Kurzemes izaicinājums

Forums „Digitalizācija izglītībā un uzņēmējdarbības atbalstam"

Digitālās ekonomikas un sabiedrības indekss EU 2014 – 2019

Lilita Ābele, Liepaja University, VPP reCOVery-LV

E-mail: lilita.abele@liepu.lv

This paper examines the issue of determining the weights / significance of the composite parameters of the digital economy and society index (DESI) for the EU countries for the period 2014-2018, where the composite parameters are individual indicators (35), sub-measures (14) and measurements (5). In this paper, the theory of inverse and ill-posed problems was chosen as the main tool for determining the desired weights of DESI compound parameters without additional requirements and assumptions: a mathematical model is constructed in the form of a finite-dimensional operator equation of the first kind, in which both the weights of DESI indicators as well as DESI itself are sought; the constructed model is reduced to a normal system of linear algebraic equations, for the solution of which a regularizing operator is constructed that depends on a parameter, called a regularization parameter, and an algorithm is proposed for finding the regularization parameter. Further, using the found weights of the indicators, weights of the sub-measures and measurements of DESI are determined and, therefore, the DESI of each country is calculated for each year of the period under consideration, i.e. DESI-ratings of EU countries are determined by year.

Key words: *Digital Economy and Society Index, weight of indicator, inverse parameter identification problem*

The Digital Economy and Society Index (DESI), first introduced by the European Commission in 2015 (according to data of 2013, this index was calculated for the year 2014, and according to data 2015, DESI was calculated for the year 2014), is a flexible interactive tool for measuring the progress of states EU members in relation to the digital economy and society. As indicated in, DESI is calculated as a weighted average of the following five main measurements / criteria:

Table 1. *DESI components and their weights*

25%	Connectivity	Fixed broadband, mobile broadband, fast and ultrafast broadband and prices
25%	Human capital	Internet user skills and advanced skills
15%	Use of internet	Citizens' use of internet services and online transactions
20%	Integration of digital tehnology	Business digitisation and e-commerce
15%	Digital public services	e-Government and e-health

It is important to note that given weights, by experts of the European Commission, these weights are weighted average and normalized weights. However, none of the numerous sources and applications of the European Commission states:

- Which of the two possible types of expert assessments do these weights belong to - individual or collective estimates?
- Which of the quantitative or qualitative expert assessment methods was used in determining these weights? It should be noted here that the number of different expert assessment methods exceeds 100, and these methods, generally speaking, vary greatly in terms of applicability and capabilities, as well as in terms of accuracy and reliability. In addition, an important stage in expert assessment is the stage of processing and analyzing expert assessments, and this stage, which contains many problems, also requires a rigorous scientific approach: for example, problems such as determining the competence of experts, finding a generalized assessment, building a generalized ranking, identifying dependencies between rankings, assessing the concordance of expert opinions, evaluating a research error, building a model of properties of objects based on expert mathematical methods answers, can not be considered solved without the use of mathematical methods.
- By what principle / law is the normalization (linear or non-linear normalization) of the measurement values, sub-measures and individual indicators has been carried out?
- According to what rule / law (weighted arithmetic mean? weighted geometric mean? weighted harmonic mean? weighted power mean?) the weighted average value of 5 measurements, 14 subdimensions and 35 indicators was calculated? This question is one of the key questions in statistics, since the choice of the applicable rule / law for calculating the weighted average of a set of values means, among other things, also determining or a priori asking the measure of the contribution of each quantity (in other words, the importance / weight / significance of the value) in the final result. For example, if the arithmetic average rule is used to find the measure of the central tendency of the studied quantities, then this by default means that for some reasons (or simply by mistake) it is considered that these investigated quantities have the same importance / significance within the framework of the problem in question, which is often a wrong assumption in the study of a variety of problems of an economic nature, ultimately, can lead to distorted results, on the basis of which it is quite possible to make erroneous decisions and false predictions, wherein as unjustifiably iridescent, and, conversely, unreasonably pessimistic. Indeed, it is intuitively clear that it cannot be assumed at all that such indicators as the corruption perception index, quality of life index and foreign direct investment index are of equal importance for a highly developed country with high economic and social indicators and an unshakable tradition of democracy, and for a country torn by civil war, and in which about 45% of the population lives on less than 1 USD per day (for example, the Federal Government of Somalia). Another example: it is intuitively obvious that it cannot be assumed that the school subjects (for example, the Federal Government of Somalia). Another example: it is intuitively obvious that it cannot be assumed that the school subjects dent (having grades in the listed subjects respectively 10, 10, 4 and 4 points for a 10-point grading system), which intends to enter the Mathematics department of the Oxford University, and for a schoolchild (corresponding grades: 4, 4, 10, 10), who after graduation intends to become a street singer – both students have the same success with an average score of 7. Of course, it is possible to cite as many real and relevant examples from various spheres of human life and activity, in which one way or another question of objective choice and / or scientifically grounded finding of weights for the studied quantities arises. In addition to the above, author would like to emphasize that assigning "from the ceiling" weights for the quantities under study (recall that doing nothing with respect to the weights of the quantities under study only means that the same weights equal to 1 are assigned to these values by default) can also lead to various paradoxes and aporia, for example, to the well-known paradox in statistics, when with the presence of several data groups, each of which has the same directional dependence (increase or decrease), when these groups are combined, the direction of dependence changes to the opposite.

In this paper, the author try using the apparatus of the theory of inverse and ill-posed problems in particular, the methods of inverse problems of parameter identification, to investigate two problems:

- determine the weights of all 14 DESI sub-measures based only on the known values of 35 individual indicators of 28 EU countries for the period 2014-2019, and then, using the found sub-measurement weights, calculate the weights of all 5 measurements of DESI;
- to identify the measure of the influence of each of the DESI parameters on each other, where the parameters mean individual indicators, sub-measures and measurements of DESI.

Solving these two problems will allow ranking the EU countries by DESI by year without a subjective assignment of weights for DESI composite indicators, where in this context, a subjective assignment means any decision or any recommendation made without a detailed description of the applicable laws and their scientific justification.