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USING MULTILEVEL MODELING TECHNIQUES FOR SOCIAL AND ECONOMIC MONITORING

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ABSTRACT

This paper studies the experience of applying the existing methods of modeling in the field of economic monitoring. The method of Group Method of Data Handling (GMDH) is suggested an alternative method for economic modeling. The research calculates and builds inductive models describing the GDP on the basis of the economic indices which are characteristic of the countries with developed information economy. The resulting models are then clustered by similar features. The obtained results are briefly analyzed.

JEL CLASSIFICATION & KEYWORDS

■ C00 ■ O1 ■ F5 ■ MULTILEVEL MODELING ■ INFORMATION ECONOMY ■ GMDH ■ ECONOMIC MONITORING ■ MODEL OF DEVELOPMENT

INTRODUCTION

Nowadays, a lot of attention is drawn to various methods of studying economy. The dynamic development of the modern society over the past decades has assisted in the transition from the industrial society to the information society. As a result, a new type of economy is being formed, information economy, which is driven and powered by information, knowledge, ICT and specialized infrastructure. Information economy is essentially open. The degree of economy's openness indicates the level of its reliance on the global market and is one of the main criteria of the economical growth and security (Dubykivskyi, 2014). Growing openness of national economies, which has been brought about by countries' gradual integration into the multidimensional system of the global economic relations in the era of the developing information society, calls for appropriate assessment of the integration process and increased professional attention to the issue of correlating personal and social and state interests. As the information economy is characterized by high dynamics and is essentially different from the industrial economy, it brings about the issue of using new approaches and economic and mathematical methods of monitoring it. The countries with developed information economy are the world's leaders in many respects. Therefore, studying their specific features makes it possible to see both positive and negative trends, which, in its turn, creates opportunities for adequate and prompt adjusting our own state's economic thrust.

The issues of specific information economy country models have been given sufficient attention. It is worth noting research by V. Schumpeter (2007), M. Castells and P. Himanen (2002), A. Averkin (1986), S. Ayvazian (1974), V. Heits , M. Kyzym, M. Klebanova and T. Cherniak, (2006), A. Suhorukov (2013), A. Ivahnenko and Yu Harazishvili (1987). Overall, some of it is a theoretical basis for studying the information economy country models, and other studies the conceptual issues of countries' development and security in the information society.

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The economic monitoring is an important kind of observing economic processes and phenomena, and it is a tool for spotting trends and making forecasts. The aforementioned works look at the concepts and models of social and economic development, which are described with the system of important indicators. The index values are compared with the border values. After the comparison results are analyzed, weaknesses are found and ways to decrease the effect of negative factors on a national economy. Thus, this analysis helps describe the social and economic state of a country over a particular time period.

One of the main flaws of this approach is that using common statistical modeling methods is bringing the variables in the data array in accordance with Gauss' normal distribution law. Also, neither model takes into account the systems of deep internal links between the elements. Another drawback of this approach is that it is essentially a 'reactive and catching up' model of economic defense. The 'reacting' mechanism only triggers the corresponding response to any negative factors, as opposed to the 'proactive' model. The 'proactive' model involves a backup resource potential and makes use of anticipating steps. It is factor-driven and target-oriented, and it is targeted at potential inner sources of negative phenomena rather than outer dangers.

To remove the above mentioned flaws, an alternative approach has been suggested, which is the method of multilevel information transformation to find out the quantitative indices of a country's economic state. It is based on GDB calculation as the target function, which indicates secure economic development.

To solve this task, the countries with developed information economies have been studied as well as China's economy as it is currently developing very fast, and Ukraine's. The choice of the countries with information economy was made based on 'The world IT industry ranking' (table 1), which was calculated on the data of the World Economic Forum (The Global Information Technology Report, 2013).

Table 1: The world IT industry ranking

Country	2014 ranking	2013 ranking
Finland	1	1
Singapore	2	2
Sweden	3	3
Netherlands	4	4
Norway	5	5
USA	7	9
Japan	16	21
Canada	17	12
New Zealand	20	20
China	62	58
Ukraine	81	73

Source: Made by the author based on the World Economic Forum's data (The Global Information Technology Report, 2013)

The country's GDP is a quantitative index of social and economic development and economic security of the countries with developed information economy. Therefore, it is important to find how much the relevant components typical for the information economy influence forming and the value of the GDP. A data array (indices) which are typical for the information economy and describe its state has been created for these countries for the period between 2000 and 2013, In particular, building the input data array (IDA) involved the absolute values of the following indices: GDP, GDP per capita, foreign trade turnover per capita, state debt, foreign debt, high tech commodity export, ICT commodity export, ICT commodity import, gross domestic expenditure on R&D, ICT service export and ICT service import. The data was collected and calculated with the help of the universally accepted statistical resources (Unctad, Worldbank, etc).

Using common statistical modeling methods essentially means bringing the variables in the data array in accordance with Gauss' normal distribution law. The task of identifying the functional relationship is as follows:

$Y=f(X)$,

where $Y=\{y_1, y_2,\ldots,y_m\}$ – the set of information economy's features (GDP);

$X=\{x_1,x_2,\ldots,x_n\}$ – the features of the conditions forming it.

To solve this task, the inductive Group Method of Data Handling (GMDH) (Ivahnenko & Yurachkovsky, 1987) was suggested in the form of an automated data multilevel transformation system.

It is notable that Group Method of Data Handling (GMDH) is universally accepted and has a wide range of applications (Holub, 2007). This method is used when there is lack of information and we do not know all the hidden deep correlations and influencing factors between the elements of dynamic systems.

The modeling resulted in obtaining and testing inductive models which describe the formation of countries' GDPs by the features of array X with the models built on one sequence and tested with another. In this case, the model was built from the sequences for the 2000-2010 period and tested in observation points in multidimensional space of array X features over the period between 2011-2013. As a result, the models were synthesized and grouped by certain similar features into 7 clusters (table 2). The influence coefficients of the model variables which have the highest indices show the greatest influence of these very indices of the model variable on a country's GDP growth.

Thus, for example, Ukraine's economy in 2009 and 2010 nearly reached cluster 5 in terms of the state debt's influence on the GDP. Cluster 5 embraced such national economies as Netherlands in 2000, Finland and Sweden in 2005, Norway and Japan 2008, Sweden in 2009 and New Zealand in 2010. This is explained by the fact that it was at that time when Ukraine's state debt did not go beyond the critical values and, therefore, it did not affect forming the GDP. Due to the value of hi-tech commodity export, especially the airspace industry, Ukraine's economy reached cluster 7 in 2005 and 2008 along with Finland in 2000 and 2010 and Norway in 2009. This is explained by signing the contracts for exporting domestic airspace commodities. Overall, clustering the synthesized models by influence coefficients explains that some countries in a particular period share the features which influence forming the GDP.

Table 2: Clustering the synthesized models by influence coefficients

Model variable	**Influence coefficients of model variables (%)**						
GDP per capita (mln. $)	1	0	0	0	0	0	0
Foreign trade turnover per capita (mln. $)	5	14	0	2	0	2,4	0
State debt (mln. $)	**27**	**71**	0	**39**	**94**	**77,5**	0
Foreign debt (mln. $)	6	0	2	1	3	4,9	0
High-Tech commodity export (mln. $)	0	0	**17**	1	0	0	**63,3**
ICT commodity export (mln. $)	0	0	6	8	0	0	0
ICT commodity import (mln. $)	2	0	3	0	0	0	0
Gross domestic expenditure on R&D (mln. $)	**48**	10	**63**	**49**	0	0	0
ICT commodity export (mln. $)	2	0	2	0	0	0	0
ICT commodity import (mln. $)	7	4	7	0	1	11,4	0
	Cluster 1	**Cluster 2**	**Cluster 3**	**Cluster 4**	**Cluster 5**	**Cluster 6**	**Cluster 7**

Source: Made by the author on the GMDH calculations

CONCLUSION

To study the features of the economic growth of the countries with information economy, synthesizing was used with the help of Group Method of Data Handling (GMDH) for inductive models which describe forming the GDPs by the features of indices typical for the countries with developed information economy. The program processing resulted in synthesizing adequate models, testing, checking and grouped into 7 clusters by similar features. The models come in the form of a huge polynom and do not contain any useful information. Therefore, the most important are the values of influence coefficients of model variables as the they have the greatest effect on the GDP value and the state of a country's economic security. So, according to these calculations, the main features of the GDP forming conditions are gross domestic expenditure on R&D (clusters 1,3, 4), state debt (clusters 1, 2, 4, 5, 6), and hi-tech commodity export (clusters 3 and 7). The obtained results fully describe the real state of countries' information economy and a‼ re relevant for the current processes. The weakness of a state's economy is its unprotected social and economic areas and brings about non-reversible technological dragging behind the global economic development, probable social regress and social disintegration. So, as the countries with information economy are the leading countries in terms of social and economic development, their development models may be considered to be the best (proactive) models of economic security. The model of proactive development involves backup resource potential and uses proactive steps. This model's work can be compared with the electronic access code or password. While the code is being searched and deciphered, the system that does not stop developing and improving will find even more complicated and advanced security methods.

In future, it is the study of information economy countries' features that will make it possible to grasp the global trends and adjust the development thrust of a national economy with the aim of avoiding the influence of the negative factors in the information society era.

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