national economies competitiveness [30], which is one of the components of SED (see Table 2).

It is also worth noting that some of the selected indicators are taken into account with a sign (-1). This indicates the need to use this indicator with a minus sign in calculating the aggregate indicator due to its negative impact on SED.

Thus, it is possible to build the most adequate aggregated indicator through the econometric modelling method "Distance P2" with the conceptual approach proposed above for measuring SED, especially for the EU countries. The DP2 indicator obtained will fully reflect the SED of the EU with all the regional specific characteristics. The indicator will be equally effective both for each EU country and for comparative research between countries.

4 Results and discussion

The proposed methodology is multifunctional and allows us to evaluate the SED in the EU as a whole, as well as its possible application for each country. As an example of applying the DP2 methodology for the EU countries, the model of SED of the EU15 countries in 2004 was built and empirical research results were obtained.

The 2004 data were used for the analysis of SED of the EU15 members as the last result of the EU15 development in such a composition (before the subsequent EU enlargement and the accession of new member states). It is important to note that the obtained DP2 indicator of the SED of the EU15 countries reflects the level of their development only for the 2004 year. This 2004 model is extremely

necessary for further research. It will become the basis of our subsequent study on inequalities in SED in the former socialist countries in the EU. Thus, we will be able to compare its progress through the years by building an additional model based on the same methodology but with updated data.

As a result of the econometric modelling, a synthetic indicator DP2 of SED was obtained for each EU15 country (Table 3). On DP2 indicator for every country combines the full set of specific indicators of SED, that was determined in the previous section of the paper and presented in Table 2. This set of indicators (Table 2) is the evaluation criteria for the EU countries SED.

Table 3. DP2 synthetic indicator on SED of the EU15 in the 2004 year

Position	Country	Synthetic Indicator DP2	
1	Sweden	19,67	maximum 19,67
2	Finland	19,08	
3	Denmark	18,85	
4	Netherlands	16,83	
5	Luxembourg	15,56	
6	Ireland	15,25	
7	Austria	15,03	
8	United Kingdom	14,28	average 14,42
9	France	13,69	
10	Germany	13,55	
11	Belgium	13,31	
12	Greece	11,08	
13	Spain	10,61	
14	Portugal	10,49	
15	Italy	9,03	minimum 9,03

Source: developed by the authors

As mentioned above, the DP2 indicator determines the distance between each country and one imaginary reference base (theoretical territory) that has the worst result for each individual indicator which are included the aggregated indicator. Thus, the higher the value of the DP2 indicator - the farther the distance of each country from the reference base in the econometric model - the higher it's level of SED.

Based on the obtained results in the model, the table-rating of the EU15 countries (Table 3) was compiled according to the level of their SED in 2004 (0 - worst value). Table 3 shows that Sweden has the highest DP2 indicator value — 19,67. This

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allows us to conclude that Sweden has the highest level of SED among other EU15 member countries in 2004 (based on the obtained model results). Italy has the lowest DP2 value — 9,03.

Accordingly, based on the obtained empirical results, Italy had the lowest level of SED in 2004. It is worth noting that the gap between the maximum and minimum in the model is 10,6 units with the 14,42 of the average value of the SED indicator for the EU15 in 2004.

To understand completely the SED of the EU15 countries in 2004 within the union, a deep analysis of the results obtained through the modelling process was carried out. Based on the results of DP2 synthetic indicator of the SED of the EU countries, all the countries were divided into 3 separate groups in accordance with their level of SED relevant for 2004 (Table 4).

These groups were calculated as an equal proportion between the minimum and maximum values of the DP2 indicator of the SED of the EU countries in 2004. Since the gap between the maximum and minimum value of the DP2 synthetic indicator was 10,64 (with a minimum of 9,03 and a maximum of 19,67) - the groups were divided according to the following criteria: first group - DP2 indicator 9,03-12,58; second group – 12,58-16,12; third group – 16,12-19,97. As a result, three groups of the EU15 countries by their level of SED were obtained:

1) Countries with a high level of SED
2) Countries with a medium level of SED
3) Countries with a low level of SED

According to the results of the analysis based on the obtained DP2 indicator (Table 4), we can select a group of the EU15 countries with a high level of SED (average value – 18,61) that includes such countries: Sweden, Finland, Denmark, the Netherlands. The group of countries with a medium level (average value – 1,38) includes such European countries as Luxemburg, Ireland, Austria, the United Kingdom, France, Germany, Belgium. The group of the EU15 countries with a low level of SED (average value – 10,30) includes Greece, Spain, Portugal, Italy.

Table 4. Groups of the EU15 countries by SED in 2004 (according to the DP2 synthetic indicator)

Group by the level of SED	Average synthetic Indicator DP2	Country
Hight level	18,61	Sweden
		Finland
		Denmark
		Netherlands
		Luxembourg
		Ireland
		Austria
Medium level	14,38	United Kingdom
		France
		Germany
		Belgium
		Greece
Low level	10,30	Spain
		Portugal
		Italy

Source: developed by the authors

Moreover, it is important to note the different share of each EU15 group over the maximum value of DP2 indicator of SED. So, if we analyse the contribution of each of the three groups of the EU15 countries over the maximum value of DP2 indicator in 2004, we will get the following results.

The share of the EU countries with a high level of SED over the maximum value of DP2 indicator is 94,62% with the average indicator of DP2 – 18,61. This result allows us to assume a very high level of SED not only for Sweden, which has the maximum value of the indicator but also for the other countries of this group, whose indicators are at a close level (Finland, Denmark, the Netherlands).

The share of the EU15 countries with a medium SED level over the maximum value of DP2 indicator is 73,11% that indicates a rather big share of this group of countries in the maximum DP2 indicator of SED. The same indicator for the EU15 countries with a low level of SED is 52,37%. This result indicates a rather positive level of development of these countries in general, despite the relatively low indicator for this group of countries in the overall ranking of the EU15.

Received materials can be extremely useful for further evaluation and correction of the EU SED policy and its development goals. A separate study is required to identify and analyse the causes of the obtained results in the DP2 model of the EU countries SED for 2004.

These empirical results are only an example of the application of the methodology proposed in the paper. Our methodology "the DP2 synthetic indicator for modelling and analysis of SED of the

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EU countries" can be used to continue future in-depth research on SED level of the EU countries: both within the EU15 and other union configurations, as well as for each country.

Based on the materials obtained for 2004 and building an additional DP2 model using the methodology presented, it is possible to compare SED inequalities in the former socialist EU countries (after they entered into the EU). Thus, we will be able to answer the question "has the gap between the former socialist EU countries and other EU members narrowed in recent years, or not?". For this, in further studies we plan to make econometric DP2 models based on the presented methodology for all the EU countries for 2004 and the current year.

The practical implication of these studies is advising the EU's public policy with the aim of its advancing. Using the DP2 synthetic indicator of the SED of the EU countries will identify and substantiate the main directions for the EU country's development policy to improve the quality of life of their populations. Also, the results of the study can be used for advisory purposes to develop and optimize the future development strategy of the EU 2020-2030.

The contribution to the body of knowledge and the value of the paper lie in further application of the methodology of SED modelling of the EU countries through synthetic indicator DP2. This will allow expanding opportunities for increasing the national economy's efficiency, that is highly important in terms of increased international competition.

5 Conclusion

There are no perfect modelling methods to measure social and economic development, as well as complete statistical information, especially towards interdimensional and intertemporal comparative analysis. However, we can summarize that it is necessary to compare studied countries within a unified conceptual approach to a research methodology. As a result, this will significantly increase the efficiency of SED estimating.

More efficient methods for such a comparison are not based on the mono-indicators, but on the composite aggregated indicators, for example – DP2. The selection of indicators (variables) – that will be the basis for composing a synthetic indicator – is a determinant factor in the final efficiency of the DP2 indicator and its adequacy in modelling SED towards empirical reality.

To model and evaluate the SED of each geographical region, it is extremely necessary to draw up a general unified concept. A research study should be conducted within the framework of the concept. In particular, this applies to the EU. Evaluation and comparison criteria for the EU countries should be conceptualized – a set of indicators should reflect common problems and development goals of all the countries.

So, as a result of the study, a conceptual approach to modelling and evaluating SED results in the EU was proposed, based on the econometric modelling method of measuring the distance P2. The synthetic indicator obtained within the aggregation procedure allows us to compare the EU countries based on a wide range of indicators, aggregated into one indicator – DP2.

The uniqueness of the proposed method lies, firstly, in its low prevalence among economists. For example, this method is absolutely not studied in the Slavic countries as well as among the Russian-speaking part of the scientific world. The extrapolation of the distance measurement method P2 to aggregating the DP2 indicator and the spread of its application in these regions can have a big effect. The effect will consist both of studies conducted in this geographical region and of its applied use to model results, evaluate and further transform economic and social policies.

Secondly, the advantage of this method is its adaptability to the study of SED in the EU countries with high efficiency. Within the framework of the paper, a unified concept of research, modelling and measuring SED for all the EU countries was proposed. The basis of the concept is the EU development strategy and its main objectives. So, as a result of deep analysis, a unified list of indicators – variables for calculating the aggregated indicator DP2 – was compiled and justified. Within the framework of the proposed concept and the indicators' base included, it is possible both to adequately model the SED level of each country of the EU and to equally compare countries based on one DP2 indicator of SED.

The importance of the proposed concept of a synthetic indicator to measure SED is quite obvious for theoretical studies, in particular for further research in this area by scientists-economists and specialists in interdisciplinary scientific fields. In addition, the high efficiency of this conceptual method can also be obtained for applied purposes and practical results. One of such applied aspect is the internal policy of the EU and its member countries.

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In modern economic reality, improving the quality of life is considered as a priority goal of society and the most important direction of public policy. At the same time, the quality of life is the result of SED, which at the same time is the basis of further changes. All this confirms the importance of using integrated measurement indicator that should be conceptually justified and based on the application of aggregation methods for the purposes of social and economic policy. All this is presented in our methodology.

As an example of the proposed methodology for modelling and analysis SED in the EU countries, an econometric model of SED for the EU15 was built (based on the 2004 data as the last result of their development until the accession of new EU member states). As a result of the described model, we obtained a synthetic indicator DP2 of the SED level for each EU15 country. The EU15 countries ranking was compiled by their level of SED in 2004. In accordance with the synthetic indicator DP2, among other member countries of the Union in 2004, Sweden has the highest SED level, Italy has the lowest. Also, the EU15 countries were divided into 3 main groups, by their level of SED. The group with a high level of SED in 2004 includes Finland, Denmark, the Netherlands; with a medium one – Luxemburg, Ireland, Austria, the United Kingdom, France, Germany, Belgium; a low – Greece, Spain, Portugal, Italy. These empirical results can be used for further in-depth research of the SED level for each country of the EU and other studies.

So, based on the methodology obtained with the DP2 modelling method in the concept of SED of the EU countries (both on the example of the obtained model, and on the results of further research) – economic and social policies of the EU countries can be optimized. At the same time, further growth may offset the cost of transformation and implementation of the new socio-economic policy, that is confirmed by several EU analysts. Also, the synthetic indicator DP2 can be used to assess the results of the SED of the EU over the last 10 years, that can form the ground of the new EU development strategy 2020-2030. Thus, the optimal social and economic policy of the EU and its member countries for the next 10 years will be improved and developed.

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