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SOCIOECONOMIC WELL-BEING – SOFT MODEL

Abstract. In the article, soft modelling has been used for the measurement of socioeconomic well-being. The method allows the relational analysis of latent variables that are not the explicit equivalents of measurable variables. On the basis of a theoretical description, a model is built that describes the dependency of the studied latent variable with its indicators as well as with the other latent variables. The study of socioeconomic well-being has to take into account the benefits of healthcare and education in addition to material factors. The model assumes that socioeconomic well-being is dependent on the level of economic development and natural environment condition. The soft model has been constructed for the analysis of socioeconomic well-being in the European Union countries.

Key words: socioeconomic well-being, soft model.

I. INTRODUCTION

The necessity of finding a new measurement of the well-being of societies is emphasized by politicians, international organizations and especially scientists. The universally used GDP indicator is only a measurement of economic progress and does not take into consideration the quality of human life. The measurement of socioeconomic well-being should consider not only the material aspect but non-material aspect as well, and natural environment condition in particular.

In the article, soft modelling has been used for the measurement of socioeconomic well-being in the European Union countries. The soft model has been built and estimated on the basis of data of the year 2007.

II. FROM GROSS DOMESTIC PRODUCT TO NEW INDICATORS OF WELL-BEING MEASUREMENT

Defining complex terms, to which well-being belongs, is very difficult. Many terms of well-being that are not precise and explicit can be found in the literature which makes the measurement complicated. A variety of terminologi-

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cal and methodological bases can be found in numerous studies of the issue. The term of well-being is frequently identified with such terms as: the level of socioeconomic development, the standard of living, the quality of life, living conditions, the dignity of life. The choice of definition of well-being is of fundamental significance for the obtained results of the measurement.

Gross domestic product is a measure which takes into account only the economic aspect of development, omitting social and environmental issues. GDP determines the total value of goods and services produced within a year in a given area. The growth rate of gross domestic product or gross domestic product per capita is, therefore, a measurement of economic growth. The measurement has been universally used since the middle of the 20th century and economists gathered around the International Association for Research in Income and Wealth had an important influence on creating the concept of its calculation. At present, two international studies: the System of National Accounts *SNA* and the European System of National Accounts *ESA* form methodological grounds for determining gross domestic product. The main arguments in favour of calculating GDP are [Zienkowski (2001), p.11–12]:

– national accounts provide the most complete picture of national economy and changes of economy structure in the longer term,
– internationally unified methodology allows keeping reliable comparisons.

Obviously, gross domestic product is not a measurement devoid of faults. By definition every good and service produced in the production activity, irrespective of whether it has positive or negative effects for the society, brings about an increase of GDP. It should also be emphasized that gross domestic product does not take into account the non-market sector of economy (work in households, neighbourly help, voluntary work and the like). The account of GDP does not reflect the exhaustion and degradation of natural resources used for the production of goods and services, either. In view of the above remarks, it should be agreed that GDP can not correctly describe the level of socioeconomic well-being which means that one and the same measurement does not measure two substantially different units – production and well-being [Zienkowski (2008), p. 25]. For this reason, there is the necessity of extending economic accounts to social and environmental accountancy. Attempts are made in socioeconomic studies to introduce alternative or complementary measurements of well-being in relation to GDP.

The Human Development Index *HDI*[1] worked out within the United Nations Development Programme is a good example of socioeconomic well-being measurement. The *HDI* index is based on three fundamental factors: level of general

[1] The way of constructing the *HDI* indicator is discussed in the annual global report UNDP *Human Development Report*, e.g. HDR 2007/2008, p. 355–356.

health (Life expectancy at birth (years)), level of education (Adult literacy rate (% aged 15 and above) and Combined gross enrolment ratio in education (%)) as well as access to consumer goods (GDP per capita (PPP US$)) which determine the enlargement of human abilities. The *HDI* index combines the assessment of social and economic development of a given area but it does not directly take into account the condition of natural environment. A very simple way of calculating the measurement (arithmetic means of normalized values of measurable variables) can be treated as its good point. It is also important that the *HDI* index has been determined annually for several years in international studies which allows comparing social development of world countries in a longer and longer term.

Taking into account the assumptions of sustainable development, in 1989 American economists H. E. Daly and J. B. Cobb Jr. constructed the Index of Sustainable Economic Welfare *ISEW* [Daly, Cobb (1989)]. Attempts to improve the *ISEW* index led to creating the Genuine Progress Indicator *GPI* [Talberth *et al*. (2007)] by a group of economists gathered in an organization known by the name Redefining Progress. The value of individual consumption provides a basis for calculating the *ISEW* or the *GPI* indicators. Individual consumption is weighted by the index of inequality of income distribution, which is the most frequently determined with the use of Gini coefficient. After determining weighted consumption, expenses and incomes connected with the realization of economic, ecological and social aims of sustainable development are added or subtracted. The social aspect of sustainable development is not considered in an adequate way in creating the *ISEW* index, which resulted in attempts made to improve the *GPI* indicator. However, it can be assumed that both measurements measure welfare mainly in the context of environment protection. The problem, unsolved so far, is to how to price and estimate components of the indicators. They are based on too arbitrary assumptions and are not economically justified. The *GPI* or *ISEW* indicators have been calculated only in some countries in the world: Australia, Austria, Chile, the Netherlands, Germany, Scotland, Sweden, the USA, Great Britain, Italy [Talberth *et. al.* (2007), p. 3] as well as Poland [Prochowicz, Śleszyński (2008)]. The results are not fully comparable because a modification of the fundamental formula in each study has been made.

In February 2008, the Commission on the Measurement of Economic Performance and Social Progress was formed in France. Joseph Stiglitz was appointed chairperson of the commission, and Amartya Sen and Jean-Paul Fitoussi participate in the work of a team. The experts stress the multidimensional character of well-being. The main elements creating well-being are the following: material standard of living, health, education, social relations, natural environment, sense of physical and economic security [*Report*...(2009), p. 14–15]. A new measurement of socioeconomic well-being has not been indicated in the

report. It has been emphasized that "a new measurement of well-being" should be suggested by scientists, but it has to be universally accepted and implemented by international institutions.

III. THE BUILDING OF SOFT MODEL

Soft modelling[2] can be used for the analysis of socioeconomic well-being. The method allows the relational analysis of the unobservable (latent) variables that are not the explicit equivalents of observable (measurable) variables. On the basis of a theoretical description a model is built that describes the dependency of the studied latent variable with its indicators (observable variables) as well as with the other latent variables. The soft model can be divided into two sub-models: internal (theoretical) and external (of a measure). The first of the mentioned models describes relations between latent variables (of unknown values). Whereas the measurement model shows relations between unobservable variables and their indicators. In the soft model, complex terms are learnt simultaneously through their definitions (external model) and through their mutual relations (internal model). Soft modeling allows connecting empirical with theoretical knowledge. Unobservable variables can be defined in two ways: deductive and inductive. Depending on the approach, differences in the method and the results of estimation are obtained. The deductive definition assumes that the latent variable as a theoretical term is a point of departure for searching empirical data, which means that the variable is primal in relation to a given indicator. Indicators of this kind of unobservable variables are called reflecting. In the other case, that is in the inductive definition whose indicators are called building there is a transition from observable to latent variables. External and internal relations in the model are of linear character.

The soft model is estimated by a method of the Partial Least Squares (PLS). Parameters of the measurement model and theoretical model are estimated simultaneously in this method. Estimation of the value of latent variable, which can be treated as a synthetic measurement, is obtained in the method apart from the parameters. The quality of soft model is tested with methods applied in classic econometric modelling and specially designed methods for the model: Stone-Geisser test and Tuckey's jackknifing. Stone-Geisser test measures the quality of model which should be understood as the accuracy of prediction made on the basis of the model compared to "trivial" prediction (e.g. arithmetic mean). Therefore it is not a typical statistic test and its application does not require ini-

[2] A detailed description of soft modeling can be found in works by Jöreskog, Wold (ed.) (1982), Rogowski (1990).

tial assumptions. The values of S-G test are not limited from the bottom, while the top limit is number 1. If the value of the test is negative, the model has a worse predicting property in relation to the trivial prediction. If the value of the test equals 1, predictions are correct, but if the value equals 0, the quality of prediction from the model and trivial prediction are identical. The assessment of the gravity of the model parameters is carried out with the "2s" rule, where s is a standard deviation. The method is called Tuckey's jackknifing.

Sustainable development assumes the improvement of the quality of life of present and future generations and points out the necessity of redefining development goals from material to non-material. The further socioeconomic development can not take place at the expense of future generations and it has to take into account the condition of natural environment. The process of sustainable development takes place within a three-element system "society – economy – environment" [Kiełczewski (2004), p. 17] and following this system the soft model has been built. The diagram of its internal relations has been shown in figure 1. The model assumes that socioeconomic well-being depends on the economic development and natural environment condition. It has also been assumed that economy affects the quality of natural environment.

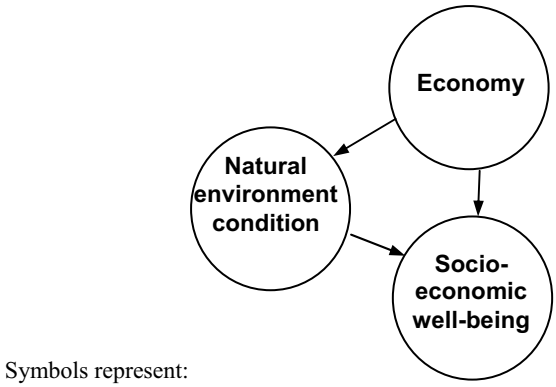

Figure 1. Diagram of internal relations of soft model

Source: Own study.

Soft modeling has been used for the measurement of socioeconomic well-being in the European Union countries. The soft model has been estimated for spatial data of 2007 and the objects were 27 countries of the European Union.

Indicators considering material, health-related and educational aspects have been used for the measurement of socioeconomic well-being (D). In the European Union countries, a uniform research methodology concerning the EU Statistics on Income and Living Conditions (EU-SILC) has been introduced. At Laeken European Council in 2001, a set of 18 indicators was accepted [Szukiełojć-Bieńkuńska (2005), p. 149–151]. The following indicators of EU-SILC study were used for the measurement of the material aspect of well-being:

– Mean equivalised net income per capita in Purchasing Power Standards – D1;

– Income quintile share ratio (relation of the total of incomes obtained by 20% of population of the highest level of income to the total of incomes obtained by 20% of population of the lowest income) – D2;

– At-risk-of-poverty rate after social transfers (% of population whose equivalised net income per capita is below the poverty line determined at 60% of mean equivalised net income per capita in a given country) – D3.

Life expectancy at birth (years) has been used as a synthetic assessment of health condition of the whole society – D4. In the society of a high level of development, education plays an important role. The growth of educational achievements serves both economic and social objectives [Galbraith (1999), p. 61-62]. Gross and net enrolment rate in education at different stages is a frequently used measurement of level of education. Combined gross enrolment ratio in education (%) has been used in the model – D5. It has been supplemented with percentage of the adult population aged 25 to 64 participating in education and training – D6. It should be accepted that among the above indicators of well-being only the income quintile share ratio[3] and at-risk-of-poverty rate are destimulants, the other measurable variables are stimulants.

The following measurable variables have been taken as indicators of economic development (G): Gross domestic product per capita in Purchasing Power Standards – G1 and unemployment rate % – G2. The former of the above measurable variables is a stimulant of economic development, the latter – destimulant.

In the European Union countries, environmental policy is coordinated by the European Environment Agency, whose main priorities are: climate change and energy consumption, air pollution and its effect on health, nature and biological diversity, waste generation and exploitation of resources as well as water abstraction and pollution. Under international agreements concluded in the Kyoto Protocol for the United Nations General Convention on climate change, the European Union countries committed themselves to limit greenhouse gas emis-

[3] In the middle of 20th century, S. Kuznets pointed out that there is a relation between economic growth and income inequalities [Kuznets, 1955]. S. Kuznets found that in the beginning inequalities deepen with the economic growth. Then, a levelling effect should follow and inequalities start to diminish. Functional relationship between the variables has the shape of the turned letter "U". This thesis has not always been supported in empirical studies.

sions to the year 2012 by 8% in relation to the level of year 1990. At present, negotiations are being conducted on new agreements as for the limits of greenhouse gas emissions after the year 2012. Unfortunately, the climate summit in Copenhagen in 2009 resulted in lack of agreements. The fundamental European Union legal instrument regulating nature and natural resources conservation and particularly wildlife conservation is the so-called the Habitat Directive. The directive takes into account economic, social, cultural and regional factors and its fundamental objective is the strategy of sustainable development. The main tool of realization of the Habitat Directive is the network of Natura 2000 protected areas. In the 20th century, waste recycle became a serious problem. It is obvious that water is an essential factor for living organisms to function and live. Unfortunately, economic development involves excessive water exploitation and water pollution. The following indicators have been used for the description of natural environment condition:

- Greenhouse gas emissions (tonnes CO_2 eq. per 1000€ GDP) – S1;
- *Natura 2000* area as % of terrestrial area – S2;
- Sufficiency of site designation under the Habitats Directive – S3;
- Municipal waste generated % landfilled – S4;
- Total fresh water abstraction per capita in m^3 – S5.

The high level of S1, S4 and S5 variables contributes to the degradation of natural environment. While the growth of S2 and S3 variables has a positive effect on the environment protection.

The above presented indicators of latent variables seem to be the most important in the light of factual criteria. Unfortunately, the selection of diagnostic variables has a subjective character, as explicit methodological basis for the study of categories occurring in the model does not exist. Access to statistical data should be taken into consideration in the selection of measures.

The constructed soft model has been estimated on the basis of cross-sectional data of the 27 European Union countries in 2007. For the estimation of the model, statistical data of Eurostat and of the studies *Environment Policy Review* (2009) have been used (in case of the lack of statistical data of year 2007, the closest new information has been used). As a result of estimating the model the following estimations of parameters of internal relations have been obtained (standard deviations obtained with Tuckey's jackknifing are given in brackets):

$$\underset{}{D} = \underset{}{+\ 0{,}3635\ G} \underset{(0{,}0608)}{-\ 0{,}5642\ S} \underset{(0{,}0444)}{+\ 9{,}6802} \underset{(0{,}6911)}{} \qquad R^2 = 0{,}7175 \qquad (1)$$

$$\underset{}{S} = \underset{}{-\ 0{,}6510\ G} \underset{(0{,}0046)}{+\ 1{,}6761} \underset{(0{,}0819)}{} \qquad R^2 = 0{,}4237 \qquad (2)$$

Consequently, it has been concluded that well-being has a positive effect on the economic development but a negative effect on the condition of natural environment. With the growth of economy, the condition of natural environment deteriorates. For this reason, it should be assumed that the latent variable occurring in the model - the condition of natural environment is connected with its degradation.

The model assumes the deductive definition of all latent variables. Each unobservable variable is a weighted sum of its indicators. That is why, the weights of this linear combination provide information as for the relative share of a given indicator, in relation to others, in the value of a given unobservable variable. The power of relation of the latent variable with its observable variable is measured with factorial charges. Estimations of parameters of external model and factorial charges are shown in table 1. They are in accordance, as for the sign, with the theoretical description, apart from the variable Natura 2000 area as % of terrestrial area. Analyzing statistical data, it can be noticed that high values of this indicator occur in the so-called "poor countries", hence the obtained result.

Table 1. Estimations of parameters of external relations

Latent variable	Indicator	Weight (error)	Factorial charge (error)
ECONOMY	G1	0,8395 (0,0119)	0,9536 (0,0054)
	G2	–0,3219 (0,0183)	–0,6196 (0,0141)
SOCIOECONOMIC WELL-BEING	D1	0,3334 (0,0353)	0,8444 (0,0261)
	D2	–0,1477 (0,0309)	–0,6536 (0,0963)
	D3	–0,1654 (0,0276)	–0,7280 (0,0544)
	D4	0,2594 (0,0117)	0,8276 (0,0331)
	D5	0,2163 (0,0141)	0,6197 (0,0658)
	D6	0,2135 (0,0186)	0,7158 (0,0365)
NATURAL ENVIRONMENT CONDITION	S1	0,4783 (0,0061)	0,8299 (0,0036)
	S2	0,1796 (0,0087)	0,5557 (0,0102)
	S3	–0,1945 (0,0123)	–0,5395 (0,0125)
	S4	0,4415 (0,0045)	0,8501 (0,0035)
	S5	0,1076 (0,0207)	0,2131 (0,0219)

Source: Own study with the use of PLS programme[4].

[4] PLS computer programme written by J. Rogowski has been used for the estimation of soft model.

The values of Stone-Geisser test for indicators of the latent variable socioeconomic well-being, informing about the quality of prediction of a given indicator and the total test, informing about the quality of prediction made on the basis of the model are shown in table 2. In the model, the worst predicted variable is D3. The total Stone-Geisser test signifies a considerably good predicting value of the model.

Table 2. Total Stone-Geisser test and for indicators of latent variable D

Indicator	Stone-Geisser test
D1	0,6319
D2	0,1468
D3	0,0867
D4	0,4494
D5	0,2701
D6	0,2620
Total	**0,6319**

Source: Own study with the use of PLS programme.

On the basis of the above considerations, it can be assumed that the model has had a positive factual and statistical verification. The soft model will be used for the analysis of spatial diversification of socioeconomic well-being in the European Union countries.

IV. SPATIAL DIVERSIFICATION OF SOCIOECONOMIC WELL-BEING IN THE EUROPEAN UNION

Estimating the soft model with PLS programme, estimations of values of latent variables are obtained. They do not have factual interpretation, but changes of their values can be interpreted. A synthetic variable obtained in this way can be used for the comparative analysis. On the basis of estimations of the value of latent variable, the studied objects can be ordered linearly. In the discussed model, there are positive estimations of weights and factorial charges for stimulants and negative for destimulants (with one exception) and therefore the higher "value of latent variable" informs about the higher level of socioeconomic well-being.

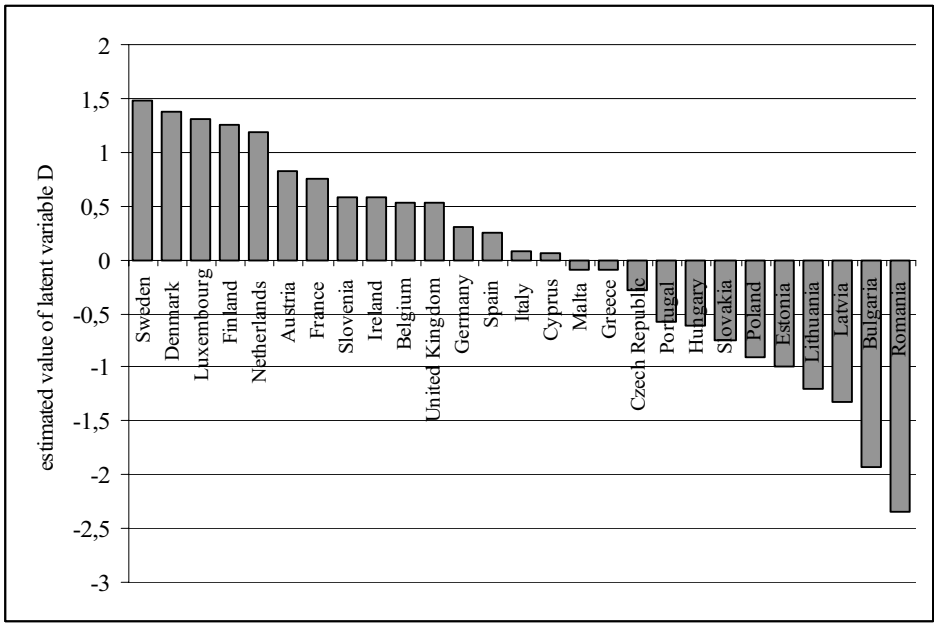

Figure 2. Ordering the European Union counties according to the latent variable socioeconomic well-being in 2007.

Source: Own study.

The order of the European Union countries in 2007 according to the level of socioeconomic well-being has been shown in figure 2. The highest positions are taken by Sweden, Denmark, Luxembourg, Finland and the Netherlands. While the countries of the lowest level of socioeconomic well-being include Estonia, Lithuania, Latvia, Bulgaria and Romania. It should be pointed out that the final positions are taken by new members of the European Union.

V. SUMMARY

Quantifying socioeconomic well-being, the economic, social and ecological aspect should be considered. It should be also pointed out that economic development leads not only to positive effects of economic activity but also its negative effects appear, e.g. natural environment degradation. Multidimensional character of socioeconomic well-being makes its measurement difficult. "A well-being measurement" is being sought.

In soft modelling, the results of ordering are affected by both the descriptive definition of the studied phenomenon (selection of latent variable indicators) and

dependency on other phenomena (introduction of cause and effect structure). Thus, empirical as well as theoretical knowledge is used to full advantage. It seems that it is soft modeling that illustrates the most accurately the real level of the studied latent variable and this tool can be used in multidimensional comparative analysis.

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DOBROBYT SPOŁECZNO-EKONOMICZNY – MODEL MIĘKKI

Dobrobyt społeczno-ekonomiczny to pojęcie złożone, które nie ma w literaturze precyzyjnego i jednoznacznego określenia, stąd trudności jego pomiaru. Wielu polityków, ekonomistów, międzynarodowe instytucje i media próbują wykorzystywać produkt krajowy brutto, czy też dochód narodowy, jako miernik dobrobytu. Jest to podejście niewłaściwe, gdyż jeden i ten sam miernik nie może poprawnie charakteryzować dwóch różnych merytorycznie agregatów – produkcji i dobrobytu. W badaniach społeczno-ekonomicznych podejmowane są próby wprowadzenia alternatywnych, czy też komplementarnych w stosunku do PKB mierników dobrobytu. Trwają poszukiwania formuły, stąd pomiar dobrobytu społeczno-ekonomicznego jest otwartym problemem badawczym. Głównym celem referatu jest zaprezentowanie próby pomiaru dobrobytu społeczno-ekonomicznego z wykorzystaniem modelowania miękkiego.

W pierwszej części referatu zaprezentowane będą rozważania na podstawie literatury o sposobach definiowania i pomiaru dobrobytu społeczno-ekonomicznego. Jednym ze nich jest opracowany w ramach Programu Narodów Zjednoczonych d.s. Rozwoju (*United Nations Development Programme*) wskaźnik rozwoju społecznego *HDI* (ang. *Human Development Index*). Wskaźnik *HDI* jest oparty na trzech podstawowych czynnikach: poziomie zdrowotności, poziomie wykształcenia oraz dostępności dóbr materialnych, które decydują o powiększaniu zdolności i możliwości człowieka. Inne podejście jest stosowane w ramach koncepcji trwałego i zrównoważonego rozwoju, która zakłada poprawę jakości życia współczesnych i przyszłych pokoleń oraz wskazuje potrzebę przewartościowania celów rozwojowych z materialnych na niematerialne. Koncepcja zrównoważonego rozwoju podkreśla trzy aspekty rozwoju: społeczeństwo, gospodarkę i środowisko naturalne, przy czym to ten ostatni element jest bardzo mocno podkreślany. Założenia trwałego i zrównoważonego rozwoju uwzględnione są przy konstrukcji wskaźnika trwałego dobrobytu ekonomicznego *ISEW* (ang. *Index of Sustainable Economic Welfare*), bądź jego modyfikacji wskaźnika autentycznego rozwoju *GPI* (ang. *Genuine Progress Indicator*).

Druga część referatu będzie poświęcona zastosowaniu do badania dobrobytu społeczno-ekonomicznego modelowania miękkiego. Metoda ta pozwala na badanie powiązań między zmiennymi ukrytymi (niemierzalnymi), czyli zmiennymi nie mającymi jednoznacznych odpowiedników wśród zmiennych obserwowalnych (mierzalnych). W oparciu o opis teoretyczny budowany jest model, który wyjaśnia kształtowanie się wartości badanej zmiennej ukrytej poprzez zależności z jej indykatorami (zmiennymi mierzalnymi), a także poprzez związki z innymi zmiennymi ukrytymi. W badaniu dobrobytu społeczno-ekonomicznego, oprócz aspektu materialnego, muszą być uwzględnione korzyści wynikające z ochrony zdrowia oraz edukacji. W modelu przyjęto, że dobrobyt społeczno-ekonomiczny jest zależny od poziomu rozwoju gospodarki i jakości środowiska naturalnego. Zbudowany model miękki ma posłużyć do analizy dobrobytu społeczno-ekonomicznego w krajach Unii Europejskiej.