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Konkurētspēju un inovāciju mijiedarbības mehānismi mūsdienu starptautiskajās ekonomikas attiecībās

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The authors of the book have come to the conclusion that it is necessary to effectively use the management approaches to regulate modern international economic relations, methodological tools for analyzing international competitiveness and innovation. Basic research focuses on assessing the effectiveness formation of competitive advantages, study of social capital and human potential, analysis of marketing environment and development of exhibition-fair activities, formation of real estate market, risk assessment, use of electronic instruments on the financial market. The research results have been implemented in the different models of financial potential management, use of crowdfunding, formation of a transport strategy, development of border regions, formation of a new industrial policy, introduction of innovations in building, health, agriculture, sector of high technologies, development of the Latvian-Ukrainian economic cooperation. The results of the study can be used in decision-making at the level of international business, ministries and departments that regulate international relations, ensuring security and overcoming risks. The results can also be used by students and young scientists in modern concepts of the formation of international economic relations in the context of ensuring the competitive advantages of actors and improving innovation policy.

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Chapter 6

FORMATION OF COMPETITIVE ADVANTAGES AND USE OF INNOVATIONS BY BUSINESS ENTITIES IN THE CONTEXT EUROPEAN INTEGRATION

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MODELING OF INTEGRATION PROCESSES OF UKRAINE TO EU USING RANDOM MATRIX THEORY

Integration processes in the global economy cause the search of new approaches to the development of economy. Integration processes give new opportunities to the UE member states.

Ukraine has chosen the course on European integration determining it as a priority in its foreign economic activity. The prospect of joining the EU can have a powerful effect on all the processes (economic, political, social, etc.) taking place in the country.

The multifaceted problem of European integration of Ukraine has been a subject and object of regular scientific research of national scientists. At the same time, there is a need to continue the scientific development of the mentioned scientific issues in the context of new factors affecting these processes, both in Ukraine and abroad.

In modern conditions, one of the efficient forms of functioning

national economy is the implementation of rational and efficient foreign economic policy. Ukraine has clearly determined the vector of its development and its focus on deep and comprehensive integration with the EU. Foreign trade activity plays a leading role in foreign economic policy of Ukraine having an influence on the development of specialization, the increase of resource productivity, the growth of production capacity, and the satisfaction of the need in those articles, the production of which is extremely ineffective or impossible in the country.

The export orientation of the domestic economy (over the past ten years, the share of exports in our country's GDP ranged from 40 to 60%) is one of the most important ways of its development. A wide range of prospects for foreign trade cooperation with the EU countries that have opened for our country as a result of accelerating the pace of European integration, signing landmark documents between Ukraine and the EU, Ukraine's unilateral trade preferences of the EU, and the consequences of these processes, have stipulated the need for this study.

Foreign trade significantly influences the dynamics of GDP. The export-import activity of the state has a positive impact on GDP growth under the conditions of high productivity and competitiveness of national products. A common and widely used method for assessing the foreign trade of the country is the statistical analysis of trade balance: the analysis of its individual indicator dynamics, particularly, the commodity structure, the use of averages (for example, the volume and rate of goods and services export growth), absolute and relative values, the use of chain substitution method. At the same time, we point out that special methods of economic mathematical modeling, which would enable predictable calculations, are not practically used in the research studies on the country's trade balance. The topicality of the research is stipulated by the use of these methods to study trade balance.

In the paper, economic data are analyzed using tools of random matrix theory. Parameters calculated on the basis of input data are mostly stationary, since they allow to obtain numerical estimates of a stationary system. In order to increase the informative character of analysis results, the algorithm of moving window was used. The consequence of its application is the derived numerical row of change in a specific indicator calculated for each window. The next step is to analyze this change, which gives an opportunity to get new information about the economic system.

The method of studying the statistical properties of matrices with

independent random elements (random matrices) originates from nuclear physics [1, 2]. The task from which the development of random matrix theory (RMT) began, was to determine the energy levels of complex nuclei, which could not be done with the existing theories at that time. Scientists have argued that the Hamiltonian, which describes heavy nuclei, can be presented with some matrix H_{ij} with independent random elements constructed on the basis of probabilistic distributions [2]. Deviations from the universal properties of RMT allowed to determine system-specific non-random properties that contained information about hidden interactions in the system [1].

Further application of RMT methods to analyze the properties of C_{ij} cross-correlation matrices shows that almost 98% of matrix eigenvalues satisfy the condition of randomness, however, it is found that about 2% of the largest eigenvalues deviate from RMT, and therefore their analysis allows obtaining specific information for the analyzed system [3].

The first attempts to apply random matrix theory for the analysis of economic systems, particularly, stock and currency markets, were the works of Y. Stanley, V. Plerou, B. Rosenow, and others [4]. Further application of random matrix theory consisted in the study of specific properties of complex economic systems, such as the management of securities portfolio based on risk assessment [5], the study of cross-correlation dynamics [6, 7], the use of random matrix ensembles for the study of economic systems [8], the evaluation of information that can be obtained by analyzing eigenvalues and eigenvectors of the cross-correlation matrix [9], the collective behaviour of agents of a complex economic system [10].

To obtain information from time series that can be interpreted, the input data are converted and presented as a tree (graph). In the connected graph with the taken distances between all the vertices found, the minimum spanning tree (MST) has an n-1 edge and the smallest length from the lengths of all spanning trees, based on the sum of the distances between two points. Hierarchical tree is obtained on the basis of MST and corresponding matrix of distances. Minimal spanning tree and associated hierarchic tree show the cluster existence of any market assets that are of great economic significance.

The International Trade Center website provides annual statistics [11, 12] having been loaded since 2001, for the data of exports volume by type of goods. In general, the website provides statistics for 99 export product groups. However, considering the fact that Ukraine has a small

export volume in many commodity groups, we suppose significant data of only selected 27 groups. At the same, according to the results, one group (musical instruments) was deleted because of the lack of sufficient data, even in such short time series. Thus, a total of 26 groups of goods exported by Ukraine and European countries were analyzed.

In table 6.1 in column 1, the short name of the group of exported goods is given. Column 2 shows the approximate cross-correlation value, which has the maximum distribution of the probability of cross-correlation coefficients. We note that in columns 1, 2 and 4, value was evaluated visually, since the small shift in the distribution of the probability of cross-correlation coefficients in comparison with the probability distribution for a matrix derived from the mixed data, means practical absence of useful information obtained by the chosen methods. We consider the results, for which the value of the cross-correlation for the maximum of probability distribution is greater than 0.4, to be significant.

Column 3 shows indexes that indicate whether the maximum is exceeded, what it precedes, and the minimum eigenvalues of the cross-correlation matrix beyond the boundaries of the random region. In the case where the corresponding value goes beyond the scope of the random field, the table uses the «+» mark, otherwise, the «-» mark is used.

Column 4 shows the approximate value of the distance of Ukraine to the nearest country in the hierarchical tree. This value was evaluated visually, as it was previously indicated. We consider only those groups of goods to be essential, for which the value of distance is received not more than 0.8 obtained for values of cross-correlation greater than 0.68. In other words, there is a close correlation between the dynamics of Ukraine and corresponding country being more than +0.68.

On the basis of the correlation analysis (using the minimum spanning and hierarchical trees), we identified 2 large groups of the exported goods.

The first group includes the following goods: products of the mill industry, animal and vegetable fats, footwear, glass and articles, cars (in table 6.1, the elements of this group are in italics on the light-grey background of the cells). In this group, the distribution of cross-correlation coefficients in the cross-correlation matrix is characterized by the bias to a positive region; the maximum distribution value is the cross-correlation coefficient being close to 0.5-0.6, which indicates a rather close (on average) link between the dynamics of exports of the

specified goods for different countries, in general; and the distance in the minimum spanning and hierarchical trees between Ukraine and the nearest European countries is from 0.8 to 0.5. We stress that in many minimal spanning trees for the given groups of goods, Ukraine is in the same cluster with powerful European countries, such as Germany, Great Britain, Italy, etc. (fig. 6.1). It shows similar dynamics between the exports of the respective groups of goods of our country and the mentioned countries of Europe. Unfortunately, it is impossible due to lack of relevant data to estimate what proportion of goods exported by Ukraine, European countries import.

Table 6.1

The investigated indicators based on ITS data and their approximate values

Goods	Shift in distribution of probability of cross-correlation coefficients	The output of eigenvectors, λ_{max}, λ_{max-1}, λ_{min}, outside the domain of random values	The degree of connection tightness of Ukraine to the nearest object in the minimal spanning and hierarchical trees
1	2	3	4
Livestock	≈0.15	+−−	≈0.9
meat	≈0.45	+++	≈0.9
food products	≈0.8	+−+	≈0.5
animal products	≈0.2	+−+	≈1.0
mill industry products	*≈0.5*	+−+	*≈0.6*
animal and vegetable fats	*≈0.5*	+−+	*≈0.8*
sugar and confectionery	≈0.3	+−+	≈0.8
tobacco	≈0	−−−	−
inorganic chemistry products	≈0.6	+−−	≈0.45
organic chemistry products	≈0.4	+−+	≈0.6

Table 6.1 (continued)

1	2	3	4
wood and wood products	≈0.8	+ – +	≈0.4
paper and its derivatives	≈0.8	+ – +	≈0.5
Cotton	≈0.2	+ – +	≈1.1
Footwear	*≈0.5*	+ – +	*≈0.5*
articles made of stone, plaster, cement	≈0.4	+ – +	≈0.5
glass and wares	*≈0.6*	+ – +	*≈0.5*
pearls, precious stones	≈0.3	+ – +	≈0.9
iron and steel	≈0.9	+ – +	≈0.15
copper and products	≈0.8	+ – +	≈0.5
nickel and products	≈0.3	+ – +	–
aluminum and products	≈0.9	+ – +	≈0.7
other metals, cermet	≈0.4	+ – +	≈0.5
mechanical machines	≈0.9	+ – +	≈0.7
electric machines	≈0.7	+ – +	≈0.6
Cars	*≈0.6*	+ – +	*≈0.6*
art products	≈0.0	– – –	–

Source: calculated by authors for [11, 12]

The second group includes the following goods: food products, inorganic chemistry products, wood and wood products, paper and its derivatives, iron, steel, copper and copper products, aluminum and aluminum products, mechanical and electrical machines (in table 6.1, the elements of this group are in the cells of dark grey background). In this group, the distribution of cross-correlation coefficients in cross-correlation matrix is characterized by shifting to positive region, the

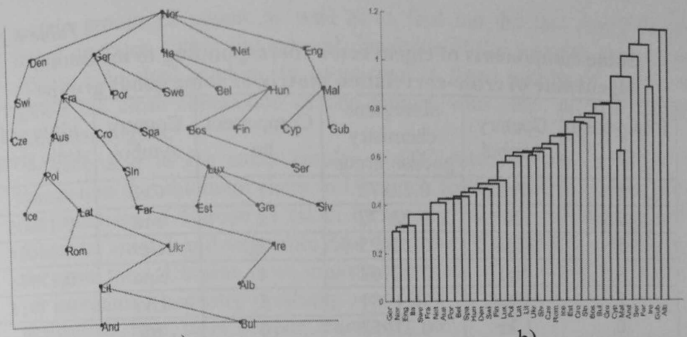

Figure 6.1. Minimal spanning (a) and hierarchic (b) trees for vehicle group (cars)

Source: calculated by authors for [11, 12]

maximum value of distribution is the coefficient of cross-correlation from 0.7 to 0.9. It shows an extremely close link (in average) between export dynamics of the mentioned goods for different countries in general. The distance in minimum spanning and hierarchic trees between Ukraine and the nearest European countries is from 0.7 to 0.15.

The analysis of eigenvector components for the largest and smallest eigenvalues of cross-correlation matrix shows the following regularity: if Ukraine is among the original components of its own vector, which corresponds to the maximum value of the cross-correlation matrix, then it is among the last components of its own vector corresponding to the minimum value of the cross-correlation matrix, and vice versa. If we consider that the maximum actual value of cross-correlation matrix indicates the same general effect of the system on individual objects, and the minimum – on the pair of the most influential for the system of countries, then Ukraine in these groups of goods either follows the general dynamics of the market, or, in some way, affects the market, which in both cases indicates the symbiosis of Ukraine and other objects of the market (system).

Table 6.2 shows the first 15 components of eigenvector corresponding to the maximum eigenvalues of cross-correlation matrices obtained for «products of inorganic chemistry» and «iron and steel» groups of products. Ukraine occupies the 6 and 5 places, respectively; it shows rather high country's response to changes in the

Table 6.2

Some components of eigenvector corresponding to maximum eigenvalue of cross-correlation matrix of some goods groups

Component no.	Country symbol	«Inorganic chemistry goods» group	Component no.	Country symbol	«Iron and steel» group
1	Pol	0.22872	1	Cze	0.1801
2	Lit	0.22872	2	Fra	0.18005
3	Hun	0.22425	3	Ger	0.18004
4	Bel	0.22162	4	Spa	0.17958
5	Ger	0.21981	5	Ukr	0.17914
6	Ukr	0.21952	6	Ita	0.179
7	Aus	0.21782	7	Swi	0.17821
8	Ita	0.20764	8	Bel	0.17629
9	Spa	0.20629	9	Por	0.17609
10	Fin	0.20245	10	Slv	0.17603
11	Swe	0.19783	11	Bul	0.17567
12	Swi	0.19549	12	Net	0.17549
13	Rom	0.19325	13	Den	0.17503
14	Cze	0.19171	14	Nor	0.17467
15	Fra	0.18916	15	Cro	0.17448

Source: calculated by authors for [11, 12]

system of goods turnover for these groups in Europe. It may point out the close connection of our country and Europe according to the specified and some other groups of goods.

Instead, the analysis of the first components of eigenvectors corresponding to the smallest eigenvalues of the cross-correlation matrices obtained for «wood and wood products» and «paper and its derivatives» groups of goods only confirms the thesis that Ukraine is a supplier of raw materials and goods of primary processing.

It is rather interesting observation that Ukraine is among the countries that are the main suppliers of the relevant group due to its location in clusters for many commodity groups. For example, for inorganic chemistry products, Ukraine is in the same cluster with Poland, for wood and products from it - with Austria, for iron and steel - with Hungary, the Czech Republic, and even more – Ukraine is the center of a separate cluster for this group of goods.

Consequently, the application of random matrix theory made it possible to determine the place of Ukraine in separate clusters for

certain groups of goods, as well as to find out the fact that Ukraine either operates within the general dynamics of the relevant market, or affects individual markets in some way in these groups of goods. It shows the close connection of our country with other subjects of the European region.

According to the study results of ITC database, we can make a conclusion that the main share in Ukraine's foreign trade activities with the countries of Europe is taken by such groups of products as mill products, animal and vegetable fats, footwear, glass and its articles. At the same time, Ukraine is an important subject of the European market for inorganic chemistry products, wood and its products, paper and its derivatives, iron, steel, copper, aluminum, etc.

We consider that in modern conditions, it is expedient for Ukraine to transfer from the export of raw materials and products of primary processing to the production and supply of the results of manufacturing industry, i.e. finished goods, to the European market. Finished goods, in their turn, contain a larger share of added value, and, therefore, can provide an increase in revenues to the state budget at the expense of exports, growth of volumes and value of GDP. At the same time, it will help to create additional job positions in the domestic labour market and increase the incomes of the population.

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INNOVATIONAL ACTIVITY DEVELOPMENT OF PERSONNEL OF INDUSTRIAL ENTERPRISES UNDER THE CONDITIONS OF EUROPEAN INTEGRATION

An industrial enterprise counts on staff by choosing a development strategy based on innovation in the context of European integration processes. However, the availability of employees with the most advanced knowledge and skills combined with a sufficient level of financial, organizational and technical resources does not guarantee that the qualifications of the staff will be effectively involved in the innovative development of the enterprise. However, innovation activity is not the dominant characteristic of employees even in some enterprises for which innovation is the principal activity [1].

The objects of innovation activity at the enterprise are: means of production and technological processes; manufactured products and their quality; human potential and development of creative and active personal background; social sphere, including changes in the behavior of workforce; organizational development, etc.