UDC 338.2(476)+316.42(476) http://doi.org/10.5281/zenodo.2539763
JEL Classification: H10, J58, P35, Z13

DYNAMIC REGRESSION MODELS OF FORECASTING INDICATORS OF SOCIAL AND ECONOMIC SECURITY

©Shvaiba D., *ORCID: 0000-0001-6783-9765, Ph.D., Belarusian Trade Union of workers of chemical, mining and oil industries, Belarusian national technical University, Minsk, Belarus, shvabia@tut.by*

ДИНАМИЧЕСКИЕ РЕГРЕССИОННЫЕ МОДЕЛИ ПРОГНОЗИРОВАНИЯ ПОКАЗАТЕЛЕЙ СОЦИАЛЬНО-ЭКОНОМИЧЕСКОЙ БЕЗОПАСНОСТИ

©Швайба Д. Н., *ORCID: 0000-0001-6783-9765, канд. экон. наук, Белорусский профсоюз работников химической, горной и нефтяной отраслей промышленности, Белорусский национальный технический университет, г. Минск, Беларусь, shvabia@tut.by*

Abstract. Dynamic multi-factor regression models make it possible to take into account the dynamics of the proportions of the resulting indicator of socio-economic security and indicators in the retrospective period. The defects of such a model include the complexity of selecting indicators and determining their values in the lead period, the difficulty of forming multivariate static regression models, the development of predictive models of regression coefficients. Without paying attention to the statistical significance of multivariate models used to form a dynamic model, the values of regression coefficients over the years have all the chances to fluctuate significantly in the time series of these coefficients. The alternately decreasing or rising regression coefficients due to the modification of the impact of indicators on the dynamics of the values of the resulting indicator of socio-economic security often does not allow to create a forecast model.

Аннотация. Динамические многофакторные регрессионные модели дают возможность принимать во внимание динамику пропорций значений результирующего показателя социально-экономической безопасности и показателей в ретроспективном периоде. К дефектам подобной модели нужно отнести сложность отбора показателей и определения их значений в периоде упреждения, трудность формирования многофакторных статических регрессионных моделей, разработку прогнозных моделей коэффициентов регрессии. Не обращая внимания на статистическую значимость многофакторных моделей, применяемых для формирования динамической модели, значения коэффициентов регрессии по годам имеют все шансы существенно колебаться во временном ряду данных коэффициентов. Попеременное понижение или же подъем коэффициентов регрессии вследствие видоизменения воздействия показателей на динамику значений результирующего показателя социально-экономической безопасности нередко не разрешает создать прогнозную модель.

Keywords: socio-economic security, the government, society, enterprise, employee, threat, security, interests, economics, analysis, system.

Ключевые слова: социально-экономическая защищенность, государство, общество, предприятие, работник, угроза, защищенность, интересы, экономика, анализ, система.

Dynamic multivariate regression model is developed on the basis of a system of static multivariate regression models that characterize the dependence of the resulting characteristics of socio-economic security on indicators in any year of the retrospective period and the formation of spatial data. Dynamic multivariate regression models make it possible to take into account the dynamics of the proportions of the resulting indicator of socio-economic security and indicators in the retrospective period. The defects of such a model include the complexity of selecting indicators and determining their values in the lead period, the difficulty of forming multivariate static regression models, the development of predictive models of regression coefficients. Ignoring the statistical significance of multivariate models used to form a dynamic model, the values of regression coefficients over the years have all chances to fluctuate significantly in the time series of these coefficients. Alternating decrease or rise of regression coefficients due to the modification of the impact of indicators on the dynamics of the values of the resulting indicator of socio-economic security often does not allow to create a predictive model. Details the issue of the Belarusian scientists, V. V., Puzikov, V. S. Sideltsev, Trunov V. A. [1].

Multivariate dynamic models of financial and economic or legal characteristics are based on the application of a number of methods and models. The choice of certain advantages and methods for determining the multifactor model is justified by the available array of information, the presence of standard programs for computer technology, monitoring probabilities, etc. However there are a number of total messages, for example, dynamic multi-factor models are generated on the basis of static regression models for projections of the coefficients of the regression models and informative features used trend models or models of exponential smoothing, and harmonic scales, as well as the components of the integrated method of economic-statistical calculations, etc. [2].

See table 1. the static models describing the dependence of the effective socio-economic indicator on the factors are demonstrated X_1, X_2, X_3.

All models are statistically significant because $Fr > Ft$ (the Ft index fluctuates in the range of 2.37-3.19, for the formation of regression static models depending on the available information array, the studied data set in different years is represented by different numbers).

Table 1.

STATIC REGRESSION MODELS OF THE DEPENDENCE
OF THE INDEX Y OF FACTORS X_1, X_2, X_3

Year	*Model*	*Fr*	*R*
t-4	$Y=256,731+0,837x_1+0,693x_2+1,276x_3$	4.182	0,917
t-3	$Y=272,332+0,876x_1+0,742x_2+1,293x_3$	5,163	0,923
t-2	$Y=287,303+0,932x_1+0,803x_2+1,328x_3$	3,27	0,976
t-1	$Y=308,608+1,025x_1+0,856x_2+1,401x_3$	4,775	0,934
t	$Y=328,515+1,147x_1+0,928x_2+1,503x_3$	5,533	0,967

Source: elaboration of author

To describe the presence of a trend in the time series of coefficients 1 (i= 0,1,2,3) the increment is calculated Δa_1.

Working through the data of table 1. you can see a clear trend in the time periods of the coefficients a_0, a_1, a_2, a_3. At the same time in time series of coefficients a_0, a_2 indicator Δa

increases and decreases which makes it difficult to model these factors. In this regard, it is possible and appropriate in the formation of a dynamic model for the calculation of the forecast at the level of coefficients a_0-a_3 use trend models, though other options are possible.

Table 2.

COEFFICIENT INCREMENT $a_i (i = 0,1,2,3)$

Year	Δa_0	Δa_1	Δa_2	Δa_3
t-3	15,601	0,039	0,049	0,017
t-2	14,971	0,056	0,061	0,035
t-1	20,305	0,093	0,053	0,073
t	20,907	1,122	0,72	0,102

Source: elaboration of author

In this case, predictive models to identify the value of the coefficients a_0, a_1, a_2, a_3 in between, the institutions will look like:

$$a_0 min = 328{,}515;$$
$$a_0 cp = 328{,}515 + 17{,}976t^*;$$
$$a_0 max = 328{,}515 + 120{,}907t^*;$$
$$a_2 min = 0{,}928;$$
$$a_2 cp = 0{,}928 + 0{,}059t^*;$$
$$a_2 max = 0{,}928 + 0{,}072t^*$$

where: t^* for t+1г. = 1;

$$a_1 = 0{,}732 + 0{,}077t$$
$$a_3 = 1{,}192 + 0{,}056t$$

where: t^* for t+1 г. = 6.

Dynamic models for the minimum, average and maximum variants of the dynamics of the resulting economic indicator will have the form:

$$Ymin = 328{,}515 + (0{,}732 + 0{,}077t)x_1 + 0{,}928x_2 + (1{,}192 + 0{,}056t)x_3$$
$$Ycp = 328{,}515 + 17{,}946t^* + (0{,}732 + 0{,}077t)x_1 + (0{,}928 + 0{,}059t^*)x_2 + (1{,}192 + 0{,}056t)x_3;$$
$$Ymax = 328{,}515 + 20{,}907t^* + (0{,}732 + 0{,}077t)x_1 + (0{,}928 + 0{,}072t^*)x_2 + (1{,}192 + 0{,}056t)x_3$$

where: t for t+1 years = 6, and t*-1.

In this case, the value x_i,t,t^* in predictive models, we will be able to identify the minimum, average and maximum options for increasing the resulting indicator in the lead time.

At the same time, the development of monitoring the characteristics of socio-economic security is a difficult task, which requires the introduction of various segments of knowledge [3, p.16; 4, p. 21; 5, p. 132]. The task is to develop a scenario monitoring in the development of the situation and the configuration of socio-economic security. The scenario is considered to be a way of system forecasting and covers all sorts of nuances of the situation in the future. Forecasting the development of the situation on the basis of the scenario is performed alternately on separate blocks

that make up, that is, forecasting the development of the situation in the way of the scenario is the grouping of an array of alternate monitoring to determine the joint result. The scenario highlights the possibility to detect the internal consistency combine in his system monitoring [6, p. 84].

In the scenario, it is necessary to think over an assessment of various qualities of development of a situation in the context of ensuring social and economic security. The scenario must be linked to the political, financial, economic, social, demographic and other vectors of the functioning of the country, territory, economic entity.

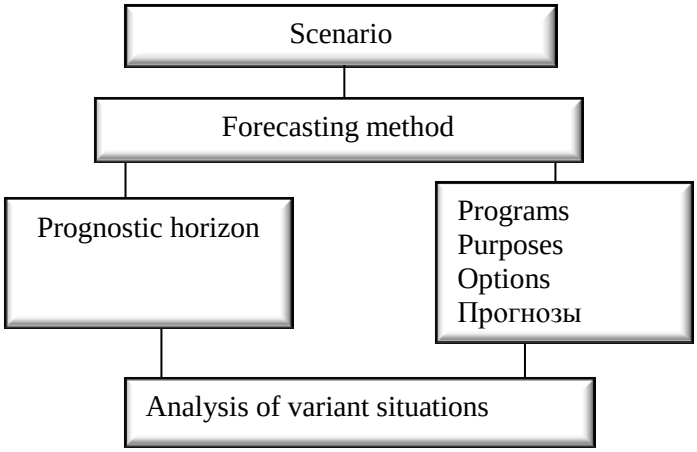

Figure 1. Scheme of forecast scenario. *Source:* elaboration of author

One of the more important parts of writing a script is considered a morphological test. When applying the morphological test, the total chain is broken into parts and possible alternatives to their resolution are identified. The leading solution to this problem by the method of morphological test is obtained by selecting one of the more likely solutions. If the discussed (solved) dilemma is divided into parts and only one conclusion is taken from each of them, then the total number of solutions will be equal to the number of all probabilities. Further, a thorough study of all possible solutions in order to choose the appropriate one is carried out.

The scenario method determines the order of execution of subprograms (chains), outlines ways to implement the set goals. Any sub-goal is divided into stages and identifies other ways to implement all stages. In some cases, alternative coefficients of conditional significance are assigned. The same coefficients are assigned to determine the conditional significance of all stages included in the subprogram.

With that said it is likely to determine the importance of all subprogrammes by comparison of their coefficients of conditional significance representing the work assigned to the coefficient the coefficient of the stage or by implementing the conclusions to which the program relates.

The advantages of the scenario method of forecasting are that it allows you to detect the structure and order the order of decision-making in determining the situation in the forecast period.

The development of scenario forecasting required the development and application of methods of the predictive graph and "goal tree".

Questions of application of graph theory (and the method of the predictive graph is based on it) are presented in a number of studies [7; 8].

A geometric graph represents an array of points connected by lines, a mathematical graph represents an expression G=(J1 U), if you specify a non-empty array J and array U, and each element of the array U is assigned an ordered measure (I, j) of the elements of the array j, the Elements of the array are displayed as points on the plane and are called the vertices of the graph. Each component of the array U is represented by a line connecting two elements of the array J and is called an edge. Figure 2. we demonstrate a graph whose vertices form the set J={1,2,3,4,5,6,7,8}, and whose edges form the set U={(1,2),(1,3),(2,6),(3,4),(3,5),(4,5),(4,7),(5,6),(5,7),(6,8),(7,8)}

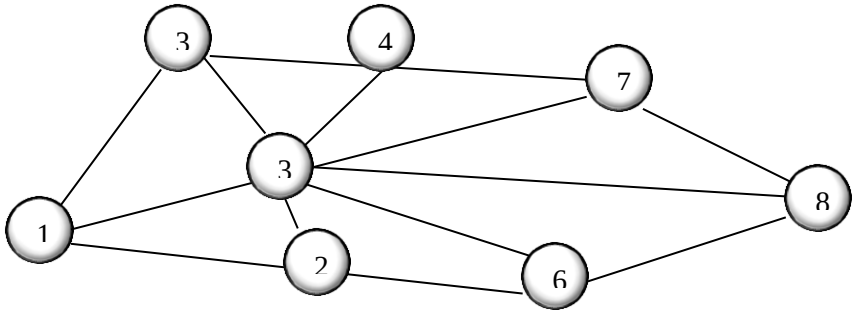

Figure 2. Graph in the most General form. *Source*: elaboration of author

If vertices i and j belong to edge U=(i,j), then edge U is incident to vertices i and j, and vertices i and j are incident to edge U. vertices i and j are called adjacent. A vertex that is not incident to any of the edges is called isolated.

A chain in the graph (J, U) is such an order of edges (U1, U2,..., Um) when 2 adjacent edges Ui and Ui+1 have a mutual vertex. The chain that links 2 vertices i and j, call S(i,j). order of edges S(2,3)={(2,6),(6,5),(5,3)} shown in figure 2. form a chain connecting the top 2 and 3. As a rule, the chain is given by the sequence of vertices through which it passes S (2,3)=2,6,5,3. The number of edges forming the chain characterizes its length. Thus, the chain length S (2,3)=3. The chain passing through all vertices of the graph and Prieto only once, called Hamiltonian. Figure 2. you can identify several Hamiltonian circuits, for example, S1(7,8)=(7,5,4,3,1,2,6,8) and so on. A chain whose initial vertex coincides with the final one is called a cycle. A closed Hamiltonian circuit is called a Hamiltonian cycle S(2,2)=(2,6,5,8,7,4,3,1,2).

A graph is called connected if any 2 vertices of it can be connected by a chain. The graph is shown in Figure 2, communication.

If for an edge U=(i,j) the order of placement of its 2 ends is weighty, then it is considered that edge U is oriented, vertex i is called the beginning, j is the end of the edge. The oriented edges are called arcs and are shown as arrows going from the beginning to the end. If all edges of the graph G=(J, U) are oriented, then we assume that the graph G is a directed graph.

In oriented graphs it is possible to consider both undirected and oriented chains and cycles. The chain is called oriented path, oriented cycle — path. The oriented Hamiltonian circuit is referred to as the Hamiltonian path, the oriented Hamiltonian cycle-Hamiltonian circuit. A graph is considered to be essentially connected if all its 2 vertices I and j can be combined by the path leading from i and j. The graph shown in Figure 3. it is not considered to be significantly connected, since the vertex cannot be combined with any other vertex of the graph. It is assumed that this graph is connected because the orientation of the arcs is not provided.

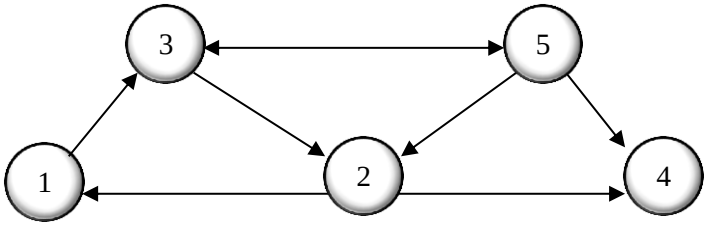

Figure 3. Oriented graph. *Source:* elaboration of author

The graph has the ability to be represented by different drawings, due to the fact that in the actual image of the graph there is freedom in the placement of the vertices and the choice of the shape of the arcs connecting them (Figure 4.).

Figure 4. Isomorphic graphs. *Source*: elaboration of author

It is considered that 2 columns G=(J,U) и $G^1=(J^1, U^1)$ is isomorphic to, if the number of vertices J and J^1 there is such a one-to-one correspondence when the vertices in the 1st of the graphs are connected by arcs if the corresponding vertices in the other graph are connected. Vatory friend in the graphs should also match each other.

The adjacency matrix of a graph (J, U) containing n vertices is called the square matrix a of sizes nxn, in which the elements aij located at the intersection of the i-th row and the j-th column numerically correspond to the number of arcs of the graph passing from the i-th vertex to j. The table shows the adjacency matrix for the graph shown in Figure 2.

Table 3.

ADJACENCY MATRIX OF THE GRAPH

i/j	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1		1	1					
2	1					1		
3	1			1				
4			1		1			
5				1		1	1	
6		1			1		1	1
7				1	1			1
8					1	1	1	

Source: elaboration of author

In an undirected graph G(J, U), the edges (i,j) and (j, i) are located simultaneously, that is, the undirected graphs correspond to symmetric adjacency matrices.

In oriented graphs, the adjacency matrix is not symmetric.

The adjacency matrix of any of the graphs includes the entire information array about the structure of the graph and it is possible to form an isomorphic display of the graph given by it [9; 10].

If the components of the graph are set in accordance with any parameters, this graph is called the network. Parameters are defined on vertices, arcs, subsets of vertices, and arcs. To describe the network, the concepts of functions on vertices and arcs are used. Each vertex i is described by the intensity d (i). Vertices for which d(i)>0 are strings, the rest are neutral. The arc is described by a bandwidth function that maps each other (i,j)ЄU of a graph(J, U) to a non-negative number r (i,j) called the bandwidth of the arc.

Table 4.

MATRIX OF ORIENTED GRAPH

i/j	*1*	*2*	*3*	*4*	*5*
1		1			1
2			1		1
3				1	1
4					1
5					

Source: elaboration of author

If a network(J,U) with one source S and one drain t is given a bandwidth function r (i,j), then it can be given a function called a stream. A stream in the network is a function that maps an integer X (i, j) to each of the arcs (i,j) and has properties:

$$0 \le X(i,j) \le r(i,j), (i,j)\epsilon U, \quad (1)$$

$$\Sigma X(i,k) - \Sigma X(k,i) = 0; k \ne \text{S, t, k}\epsilon\text{J}, \quad (2)$$

$$\sum_{k}^{i} X(S,k) = \sum_{k}^{i} X(k,t) = V \quad (3)$$

Characterizing circumstances 1-3 it is possible to highlight that:

- by condition (1) — the flow along any arc is not negative and is not higher than its capacity;
- under the condition (2) — the volume of the substance flowing into any neutral vertex is equal to the volume of the substance flowing out of it;
- under the condition (3) — the total volume of the substance flowing from the source coincides with the total volume of the substance flowing into the current.

References:

1. Puzikov, V. V., Gaidel'tsov, V. S., & Trukhov, V. A. (2003). Metody analiza i prognozirovaniya dinamiki pokazatelei v operativno-rozysknoi deyatel'nosti po obespecheniyu natsional'noi bezopasnosti Respubliki Belarus'. Minsk: In-t nats. bezopasnosti Resp. Belarus', 245.

2. Daurbekov, S.-E. S., & Khadisov, M.-R. B. (2015). Index of the quality of life of the population - an indicator of the economic security of the region. *Management of economic systems,* (5). 10.

3. Burkal'tseva, D. D. (2014). Metodologiya rascheta i upravleniya optimizatsiei pokazatelei ekonomicheskoi bezopasnosti. *Bulletin of the Catherine Institute,* (1). 12-18.

4. Grigorieva, E. A. 2014. Socio-economic indicators of economic security of Russia. *Actual problems of economics and law,* (2). 19-24.

5. Savina, T. N., & Fedonina, O. V. (2014). Formirovanie sotsial'no-orientirovannoi rynochnoi ekonomiki s pozitsii obespecheniya natsional'noi ekonomicheskoi bezopasnosti: vozmozhnosti, problemy, perspektivy. Saransk: Print-Izdat, 192.

6. Nikolaeva, A., & Karakhanyan, K. (2016). Rationalization of social interactions in modern society. *Path of Science,* (8). 83–85.

7. Kuz'bozhev, E. N., & Trukhov, V. A. (1992). Kontseptsiya formirovaniya plana-prognoza sotsial'no-ekonomicheskogo razvitiya regiona. Syktyvkar-Gomel': SGU, GGU, 34-37.

8. Korolev, Yu. G. (1990). Metody «dereva tsepei» i prognoznogo grafa. Statisticheskoe modelirovanie i prognozirovanie. Moscow. 255-257.

9. Shvaiba, D. (2018). Structural stability and socio-economic security of the hierarchical system. *Bulletin of Science and Practice, 4(*6), 233-239. doi:10.5281/zenodo.1289852.

10. Shvaiba, D. (2018). Socio-economic security of the hierarchical system. *Bulletin of Science and Practice, 4*(6), 248-254. doi:10.5281/zenodo.1289862.

Список литературы:

1. Пузиков В. В., Гайдельцов В. С., Трухов В. А. Методы анализа и прогнозирования динамики показателей в оперативно-розыскной деятельности по обеспечению национальной безопасности Республики Беларусь. Минск: Ин-т нац. безопасности Респ. Беларусь, 2003. 245 с.

2. Даурбеков С.-Э. С., Хадисов М.-Р. Б. Индекс качества жизни населения – индикатор экономической безопасности региона // Управление экономическими системами. 2015. № 5. С. 10.

3. Буркальцева Д. Д. Методология расчета и управления оптимизацией показателей экономической безопасности // Вестник Екатерининского института. 2014. № 1. С. 12-18.

4. Григорьева Е. А. Социально-экономические индикаторы экономической безопасности России // Актуальные проблемы экономики и права. 2014. № 2. С. 19-24.

5. Савина Т. Н., Федонина О. В. Формирование социально-ориентированной рыночной экономики с позиции обеспечения национальной экономической безопасности: возможности, проблемы, перспективы. Саранск : Принт-Издат, 2014. 192 с.

6. Николаева А., Караханян К. Рационализация социальных взаимодействий в современном обществе // Путь науки. 2016. № 8. С. 83-85.

7. Кузьбожев Э. Н., Трухов В. А. Концепция формирования плана-прогноза социально-экономического развития региона. Сыктывкар-Гомель: СГУ, ГГУ, 1992. С. 34-37.

8. Королев Ю. Г. Методы «дерева цепей» и прогнозного графа // Статистическое моделирование и прогнозирование. М., 1990. С. 255-257.

9. Shvaiba D. Structural stability and socio-economic security of the hierarchical system // Бюллетень науки и практики. 2018. Т. 4. №6. С. 233-239. DOI:10.5281/zenodo.1289852.

10. Shvaiba D. Socio-economic security of the hierarchical system // Бюллетень науки и практики. 2018. Т. 4. №6. С. 248-254. DOI:10.5281/zenodo.1289862.

Работа поступила
в редакцию 15.12.2018 г.

Принята к публикации
18.12.2018 г.

Ссылка для цитирования:

Shvaiba D. Dynamic regression models of forecasting indicators of social and economic security // Бюллетень науки и практики. 2019. Т. 5. №1. С. 249-257. Режим доступа: http://www.bulletennauki.com/38-53 (дата обращения 15.01.2019).

Cite as (APA):

Shvaiba, D. (2019). Dynamic regression models of forecasting indicators of social and economic security. *Bulletin of Science and Practice, 5*(1), 249-257. (in Russian).