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THE STUDY OF THE HISTORICAL DEVELOPMENT OF INFORMATION ECONOMY AND SOCIETY

Abstract. This research describes the technology of processing historical data through multilevel modeling of leading countries' information economy indices. This helps avoid the need to agree the distribution of data with Gaussian law and obtain models with acceptable errors. The use of the obtained models makes it possible to use cliometric studies to forecast the consequences of planned decisions.

Keywords: information economy, cliometric, processing of historical data, multilevel modeling, error.

As early as the end of the XXth century, academician V.Glushkov introduced the concept of 'information barriers' [1]. It symbolizes the controversy between the society's information demands and its technical means to meet them. According to this concept, there have been three information barriers throughout history:

- the first information barrier was that the human mind was the only media for storing information. It was overcome in the Vth century B.C. thanks to inventing writing, which made it possible to store and pass on knowledge;

- the second information barrier was that the ways and methods of spreading knowledge were limited. This was overcome in the XVth century due to Johannes Gutenberg's invention of printing as well as later inventions, such as the telegraph, telephone, photography, films and television;
- the third information barrier was that the human mind was limited to perceive and process vast information scopes, which made certain managerial decisions impossible. This was overcome after the computer was invented.

It is the overcome of the third barrier that laid the foundation for a new type of economy, the information economy, which, in its turn, gave rise to the information and post-industrial society.

This time also saw the wide-spread use of cliometrics, an interdisciplinary trend primarily related to using mathematical methods in studying economic history. Cliometrics received the greatest recognition due to awarding the Nobel Prize in Economics to R.Fogel and D.North (the editor of 'Journal of Economic History') in 1993.

Thanks to applying statistical information and methods (regression, correlation and functional analysis), economic history scholars developed cliometrics to a totally new level. The reliability of cliometric research results is considerably affected by the limitations of the input data which is processed statistically. This entails the normal Gaussian index distribution law. However, the authors of cliometric studies did not manage to find the description of statistic data processing, which make the economic indexes agree with the normal law. Thus, the conclusions drawn on the basis of statistic processing of economic indexes may be inadequate.

The objective of this research is to study the processes of applying the methods of multilevel information transformation in the context of information economics.

Four hypotheses have been suggested.

Hypothesis 1. Overall, the economic results of observations are far from agreeing with the normal law and significant amount of data is lost if they are made to agree with it.

It is expected that model synthesis methods which do not involve agreeing the input data with the normal law should be used in cliometric studies. There is a number of methods that do not make use of the external criteria of model qualities. An example of these could be inductive methods and the Group Method of Data Handling (GMDH) in particular [2].

Hypothesis 2. Historical data often lacks too much information for adequate precise and stable models to be built even if the GMDH is used, and it is impossible to obtain any additional data.

In this case, it is necessary to increase the variety of synthesis models, for example, by using multilevel modeling technology.

Hypothesis 3. Input data bodies (IDB) are known to reflect the data qualities in various states. A single model does not have enough variety of the existing model synthesis means to reflect all the qualities of an object contained in an IDB even if it is the multilevel modeling technology.

In this case, the input data to be processed with the model synthesis should only describe one state of an object. In order to do this, it is necessary to find out which state is described by each item of the data.

Hypothesis 4. We need to use history as a source of information to describe future events (extrapolation). In order to do this, we need to test the models on future data which was not involved in building the given models and which was obtained later.

The speed of object qualities change is increasing (1-2 years) as technologies fundamentally change along with the development of the information society.

These four hypotheses have been tested in experiments. Table 1 provides the quantitative indices (characteristics) of information economic development of

the world leading countries and Ukraine (for 2000-2011 years) [3], which were used in the modeling process.

Indices of the input data body **Table 1**

№	Index	Variable
1	Life Expectancy Index	y_1
2	GDP, mln.$	y_2
3	GDP per capita, mln. $	y_3
4	Foreign debt mln. $	y_4
5	Monitoring location	x_1
6	High-Tech commodity export, mln. $	x_2
7	ICT commodity export, mln. $	x_3
8	ICT commodity import, mln. $	x_4
9	GERD, Gross Expenditure on R&D, mln. $	x_5
10	ICT service export, mln. $	x_6
11	ICT service import, mln. $	x_7

Source: Compiled by the author

The indices obtained during 2011 were used to test the models and were not involved in studying the models.

To synthesize the models, the least square method was used for building multiple regression, multi-row algorithm GMDH [2], multilevel modelling technology with consecutive testing of several inductive model synthesis algorithms and neuronets of different topologies [4] as well as clustering IDB observation points [5].

Table 2 provides the results of the experiments. The model characteristics were defined through calculating the ratio error of economic index modelling in comparison with their real values.

The use of GMDH which uses the external quality criterion to synthesize models makes it possible to decrease the modelling error to 11-71% compared with regression models. Thus, the first hypothesis was experimentally proved.

Still, despite the use of GMDH to synthesize models, the modelling error for indices y3 (GDP per capita) and y4 (foreign debt) is still significant. This calls for increasing the variety of model synthesis means. The multilevel modelling was used for this purpose, which lowered the modelling error for index y3 by 10% and that for y4 by 50%. Thus, hypothesis 2 was proved experimentally.

The results of the experiments **Table 2**

Modelled index	Method of synthesis of models	Monitoring point										Middle error, %
		Singapore	Sweden	Netherlands	Norway	USA	Canada	Japan	New Zeland	China	Ukraine	
y1	Actual	81,98	80,86	79,40	79,95	78,11	81,23	82,12	80,36	73,47	69,60	
y2	Actual	2,67E+05	5,72E+05	8,58E+05	4,79E+05	1,51E+07	1,76E+06	5,86E+06	1,69E+05	6,99E+06	1,63E+05	
y3	Actual	0,0525	0,0565	0,0499	0,0992	0,0498	0,0519	0,0462	0,0369	0,0054	0,0036	
y4	Actual	1,11E+06	1,02E+06	3,66E+06	6,50E+05	1,48E+07	1,18E+06	2,72E+06	2,05E+05	7,01E+05	1,18E+05	
y1	Regression	80,91	81,47	80,30	79,73	77,57	77,55	80,67	75,76	75,59	74,48	2,61
y2	Regression	2,65E+05	6,81E+05	8,90E+05	4,41E+05	1,48E+07	1,18E+06	5,01E+06	1,94E+05	6,48E+06	3,05E+05	18,95
y3	Regression	0,04	0,0474	0,0399	0,0411	0,0376	0,0303	0,0347	0,0235	-0,0082	0,0177	90,05
y4	Regression	5,39E+05	2,11E+06	2,96E+06	1,52E+06	1,91E+07	2,13E+06	3,24E+06	1,37E+05	1,75E+06	-4,19E+04	75,78
y1	GMDH	80,64	80,90	81,36	80,62	79,49	80,45	80,99	78,73	72,12	68,18	1,50
y2	GMDH	2,77E+05	4,00E+05	7,29E+05	3,80E+05	1,57E+07	1,43E+06	4,72E+06	1,41E+05	6,49E+06	1,10E+05	16,81
y3	GMDH	0,03	0,0462	0,0430	0,0680	0,0611	0,0403	0,0306	0,0322	0,0082	0,0033	25,63
y4	GMDH	9,99E+05	1,02E+06	2,18E+06	5,99E+05	1,63E+07	1,18E+06	1,78E+06	3,07E+05	2,69E+06	2,23E+05	52,67
y1	Multilevel	80,02	81,05	81,27	81,03	78,58	80,72	80,95	79,20	71,91	68,26	1,45
y2	Multilevel	2,77E+05	4,00E+05	7,29E+05	3,80E+05	1,57E+07	1,43E+06	4,72E+06	1,41E+05	6,49E+06	1,10E+05	16,81
y3	Multilevel	0,03	0,0549	0,0486	0,0595	0,0397	0,0480	0,0332	0,0269	0,0089	0,0037	23,01
y4	Multilevel	7,07E+05	1,24E+06	1,86E+06	9,13E+05	1,52E+07	1,28E+06	2,60E+06	1,03E+05	6,71E+05	6,52E+04	26,23
y1	Multilevel with a clusterization IDB	Cluster not found	80,82	79,97	80,18	78,13	81,16	81,66	79,92	73,19	68,87	0,41
y2	Multilevel with a clusterization IDB	2,65E+05	5,59E+05	8,61E+05	4,73E+05	1,52E+07	Cluster not found	Cluster not found	Cluster not found	7,00E+06	1,59E+05	1,13
y3	Multilevel with a clusterization IDB	Cluster not found	0,055	0,049	Cluster not found	0,048	0,050	Cluster not found	Cluster not found	0,006	0,004	2,29
y4	Multilevel with a clusterization IDB	1,12E+06	1,01E+06	Cluster not found	Cluster not found	1,47E+07	1,18E+06	2,69E+06	Cluster not found	6,92E+05	Cluster not found	0,65

The use of clustering for cliometric data drastically lowered the modelling error for every index, which experimentally proves hypothesis 3. However,

clusters among historical data were not found for every observation point from the examined sequence, which leaves this a subject for future research.

The use of the most recent observation points as the examined sequence proves that it is possible to use the described the cliometric data modeling technology to forecast the consequences of decisions. Thus, hypothesis 4 was proved experimentally.

Conclusion. The use of multilevel modelling technology along with clustering IDB makes it possible to overcome the problem of having to agree the IDB index distribution with the Gaussian law. This provides an effective tool for decision-making support in the field of information economy based on the results of processing historical data.

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