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### **MIGRATION PROCESS IN UKRAINE: THE FINANCIAL, SOCIAL AND ECONOMIC DETERMINANTS**

**Abstract.** The paper is focused on identifying interlinks between migration growth and economic development indicators. The main idea is to check the statements that migrants move to the countries with high levels of urbanization, high export-import, and budget potential, social, economic, and infrastructural development, high rates of innovations, accessible and effective health care system, financial stability. The previous studies in the sphere of migration were analyzed in detail, and their outcomes became a starting point for selection of the parameters that may affect the net migration growth.

The paper is designed as quantitative research, based on Fuzzy-Logic Cognitive Maps (FCM) modeling for mapping the most influential parameters of nine systems (concepts) of national economic development and migration growth.

In this study the matrices of causality and directions of influence of parameters of the nine concepts and 53 sub-concepts and migration growth were computed, and cognitive maps of causal links between net migration growth and chosen parameters of national development were visualized.

It was found that the highest level of positive interaction exists between net migration growth and such indicators as «International Tourism», «Income», «Total Government Spending», «Birth rates», «GDP per capita». And negative interactions were found between migration growth and risk of not covering the expenditures of surgical care, including catastrophic non-coverage, and mortality. The recommendations for further improvements of migration policy, social policy and budgeting policy were offered.

**Keywords:** migration, net migration growth, national development, fuzzy cognitive maps, FCM modelling, determinants.

**JEL Classification** F22, J01, O15

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### **МІГРАЦІЙНІ ПРОЦЕСИ В УКРАЇНІ: ФІНАНСОВІ, СОЦІАЛЬНІ І ЕКОНОМІЧНІ ДЕТЕРМІНАНТИ**

**Анотація.** Дослідження зосереджено на виявленні взаємозв'язків між показниками зростання міграції та показниками економічного розвитку і спрямовано на перевірку тверджень про те, що мігранти переміщуються до країн із високим рівнем урбанізації, високим експортно-імпортом і бюджетним потенціалом, соціальним, економічним та інфраструктурним розвитком, високими темпами інновацій, із доступною та ефективною системою охорони здоров'я, фінансовою стабільністю. Попередні дослідження у сфері міграції були детально проаналізовані і їхні результати стали відправною точкою для вибору параметрів, які можуть вплинути на зростання міграції. Статтю розроблено як кількісне дослідження, засноване на моделюванні нечітко-логічних когнітивних карт (FCM), що дозволили віднайти параметри дев'яти систем (концепцій) національного економічного розвитку, які впливають на зростання міграції. Були розраховані матриці причинно-наслідкових зв'язків і напрями впливу параметрів 9 концепції та 53 підконцепцій на зростання міграції, а також візуалізовано когнітивні карти причинно-наслідкових зв'язків між зростанням чистої міграції та обраними параметрами національного розвитку. Було виявлено, що найвищий рівень позитивної взаємодії існує між зростанням чистої міграції і такими показниками, як «Міжнародний туризм», «Дохід», «Загальні державні витрати», «Народжуваність», «ВВП на душу населення». Було виявлено негативну взаємодію між зростанням міграції і ризиком непокриття витрат на хірургічну допомогу, включаючи катастрофічне непокриття витрат на медичну допомогу, і рівнем смертності. Були запропоновані рекомендації щодо подальшого вдосконалення міграційної політики, соціальної політики та політики бюджетування.

**Ключові слова:** міграція, зростання чистої міграції, національний розвиток, нечіткі когнітивні карти, моделювання FCM, детермінанти.

Формул: 3; рис.: 11; табл.: 17; бібл.: 45.

**Introduction.** The study is preconditioned by the rapid changes in the population in Ukraine, namely the high rate of migration, that coupled with increased technological advances and resources reallocation. Several more tendencies like the rapid rate of urbanization, technology innovations, the gap between regional and country development, and the will to get access to a better quality of life became factors of high migration rates in Ukraine. The migration processes are natural and accompany the trade and industrial evolution of nations. Nevertheless, the depopulation in Ukraine became crucial for maintaining further economic growth, and labor migration now is one of the severe problems.

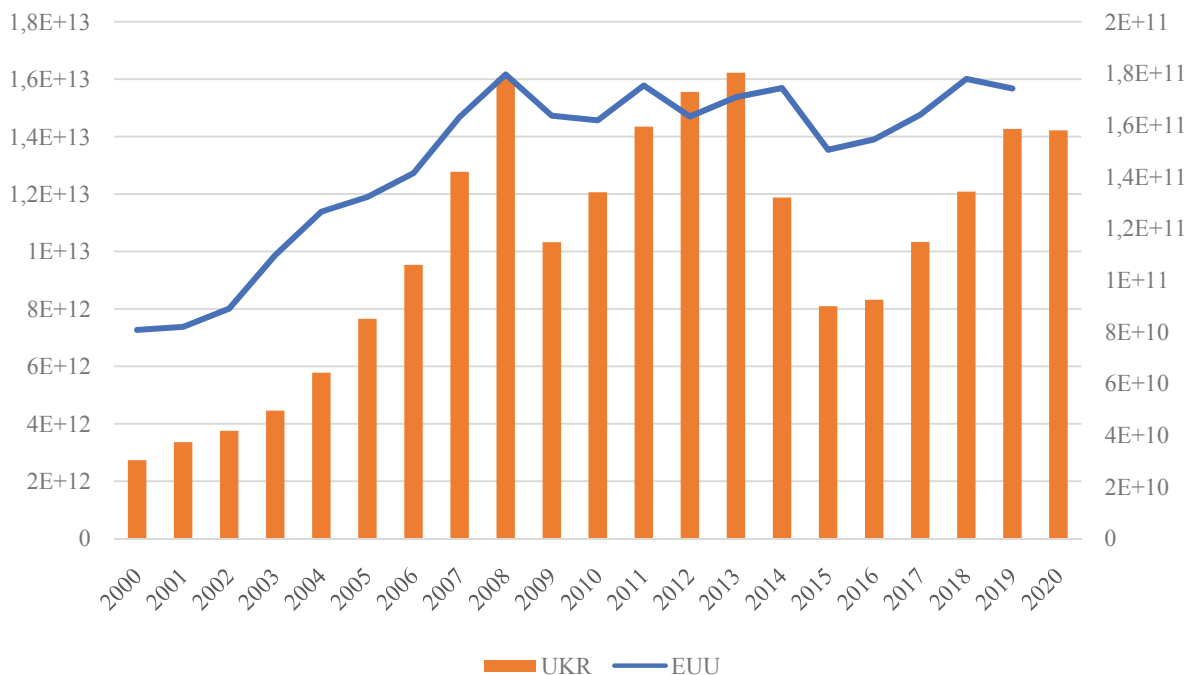
According to the International Bank for Reconstruction and Development (IBRD) data, more than 68% of Ukrainian cities show a permanent tendency to decrease the rate of economic activity due to the rapid decline of their population [35]. According to experts, further decline in

Ukraine's population and the outflow of workers, and low attractiveness for immigrants will lead to a decline in consumer demand in the country in the long run, thus reducing incentives for investment by external stakeholders and negatively affect GDP growth. The migration mitigating is interconnected with the incentives for overcoming the specified negative tendencies.

Therefore, this study is aimed to identify the causal links between the effectiveness of state migration policies and the determinants of national economic development to develop a clear understanding of further improvements in migration policy.

**Literature review and the problem statement.** In Ukraine, the largest number of immigrants in 2020 was observed in regions with high population density: Kyiv region (1,781.0 thousand people), Kharkiv region (2,658.5 thousand people), Odessa region (2,377.2 thousand people). Thus, 49,252 people immigrated to Kyiv region (by type of locality: urban — 26,465 people, rural — 22,787 people), Kharkiv region — 38,711 people (urban — 32,341 people, rural — 6,370 people), Odessa region — 28,402 people (urban — 20,031 persons, rural — 8,371 persons).

According to the Chairman of the National Bank of Ukraine, migration processes, on the one hand, help reduce economic inequality in the country, increase productivity, financial stability of the population, and on the other — increase the financial burden on social protection and health care systems [40]. It was revealed by the experts of the International Organization for Migration that the projected wages, living costs, labor market demand are important factors in choosing a destination country for emigrants [44], and the main purpose of staying abroad (about 90% of respondents' answers) is employment. Therefore, public policy should be aimed at financing large-scale job creation and providing investment and savings opportunities for migrant workers. It should be noted that the level of income of the population of the European Union is on average 10% higher than the average income of the population of Ukraine (Fig. 1).



**Fig. 1. Average income level of the population of Ukraine (UKR) and the countries of the European Union (EUU), 2000—2020.**

Source: Constructed using the data [33].

A number of papers of academic scholars from all around the world are devoted to the study of the determinants of national economic development. Some systematic investigations should be mentioned, such as the study on job opportunities for migrants [6], workforce diversity [19], and division of labor [13] as possible factors of migrations. The innovations development may become a beacon for migrants who are highly skilled [28, p. 10] and quality of education service in EU countries [33, p. 20].

The scale and scope of the investigation on migration may differ from EU region [11] to biological antecedents of migration per se [16], or historical view on complex temporal dimensions of the migration process [12].

The main reason for considering this topic is the growing rank of social and migration issues related to globalization, urbanization, the efficiency of the country's health care system, its infrastructural development, financial stability, etc. In particular, the development potential of large cities and their ability to increase trade (as a condition for ensuring acceptable levels of social and economic guarantees and infrastructure development) leads to an increase in their attractiveness for highly-skilled migrants. International migration as a driver of country development is widely studied by national and international scientists. For instance, the determinants of migration processes were identified, classified at the macroeconomic and microeconomic levels [15]. Other studies are devoted to one factor, such as corruption that can be a barrier to reach the high level of life [31], or income inequality [18], or lack of financial inclusion [17], as well as systematic financial, economic and educational transformations [24].

The consequences of migration are the focus of attention of many researchers. For instance, the rise of fake news due to immigration, and opinions polarization were investigated by Borella and Rossinelli [8]. Another big stream of academic thought that emerged recently is how COVID-19 affected business [9§ 32] and tourism [21], which became a catalyst for migration processes.

To identify the causal links between the effectiveness of state migration policies, as well as the determinants of national economic development, it is crucial to test the hypothesis that emigrants prefer to move to countries with high levels of urbanization, high export-import and budget potential, social, economic and infrastructural development, high rates of innovations, accessible and effective health care system, financial stability. This creates both additional benefits for such countries (influx of migrants contributes to the spread of new knowledge, technologies, use of international experience, etc.) and new risks (increasing the gap between urban and rural development, pollution, morbidity, labor supply surplus, etc.), which must be considered in the process of developing state migration policy.

**Methodology.** According to Hozhyj [41], a modern tool for studying the causal relationships of the parameters of the economic system is the apparatus of fuzzy cognitive maps. Using a modern economic-mathematical toolbox of data analysis and dynamic modeling in the software environment, FCMapper allowed the authors to identify the most influential indicators of the studied system and to determine the direction of their interaction and scenarios of change. The advantage of the cognitive model is that it allows the identification of causal relationships in poorly structured and poorly formalized systems [2, 3]. In the previous study [5], scientists proved the applicability of the cognitive maps toolbox for presenting the imaginary causal structure of a complex economic system to develop a long-term strategy for the national economy. The authors emphasize that fuzzy cognitive maps are designed to formalize the problem of a complex system as a set of factors that reflect systemic variables (signs) and causal relationships between them, taking into account mutual interactions and changes of relations. The scientists have identified 20 concepts and 129 sub-concepts of sustainable socio-economic development for the sample of 31 countries. According to this methodology, the causal relationships between concepts and subconcepts should be carried out in the following sequence:

1) definition of concepts (vertices) of the oriented graph. Depending on the information base and the type of parameters that implement the relevant causal relationships, the topology of the future cognitive map is determined;

2) construction of a cognitive model of cause-and-effect relations of concepts of an oriented graph with the help of nonlinear differential equations. The mathematical form of the functional dependence of the two concepts can be represented as the following functional dependence:

$$X_j(t + 1) = f_j(\sum_{i=1}^N r_{ij}X_i(t) + X_j(t)) , \quad (1)$$

where  $X_j, X_i$  – concepts of the economic system,

$r_{ij}$  – numerical values of the ratio of concepts  $X_j$  to  $X_i$ ,

$N$  – the number of concepts of the economic system in the  $t$ -th period.

3) establishment of the force (weight) and direction of mutual influence of concepts by using the values of search parameters of nonlinear differential equations which are limited by ranges [0, 1] or [-1, 1];

4) visualization of causal relationships of concepts of an oriented graph.

Additional arguments in favor of using this methodology are the following. The replication of the research [27] and implementation of the mentioned methodology allowed the authors of the study [29] to identify catalysts and inhibitors of innovation transfer in the system «enterprise-region-state». In addition, the developed cognitive model of innovation transfer in the system «enterprise-region-state», which considers 100 indicators, allows to describe the dynamic behavior of the system and can be used for decision-making in the long run. The research [5] is based on the use of the method of fuzzy cognitive maps as a tool for determining the level of achievement of the Sustainable Development Goals by the countries of the European Union. In this study [5], 23 indicators describing social development were analyzed: Goal 1, No poverty; economic development, Goal 8, Decent work and economic growth; environmental development, Goal 13, Climate Action, and institutional and political development, Goal 17, Partnerships for the goals. And as a result, the relationships between the factors determining the development of the EU economies within the framework of sustainable development were identified. The empirical results showed that there are causal relationships only between the indicators of Goal 8 and Goal 1, Goal 13, and Goal 17. At the same time, no causal relationships between other indicators of the Sustainable Development Goals have been identified.

The algorithm proposed in [42] to build a fuzzy cognitive model of the innovative potential of the machine-building enterprise allowed the author of scientific work to identify stable concepts of innovative activity of the enterprise and, on their basis, to develop alternative strategies for managing innovation processes.

The use of fuzzy cognitive maps has also been widely used in research of political and social development [2; 3], stability of the financial system [37], the efficiency of the health care system [26], agro-industrial complex [25], the foresight of long-term economic development [30], etc.

The general view of the results is presented as an oriented graph and a matrix of interrelations of concepts of this graph (Please, see Fig. 2).

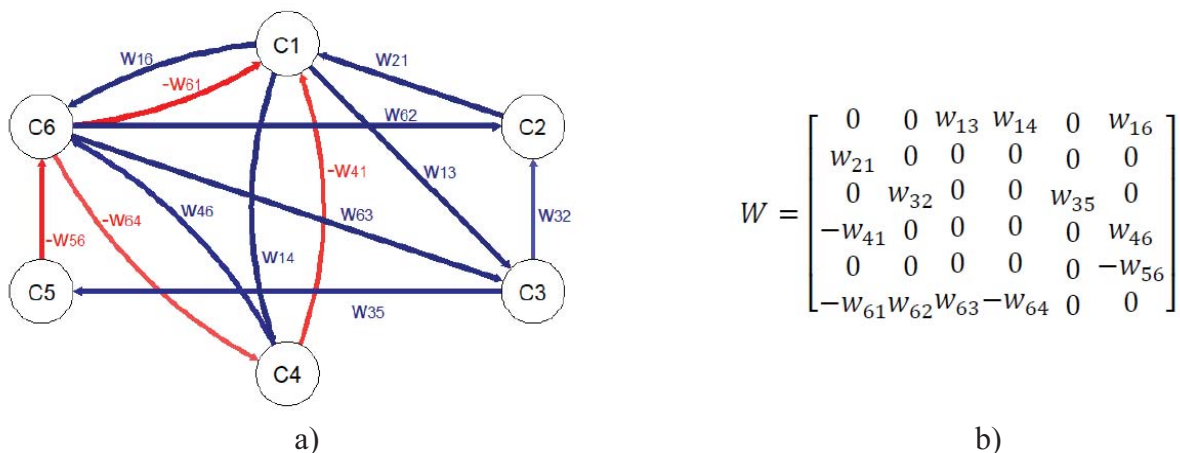


Fig. 2. The general form of the oriented graph (a) and the matrix of interrelation (b) of the concepts of this graph

Source: [27].

Thus, the use of cognitive modeling allows a more profound and multifaceted study of the causal links between the level of net migration and the set of parameters of the national economy, taking into account not only their direct but also indirect effects. Comprehensive retrospective analysis of the educational, demographic-migration, and social-labor environments of Ukraine, considering the experience of advanced countries in reforming the education system to prevent labor migration, allowed to form a base of factors (concepts) that promote or prevent the «brain drain».

**Research results.** The following determinants (or concepts) of national economy development were chosen for further computing: a) export-import potential, b) infrastructural development, c) urbanization, d) innovation, e) budget potential, f) social development, g) financial stability, h) efficiency of the health care system, i) economic growth.

The main elements of Ukraine's infrastructural development are transport, communications, electricity consumption (see *Table 1*). The direct implementation of the tasks of economic growth of the country depends on the pace of modernization of the infrastructure of the economy. It thus acts as a catalyst or inhibitor of the efficiency of the sphere of material production.

Table 1

**The description for the concepts of «Infrastructural Development»**

Group name	Symbol	Name of the concept	Mean	Median
Infrastructure	I1	Number of registered air transport	50266,41	48562,0
	I2	Electricity consumption (kWh per capita)	3291,50	3399,52
	I3	Cellular network subscription (per 100 people)	95,16	120,01
	I4	Secure Internet servers (per 1 million people)	2009,35	108,25

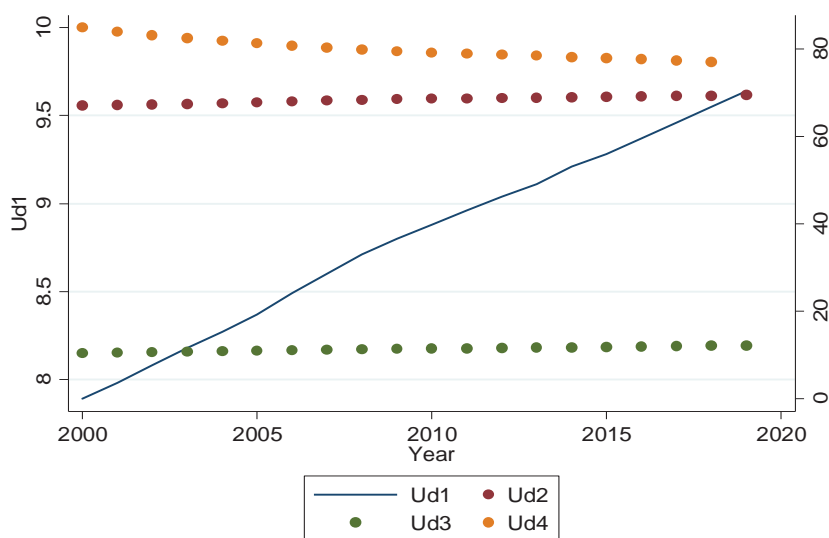
According to one of the broadest approaches presented by Liang and Yang [20], the concept of «Urbanization» includes four components (*Table 2*).

Table 2

**The description for the concepts of «Urbanization»**

Group name	Symbol	Name of the concept	Mean	Median
Urbanization	Ud1	Population living in large cities (% of urban population)	8.79	8.84
	Ud2	Urban population (% of total population)	68.38	68.55
	Ud3	Population living in urban agglomerations over 1 million (% of the total population)	11.35	11.42
	Ud4	Population density (persons per 1 sq. km of land area)	80.09	79.50

Among the studied indicators of the concept of «Urbanization», the growing trend during 2000—2020 has an indicator of the number of people living in large cities (% of urban population) (*Fig. 3*). Compared to 2000, this figure in 2020 increased by almost 22%. That is explained by the concentration of material production in large cities, higher infrastructural development, social progress, medical care, etc.



**Fig. 3. Dynamics of indicators of the concept of «Urbanization», 2000—2020**

Source: Computed by authors.

The main impetus for recognizing the need for an active state migration policy was the

openness. The integration of countries contributes to the simplification of export-import operations, the development of trade relations, free capital and technology exchange, intensification of investment activities, increasing living standards, increasing the level of migration attractiveness of the country. Thus, the paper [7] empirically confirmed the hypothesis that economic recovery, reducing unemployment, and ensuring sustainable economic growth depending on the level of export-import potential. The study is based on the production function of Cobb—Douglas:

$$Q = AL^\alpha \cdot K^\beta \tag{2}$$

where  $Q$  — total production (monetary value of all goods produced during the year);

$L$  — labor intensity (total number of hours worked per person per year);

$K$  — capital (monetary value of all machines, equipment, and buildings);

$A$  — total productivity ratio;

$\alpha, \beta$  — elasticity of production and capital, respectively.

Thus, the modified function (3), taking into account the level of openness of the economy, the authors presented in the form of an econometric equation:

$$\ln Y_i = \phi + \alpha \ln REC + \beta \ln SREC + \gamma \ln K + \delta \ln L + \lambda \ln T + \mu \tag{3}$$

where  $\phi, \alpha, \beta, \lambda, \gamma, \delta$  — search parameters of the model;

REC — renewable energy consumption;

T — the level of export-import potential of the country;

$\mu$  — statistical error of the equation;

SREC — renewable energy consumption.

The prolongation of this study on assessing the level of export-import potential allowed identifying the eight concepts (Table 3).

Table 3

**The description for the concepts of «Export-import Potential»**

Group name	Symbol	Name of the concept	Mean	Median
Export-import Potential	T1	Energy imports, net (% of energy consumption)	37.62	39.56
	T2	Fuel exports (% of exports of goods)	5.71	5.34
	T3	International tourism, costs (% of total imports)	6.87	6.23
	T4	Exports of goods and services (% of GDP)	48.91	48.3
	T5	High technology exports (% of exports)	6.69	6.81
	T6	Imports of goods and services (% of GDP)	52.22	52.36
	T7	International tourism, receipts (% of total exports)	5.85	6.46
	T8	Trade in goods (% of GDP)	82.91	82.56

The budgetary potential has a vital role as a crisis management tool. Government interventions are necessary because people tend to save and increase consumption by a smaller share than their income increases. Taxes and government loans were used to cover the required additional public expenditures. Therefore, the budget deficit and the amount of public debt increased, which contributed to the growth of emigration [23]. Descriptive characteristics of the concept of «Budget Potential» are presented in Table 4.

Table 4

**The description for the concepts of «Budget Potential»**

Group name	Symbol	Name of the concept	Mean	Median
Budget Potential	PS1	Total tax rate and contributions (% of the profit)	52,64	55,40
	PS2	Tax revenues (% of GDP)	16,81	17,29
	PS3	Income, excluding grants (% of GDP)	33,11	34,35
	PS4	Military expenditures (% of government expenditures)	5,28	4,96
	PS5	Total government spending (% of GDP)	35,48	36,08
	PS6	Net investment in non-financial assets (% of GDP)	0,79	0,76
	PS7	Net lending (+) / net borrowing (-) (% of GDP)	-2,32	-1,49

To include the financial determinants of the national economy and the concept of «budget potential», it is proposed to consider the parameters of the country's financial stability (Table 5).

Table 5

**The description for the concepts of «Financial Stability»**

Group name	Symbol	Name of the concept	Mean	Median
Financial Stability	FS1	Money supply (% of GDP)	44.56	44.56
	FS2	Foreign direct investment (US dollars)	4.47E+09	4.47E+09
	FS3	Inflation (annual%)	12.87	12.87
	FS4	General reserves (includes gold, current US dollars)	1.85E+10	1.85E+10
	FS5	Interest rate on the loan (%)	19.94	19.94
	FS6	Real interest rate (%)	3.78	3.78

Analyzing the impact of financial stability on the effectiveness of state migration policy, it can be stated that significant differences in taxation, inflation, foreign direct investment between countries, and conditions for free movement of capital between them, all else being equal, will lead to a gradual transition of intellectual capital. In the long run, it can significantly affect the national economy's economic development (*Table 6*).

Table 6

**The description for the concepts of «Economic Development»**

Назва групи	Умовне позначення концепту	Назва концепту	Mean	Median
Economic Development	Eg1	GDP per capita (US dollars)	2478.2	2478.2
	Eg2	Gross capital formation (% of GDP)	22.24	22.24
	Eg3	Industry (including construction), value added (% of GDP)	26.86	26.86

Effective social policy in the country is one of the ways to reduce the harmful effects of migration. The previous studies revealed set indicators of the social development [36; p. 1, 4] among them the most common are: a) crime rate (number of cases per 100 thousand population); b) share of women in national parliaments (%); c) adult literacy index; d) scientific and pedagogical staff in institutions of higher education (persons); e) birth rate in adolescents (birth per 1,000 women aged 15—19 years).

Descriptive characteristics of these indicators of the «Social Development» concept are presented in *Table 7*.

Table 7

**The description for the concepts of «Social Development»**

Group name	Symbol	Name of the concept	Mean	Median
Social Development	SD1	Crime rate (number of cases per 100 thousand population)	8,58	8,82
	SD2	Share of women in national parliaments (%)	9,49	8,22
	SD3	Adult literacy index	1,01	1,00
	SD4	Scientific and pedagogical staff in institutions of higher education (persons);	0,99	0,99
	SD5	Birth rate in adolescents (birth per 1,000 women aged 15—19 years).	28,46	29,28

One of the state migration policy goals is to prevent illegal immigration, human trafficking, ensure fair treatment of immigrants, support their adaptation to the new culture and society, and equal access to health services. Indeed, the timely resolution of immigrants' health care issues helps to remove barriers to their social integration, employment, and training. Thus, an inefficient health care system can make the state migration policy more vulnerable to destabilizing factors, significantly reduce the possibility of neutralizing the negative impact on long-term economic growth. Given the above, the main parameters of the concept of «health» include: a) risk of not covering the expenditures of surgical care (% of people at risk); b) risk of catastrophic non-coverage of expenditures for surgical care (% of people at risk); c) private health care expenditures



(% of total health care expenditures); d) government spending on health care; e) prevalence of malnutrition (% of the population); f) life expectancy; g) population over 65 years of age (% of the total population); h) population aged 15–64 (% of the total population); i) infant mortality rate (per 1,000 live births); j) mortality rate up to 5 years (per 1,000 live births); k) life expectancy at birth (years); l) birth rate (birth per woman); m) mortality (per 1,000 people); n) birth rate (per 1,000 people). Table 8 shows the same parameters describing the concept of «health system efficiency».

Table 8

**The description for the concepts of «Health Care Efficiency»**

Group name	Symbol	Name of the concept	Mean	Median
Health Care Efficiency	H1	Risk of not covering the expenditures of surgical care (% of people at risk)	5.89	5.89
	H2	Risk of catastrophic non-coverage of expenditures for surgical care (% of people at risk)	16.07	16.07
	H3	Private health care expenditures (% of total health care expenditures);	85673	85673
	H4	Government spending on health care;	3510.1	3510.1
	H5	Prevalence of malnutrition (% of the population);	2.64	2.64
	H6	Life expectancy	-0.56	-0.56
	H7	Population over 65 years of age (% of the total population)	15.62	15.62
	H8	Population aged 15—64 (% of the total population)	69.27	69.27
	H9	Infant mortality rate (per 1,000 live births)	7.48	7.48
	H10	Mortality rate up to 5 years (per 1,000 live births)	12.44	12.44
	H11	Life expectancy at birth (years)	69.59	69.59
	H12	Birth rate (birth per woman)	1.35	1.35
	H13	Mortality (per 1,000 people)	15.35	15.35
	H14	Birth rate (per 1,000 people).	9.81	9.81

According to Androschuk [38], almost 25% of Ukrainian scientists and researchers are employed abroad. The imperfection of the state support system (tax, insurance, etc.), poor stimulation of inventive activity leads to the outflow of highly qualified personnel capable of producing an innovative product, know-how technologies, etc. Therefore, two parameters will form the concept «Innovativeness», as Table 9 shows.

Table 9

**The description for the concepts of «Innovativeness»**

Group name	Symbol	Name of the concept	Mean	Median
Innovativeness	ST1	Export of high-tech goods (% of industrial exports)	0,81	0,85
	ST2	The number of articles published in scientific and technical journals	6611,13	5963,76

The list of descriptors of the concepts proposed for FCM analysis is presented in Appendix A. The migration growth (Mig) was chosen as a target factor in this study. In the first stage of FCM analysis, the values of the relationship ( $w_{ij}$ ) between the vertices (concepts) of the oriented graph are established. This weighting factor, which characterizes the strength of the influence of factors, has a value in the range from «-1» to «+1» and corresponds to three main types:

- no causal link between the concepts:  $w_{ij} = 0$ ;
- causal increase (increase (decrease) of one factor leads to increase (decrease) of another):  $w_{ij} > 0$ ;
- for a causal increase (decrease) of one factor leads to a decrease (increase) of another):  $w_{ij} < 0$ .

To interpret in more detail the strength of the relationship between concepts in the study, it is proposed to use a linguistic scale for assessing the relationship between basic concepts as showed below. Same logic of scale was used in the previous studies [39, 42, 45]. The scale is the following:

- $w_{ij} = 0$  – no influence;
- $w_{ij} \in (0; 0,2]$  or  $(0; -0,2]$  — poor influence (or weakens);
- $w_{ij} \in (0,2; 0,4]$  or  $(-0,2; -0,4]$  — weakly amplifies (or weakens);
- $w_{ij} \in (0,4; 0,6]$  or  $(-0,4; -0,6]$  — moderately strengthens (or weakens);

- $w_{ij} \in (0,6; 0,8]$  or  $(-0,6; -0,8]$  — strongly strengthens (or weakens);
- $w_{ij} \in (0,8; 1]$  or  $(-0,8; -1]$  — very much strengthens (or weakens).

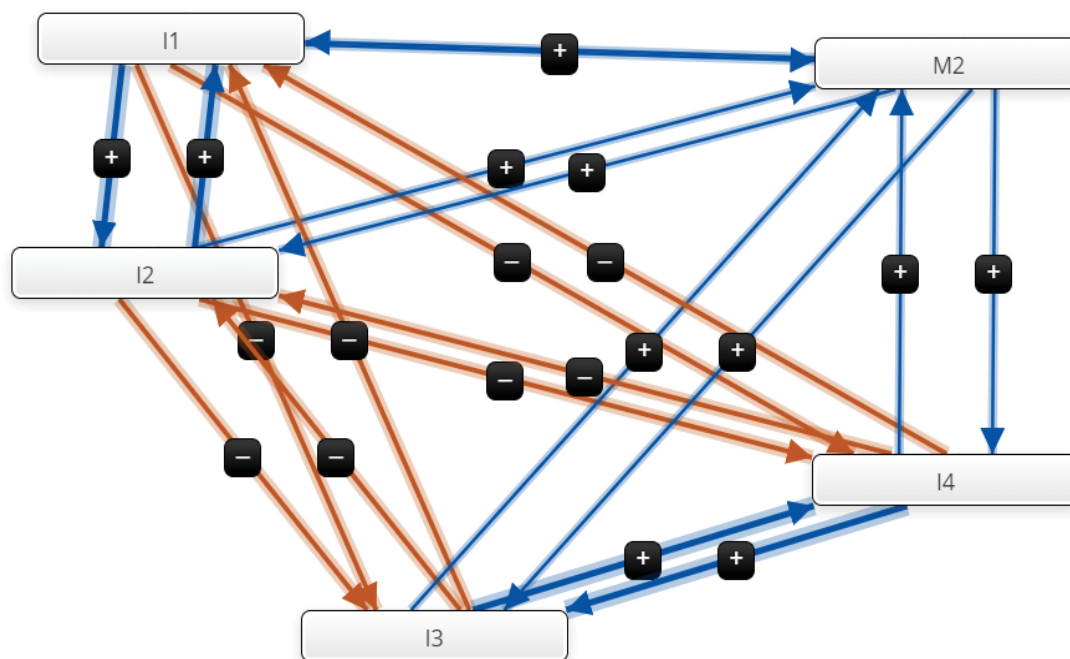
In the next stage of FCM-analysis, matrices are built that identify the causality and directions of influence of the parameters of the national economy and the level of net migration according to the proposed scale. The obtained matrices of causality and directions of crucial factors influence allow building their cognitive maps. The results of calculating the magnitude of the relationship ( $w_{ij}$ ) between the parameters of the concept of «infrastructure development» and migration growth are presented in *Table 10*) and the corresponding cognitive map is demonstrated in *Fig. 4*.

Table 10

**Matrix of causality and directions of influence of parameters of the concept of «Infrastructural Development» and migration growth**

	I1	I2	I3	I4
I1	0.00	0.90	-0.77	-0.79
I2	0.90	0.00	-0.55	-0.61
I3	-0.77	-0.55	0.00	0.99
I4	-0.79	-0.61	0.99	0.00
Mig	0.25	0.34	0.25	0.23

Note: The color (blue — positive, yellow — negative) indicates the highest statistically significant level of relationship between indicators and Mig.



**Fig. 4. Cognitive map of formalization of causal links between the level of net migration growth and the parameters of the concept of «Infrastructure Development»**

Source: developed by authors, red color means positive links between concepts and blue – negative.

The results showed a weak causal relationship between the level of net migration and the concept of «infrastructure development» parameters. All parameters of this concept enhance the growth of net migration growth.

Talking about the concept of «urbanization», there is also a weak causal relationship with the level of net migration growth (*Table 11*).

Table 11

**Matrix of causality and directions of influence of parameters of the concept of «Urbanization» and migration growth**

	UD1	UD2	UD3	UD4
UD1	0.00	1.00	1.00	-0.98
UD2	1.00	0.00	1.00	-0.99
UD3	1.00	1.00	0.00	-0.99
UD4	-0.98	-0.99	-0.99	0.00
M2	0.23	0.23	0.24	-0.27

Note: The color (blue — positive, yellow — negative) indicates the highest statistically significant level of relationship between indicators and Mig.

At the same time, the parameter population density (persons per 1 sq. km of land area) has a negative character and weakly weakens the dynamics of net migration growth (Fig. 5).

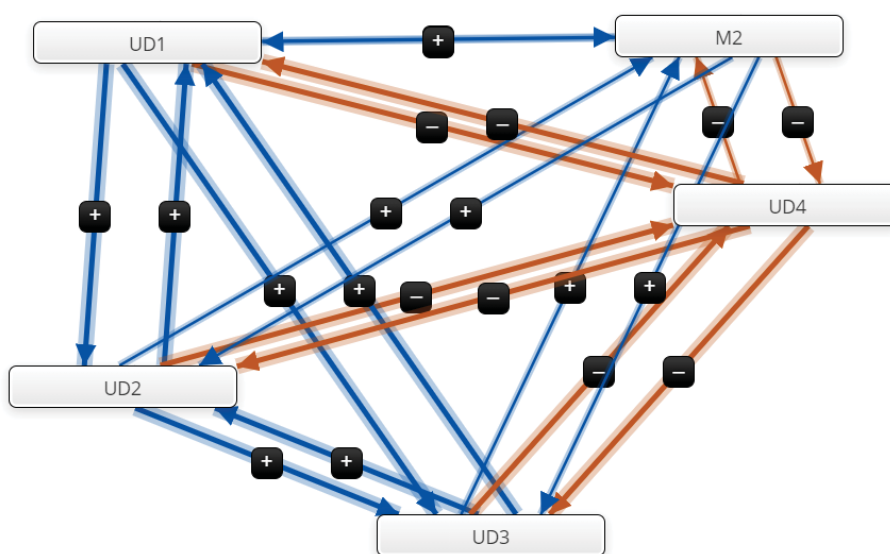


Fig. 5. Cognitive map of formalization of causal links between the level of net migration growth and the parameters of the concept of «Urbanization».

Source: developed by authors, red color means positive links between concepts and blue — negative.

The analysis of the matrix of dependence between the parameters of the concept of «export-import potential» (Table 12) shows it is reasonable to include international tourism in the model (revenues, % of total exports). This fact is confirmed by the moderate value of its relationship with the level of net migration growth (0.42).

Table 12

**Matrix of causality and directions of influence of parameters of the concept of «Export-import Potential» and migration growth**

	T1	T2	T3	T4	T5	T6	T7	T8
T1	0.00	0.86	-0.76	0.78	-0.72	0.94	0.20	1.00
T2	0.86	0.00	-0.83	0.50	-0.97	0.79	0.42	0.87
T3	-0.76	-0.83	0.00	-0.19	0.77	-0.89	-0.78	-0.73
T4	0.78	0.50	-0.19	0.00	-0.33	0.57	-0.46	0.81
T5	-0.72	-0.97	0.77	-0.33	0.00	-0.63	-0.47	-0.72
T6	0.94	0.79	-0.89	0.57	-0.63	0.00	0.45	0.91
T7	0.20	0.42	-0.78	-0.46	-0.47	0.45	0.00	0.15
T8	1.00	0.87	-0.73	0.81	-0.72	0.91	0.15	0.00
M2	0.04	-0.25	-0.29	-0.20	0.38	0.35	0.42	-0.02

Note: The color (blue — positive, yellow — negative) indicates the highest statistically significant level of relationship between indicators and Mig

The parameters that weaken migration growth in Ukraine are shown in Fig. 6 and are the following:

- fuel exports (% of exports of goods) — 0.25;
- international tourism, expenditures (% of total imports) — 0.29;
- exports of goods and services (% of GDP) — 0.2;
- trade in goods (% of GDP) — 0.02.

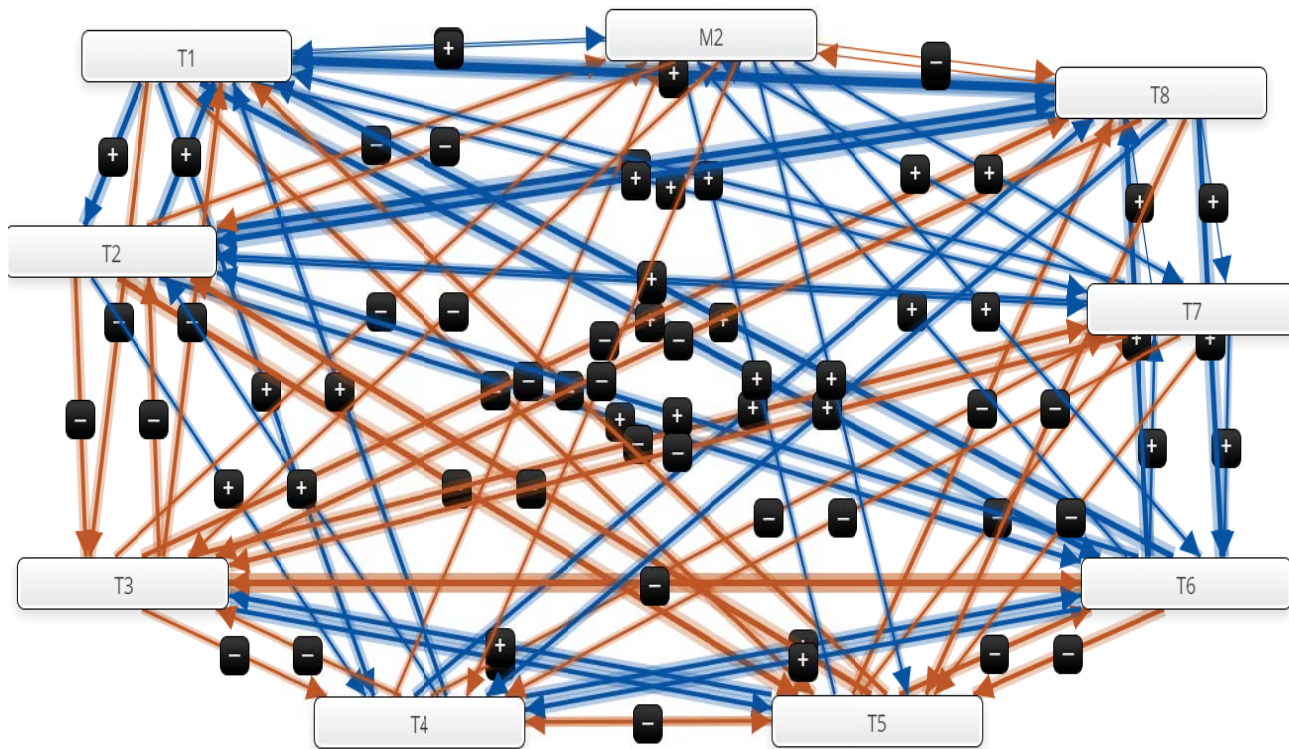


Fig. 6. Cognitive map of formalization of causal links between the level of net migration growth and the parameters of the concept of «Export-import Potential»

Source: developed by authors, red color means positive links between concepts and blue —negative.

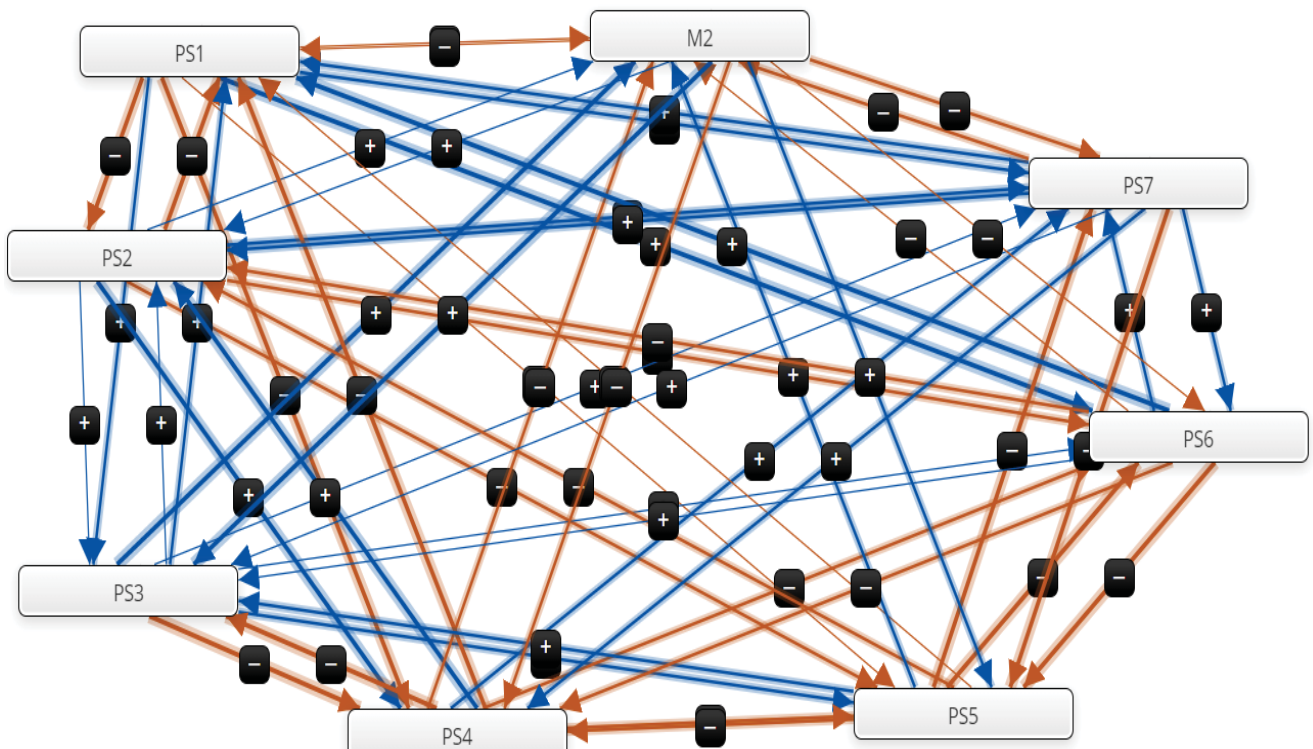
Turning to the analysis of the impact of each of the seven indicators of the concept of «budget potential» on net migration, it is an obvious direct positive correlation with PS3, PS5, and negative — with PS4 (Table 13, Fig. 7).

Table 13

**Matrix of causality and directions of influence of parameters of the concept of «Budget Potential» and migration growth**

	PS1	PS2	PS3	PS4	PS5	PS6	PS7
PS1	0.00	-0.55	0.45	-0.72	-0.09	0.68	0.18
PS2	-0.55	0.00	0.01	0.64	-0.38	-0.32	0.47
PS3	0.45	0.01	0.00	-0.63	0.31	0.06	0.13
PS4	-0.72	0.64	-0.63	0.00	-0.48	-0.35	0.29
PS5	-0.09	-0.38	0.31	-0.48	0.00	-0.57	-0.79
PS6	0.68	-0.32	0.06	-0.35	-0.57	0.00	0.47
PS7	0.18	0.47	0.13	0.29	-0.79	0.47	0.00
M2	-0.12	0.07	0.51	-0.40	0.49	-0.12	-0.32

Note: The color (blue — positive, yellow — negative) indicates the highest statistically significant level of relationship between indicators and Mig.



**Fig. 7. Cognitive map of formalization of causal links between the level of net migration growth and the parameters of the concept of «Budget Potential»**

Source: developed by authors, red color means positive links between concepts and blue – negative.

To study the quantitative characteristics of the causal links between the level of net migration and the set of parameters of the concept of «financial stability», such indicators were used as money supply (% of GDP); foreign direct investment (US dollars); inflation (annual%); general reserves (contains gold, current US dollars); interest rate on loan (%), actual interest rate (%).

These parameters mainly reinforce the level of net migration growth, except for FS3 and FS5, but their causal relationships are weak (FS1, FS3, FS4, FS5) and very weak (FS2, FS6) (Table 14, Fig. 8).

Table 14

**Matrix of causality and directions of influence of parameters of the concept of «Financial Stability» and migration growth**

	FS1	FS2	FS3	FS4	FS5	FS6
FS1	0.00	0.52	-0.06	0.67	-0.74	-0.53
FS2	0.52	0.00	-0.21	0.87	-0.56	-0.42
FS3	-0.06	-0.21	0.00	-0.10	0.31	-0.52
FS4	0.67	0.87	-0.10	0.00	-0.65	-0.49
FS5	-0.74	-0.56	0.31	-0.65	0.00	0.59
FS6	-0.53	-0.42	-0.52	-0.49	0.59	0.00
M2	0.25	0.18	-0.22	0.21	-0.28	0.03

Note: The color (blue — positive, yellow — negative) indicates the highest statistically significant level of relationship between indicators and Mig.

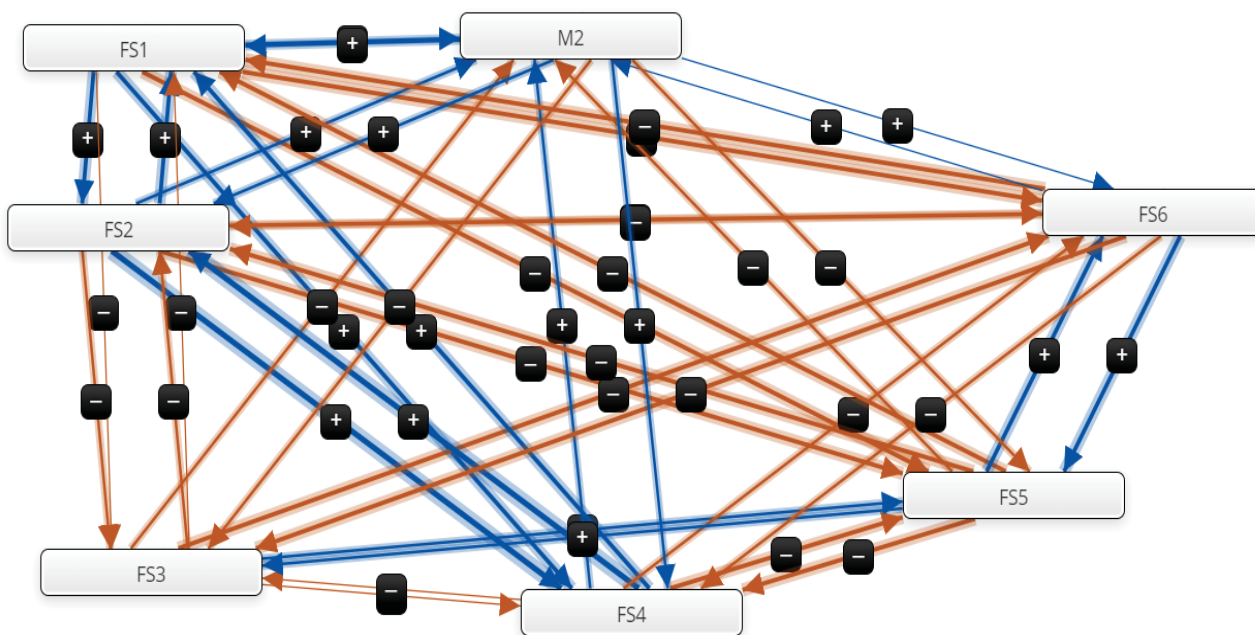


Fig. 8. Cognitive map of formalization of causal links between the level of net migration growth and the parameters of the concept of «Financial Stability»

Source: developed by authors, red color means positive links between concepts and blue – negative.

Among the parameters of the concept of «Social development» and «Innovativeness» that would be moderate, strong, or very strong causal links with net migration growth was not identified (Table 15, Fig. 9).

Table 15

Matrix of causality and directions of influence of parameters of the concept of «Social Development», «Innovativeness» and migration growth

	ST1		ST2		
ST1	0.00		-0.82		
ST2	-0.82		0.00		
M2	-0.14		0.25		
	SD1	SD2	SD3	SD4	SD5
SD1	0.00	-0.06	-0.13	0.49	0.52
SD2	-0.06	0.00	0.76	0.36	-0.42
SD3	-0.13	0.76	0.00	0.03	-0.66
SD4	0.49	0.36	0.03	0.00	0.27
SD5	0.52	-0.42	-0.66	0.27	0.00
M2	-0.16	0.23	0.24	-0.14	-0.37

Note: The color (blue — positive, yellow — negative) indicates the highest statistically significant level of relationship between indicators and Mig.

Concluding the analysis of causal links with the evaluation of interconnections between the net migration growth and «efficiency of the health care system» and «economic development». The formation of the relevant concepts was based on ten parameters, seven of which are devoted to «efficiency of the health care system», and the rest — to «economic development».

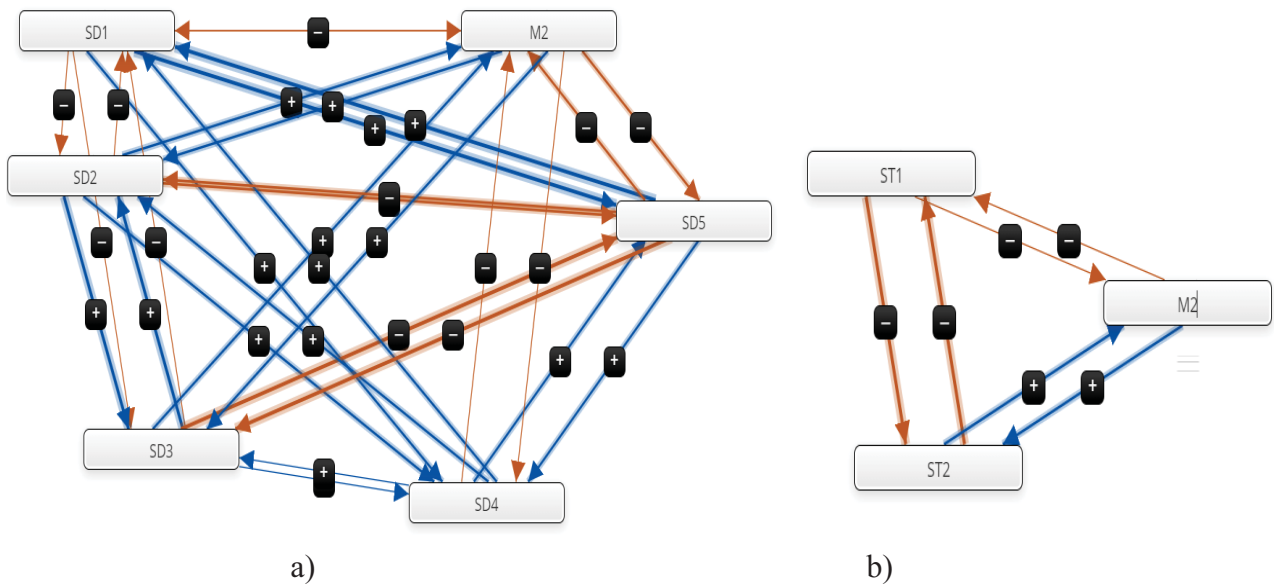


Fig. 9. Cognitive map of formalization of causal links between the level of net migration growth and the parameters of the concept «Financial Stability» (a) and «Innovativeness» (b)

Source: developed by authors, red color means positive links between concepts and blue — negative.

Despite the significant theoretical validity of each parameter of concepts with migration, empirical calculations confirmed a high degree of interdependence with the level of net migration growth for the following parameters of the concept «health system efficiency» (Table 16):

- H1 — strongly weakens (-0.76);
- H2 — very weakens (-0.81);
- H10 — moderately weakens (-0.58);
- H11 — moderately enhances (0.50);
- H12 — strongly enhances (0.76);
- H13 — moderately weakens (-0.51);
- H14 — strongly amplifies (0.78).

Table 16

**Matrix of causality and directions of influence of parameters of the concept of «Health Care Efficiency» and migration growth**

	H1	H10	H11	H12	H13	H14	H2	H3	H4	H5	H6
H1	0.00	0.84	-0.70	-0.93	0.65	-0.87	0.97	-0.05	-0.29	-0.19	-0.87
H10	0.84	0.00	-0.94	-0.82	0.86	-0.60	0.71	-0.45	0.06	-0.46	-0.90
H11	-0.70	-0.94	0.00	0.72	-0.96	0.49	-0.56	0.43	-0.28	0.44	0.87
H12	-0.93	-0.82	0.72	0.00	-0.72	0.94	-0.89	0.14	0.23	0.03	0.91
H13	0.65	0.86	-0.96	-0.72	0.00	-0.53	0.54	-0.28	0.27	-0.34	-0.85
H14	-0.87	-0.60	0.49	0.94	-0.53	0.00	-0.90	-0.13	0.35	-0.21	0.79
H2	0.97	0.71	-0.56	-0.89	0.54	-0.90	0.00	0.14	-0.32	-0.05	-0.79
H3	-0.05	-0.45	0.43	0.14	-0.28	-0.13	0.14	0.00	-0.28	0.35	0.16
H4	-0.29	0.06	-0.28	0.23	0.27	0.35	-0.32	-0.28	0.00	-0.10	0.01
H5	-0.19	-0.46	0.44	0.03	-0.34	-0.21	-0.05	0.35	-0.10	0.00	0.24
H6	-0.87	-0.90	0.87	0.91	-0.85	0.79	-0.79	0.16	0.01	0.24	0.00
H7	-0.29	-0.17	-0.07	-0.01	0.21	-0.04	-0.28	-0.03	0.29	0.42	-0.01
H8	-0.13	0.36	-0.40	0.18	0.27	0.49	-0.33	-0.68	0.39	-0.70	-0.04
H9	0.85	1.00	-0.94	-0.82	0.86	-0.60	0.71	-0.44	0.06	-0.47	-0.90
M2	-0.76	-0.58	0.50	0.76	-0.51	0.78	-0.81	-0.18	0.04	-0.04	0.72

Note: The color (blue — positive, yellow — negative) indicates the highest statistically significant level of relationship between indicators and Mig.

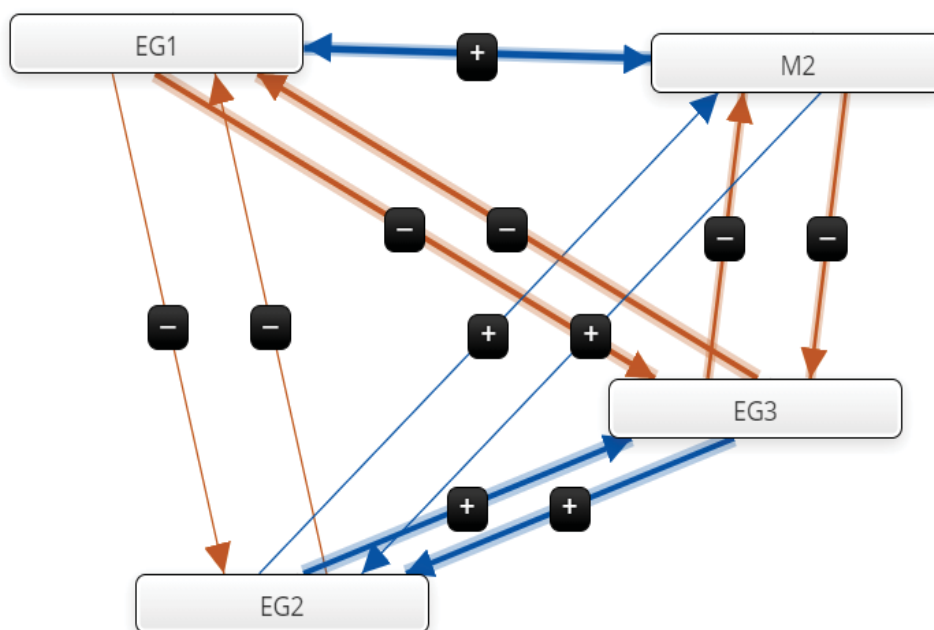
For its part, among the parameters of the concept of «Economic Development» EG1 has a very strong causal relationship with the level of net migration growth of Ukraine (Table 17, Fig. 10).

Table 17

**Matrix of causality and directions of influence of parameters of the concept of «Economic Development» and migration growth**

	EG1	EG2	EG3
EG1	0.00	-0.15	-0.58
EG2	-0.15	0.00	0.77
EG3	-0.58	0.77	0.00
M2	0.80	0.06	-0.22

Note: The color (blue — positive, yellow — negative) indicates the highest statistically significant level of relationship between indicators and Mig.



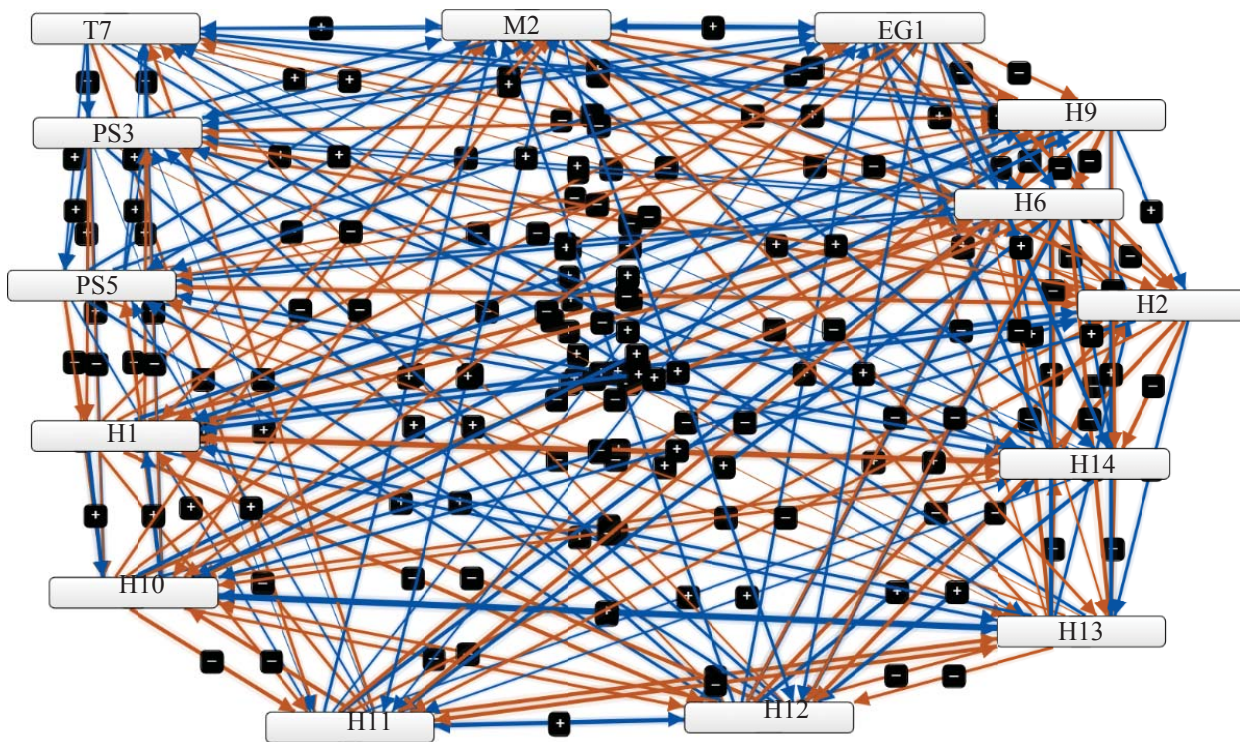
**Fig. 10. Cognitive map of formalization of causal links between the level of net migration growth and the parameters of the concept of «Economic Development»**

Source: developed by authors, red color means positive links between concepts and blue – negative.

The abovementioned cognitive maps allow identifying the most influential factors that are incentives and deterrents for changes in net migration. A generalized view of cognitive maps of formalization of convergent relationships between the defined parameters of all concepts investigated in this study is shown in Fig. 11.

The results of cognitive modeling showed that the highest level of positive interaction (when the factors reinforce each other) was found between net migration growth and indicators T7 («Export-import Potential»), PS3, PS5 («Budget Potential»), H12, H14 («Health Care System»), EG1 («Economic Development»). The negative interactions (when factors weaken each other) were identified for concepts H1, H2, H9, H10, H13 («Health Care System»).





**Fig. 11. Cognitive map of formalization of causal links between the level of net migration growth and the most influential parameters of investigated concepts**

*Source:* developed by authors, red color means positive links between concepts and blue – negative.

**Conclusions.** The paper is focused on identifying the causal links between the effectiveness of state migration policies and the determinants of national economic development to develop a clear understanding of further improvements in migration policy. This study uses quantitative methods, namely FCM modeling, to reveal the most influential indicators of the studied system and determine the direction of their interaction and scenarios of change. As a result, among all the concepts (nine concepts were analyzed) and cognitive modeling showed that the highest level of positive interaction (when the factors reinforce each other) was found between net migration growth and such indicators as «International Tourism», «Income», «Total Government Spending», «Birth rates», «GDP per capita». The negative interactions were found between migration growth and the risk of not covering the expenditures of surgical care, including catastrophic non-coverage and mortality (as well as infant mortality rate, mortality rate up to 5 years).

Based on these pieces of evidence, a set of recommendations for reforming the migration policy in Ukraine may be offered formulated, in particular: in the sphere of «health care system efficiency» the recommendations include implementation of state programs of medical guarantees and social security for migrants, developing information campaigns among migrants on accessible and timely health care, and existing information online portals of the health care system. In the sphere of the improving of «export-import potential» the recommendations include development of a strategy for the promoting Ukraine's national brand, in a parallel, developing a reputable strategy for Ukraine's perception of the international community, improving intercultural awareness, and dissemination of successful cases and best practices of immigrants to start-up their own business in innovative technologies, high-tech production, creative industry, etc. Regarding the concept of «budget potential» some improvements are needed, such as the introduction of tax relief programs for companies whose activities are focused on education and integration of migrants into the cultural environment of the country, the implementation of programs for training and retraining of migrants and their families. In a sphere of «economic development» some new targeted employment programs for migrants should be developed considering their qualifications and competencies, as well as social security programs for employed migrants in national industrial

sectors, designing a state information online portal to integrate employers' requests for vacancies and resumes of migrants in one network.

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#### Література

1. Anderson G. L. Social development and the evolution of civil society. *International Journal on World Peace*. 2017. № 34 (1). P. 3—6.
2. Andreou A. S., Mateou N. H., Zombanakis G. A. Evolutionary fuzzy cognitive maps: A hybrid system for crisis management and political decision-making. *Conference Proceedings on Computational Intelligence for Modelling Control and Automation*. 2003. № 1. P. 1—12.
3. Andreou A. S., Mateou N. H., Zombanakis G. A. Soft computing for crisis management and political decision making: The use of genetically evolved fuzzy cognitive maps. *Soft Computing Journal*. 2005. № 9 (3). P. 194—210.
4. Azzopardi P., Kennedy E., Patton G. C. Data and Indicators to Measure Adolescent Health, Social Development and Well-being, Innocenti Research Briefs. 2017. № 04. UNICEF Office of Research — Innocenti, Florence.
5. Bāk I., Cheba K. Fuzzy cognitive maps and their application in the economic sciences. *Ekonometria*. 2020. № 24 (3). P. 20—36.
6. Bardy R., Rubens A., Eberle P. Soft Skills and Job Opportunities of Migrants: Systemic Relationships in the Labor Market. *Business Ethics and Leadership*. 2017. № 1 (4). P. 5—21.
7. Bilan Y., Streimikiene D., Vasylieva T., Lyulyov O., Pimonenko T., Pavlyk A. Linking between renewable energy, CO2 emissions, and economic growth: Challenges for candidates and potential candidates for the EU membership. *Sustainability*. 2019. № 11 (6). P. 1528.
8. Borella C. A., Rossinelli D. Fake News, Immigration, and Opinion Polarization. *Socio Economic Challenges*. 2017. № 1 (4). P. 59—72.
9. Boronos V., Zakharkin O., Zakharkina L., Bilous Y. The impact of the COVID-19 pandemic on business activities in Ukraine. *Health Economics and Management Review*. 2020. № 1 (1). P. 76—83.
10. Butko M., Popelo O., Pishenin I. Innovations in Human Resources Management in Eurointegration Conditions: Case for Ukrainian Agro-Industrial Complex. *Marketing and Management of Innovations*. 2019. № 2. P. 74—82.
11. Butkus M., Maciulyte-Sniukiene A., Matuzeviciute K., Davidaviciene V. Society's attitudes towards impact of immigration: case of EU countries. *Marketing and Management of Innovations*. 2018. № 1. P. 338—352.
12. Cwerner S. B. The times of migration. *Journal of Ethnic and Migration Studies*. 2001. № 27 (1). P. 7—36.
13. Dave H. Elementary investigation on Division of Labour. Part 2. *Financial Markets, Institutions and Risks*. 2018. № 2 (4). P. 39—56.
14. De Haas H. Migration theory: quo vadis? International Migration Institute. 2014. URL : [https://ora.ox.ac.uk/objects/uuid:45aacf94-8f24-4294-9c74-cbc8453fcbfb/download\\_file?safe\\_filename=WP100%2520Migration%2520Theory.pdf&type\\_of\\_work=Working+paper](https://ora.ox.ac.uk/objects/uuid:45aacf94-8f24-4294-9c74-cbc8453fcbfb/download_file?safe_filename=WP100%2520Migration%2520Theory.pdf&type_of_work=Working+paper).
15. Pudryk D. International Migration As A Driver Of Country Development. *Socio Economic Challenges*. 2021. № 5 (1). P. 133—143.
16. Dingle H., Drake V. A. What Is Migration? *BioScience*. 2007. February. № 57 (2). P. 113—121.
17. Gatsi J. G. Effects of International and Internal Remittances on Financial Inclusion in Ghana. *Financial Markets, Institutions and Risks*. 2020. № 4 (3). P. 109—123.
18. Jafarzadeh E., He Shuquan. The Impact of Income Inequality on the Economic Growth of Iran: An Empirical Analysis. *Business Ethics and Leadership*. 2019. № 3 (2). P. 53—62.
19. Kowo S. A., Kadiri B. I., Zekeri A. Correlate of Workforce Diversity and Organisational Performance of Multinational Food Producing Industry in Nigeria. *Business Ethics and Leadership*. 2020. № 4 (1). P. 126—137.
20. Kuzior A., Grebski M., Grebski W. Marketing of an Academic Program: Case Study of an Engineering Program. *Marketing and Management of Innovations*. 2021. № 1. P. 56—64.
21. Letunovska N., Kwilinski A., Kaminska B. Scientific Research In The Health Tourism Market: A Systematic Literature Review. *Health Economics and Management Review*. 2020. № 1 (1). P. 8—19.
22. Liang W., Yang M. Urbanization, economic growth and environmental pollution: Evidence from China. *Sustainable Computing: Informatics and Systems*. 2019. № 21. P. 1—9.
23. Moniruzzaman M., Walton-Roberts M. Migration, debt and resource backwash: how sustainable is Bangladesh-Gulf circular migration? *Migration and Development*. 2018. № 7 (1). P. 85—103.
24. Novikov V. Intercept of Financial, Economic and Educational Transformations: Bibliometric Analysis. *Financial Markets, Institutions and Risks*. 2021. № 5 (2). P. 120—129.
25. Papageorgiou E. I., Markinos A., Gemtos T. Application of fuzzy cognitive maps for cotton yield management in precision farming. *Experts Systems with Applications*. 2009. № 36 (10). P. 12399—12413.
26. Papageorgiou E. I., Spyridonos P., Glotsos D., Stylios C. D., Groumpos P. P., Nikiforidis G. Brain tumor characterization using the soft computing technique of fuzzy cognitive maps. *Applied Soft Computing Journal*. 2008. № 8. P. 820—828.
27. Papageorgiou K., Singh P. K., Papageorgiou E., Chudasama H., Bochtis D., Stamoulis G. Fuzzy cognitive map-based sustainable socio-economic development planning for rural communities. *Sustainability*. 2020. № 12 (1). P. 305.
28. Pudryk D., Legenkyi M., Alioshkina L. Innovation Development and Migration: Panel Data Approach. *Marketing and Management of Innovations*. 2021. № 1. P. 336—347.
29. Shkarupa O. V., Boronos V. H., Vlasenko D. O., Fedchenko K. A. Multilevel transfer of innovations: Cognitive modeling to decision support in managing the economic growth. *Problems and Perspectives in Management*. 2021. № 19 (1). P. 151—162.

30. Song H., Miao C., Roel W., Shen Z., Catthoor F. Implementation of fuzzy cognitive maps based on fuzzy neural networks and application in prediction of time series. *IEEE Transactions on Fuzzy Systems*. 2010. № 18 (2). P. 233—250.
31. Sysoyeva L., Kleinschmidt H. Corruption and migration policy. EU crisis management revisited. *SocioEconomic Challenges*. 2017. № 1 (1). P. 48—53.
32. Tiutiunyk I., Humenna Yu., Flaumer A. COVID-19 impact on business sector activity in the EU countries: digital issues. *Health Economics and Management Review*. 2021. № 2 (1). P. 54—66.
33. Vorontsova A., Mayboroda T., Lieonov H. Innovation management in education: impact on socio-labour relations in the national economy. *Marketing and Management of Innovations*. 2020. № 3. P. 346—357.
34. World Bank Open Data. *The World bank*. URL : <https://data.worldbank.org>.
35. Україна: огляд процесів урбанізації. Звіт Міжнародного банку реконструкції та розвитку № ACS15060 / The World Bank. Washington, 2015. 218 p. URL : [https://city2030.org.ua/sites/default/files/documents/Urban%20Review%20UA\\_0.pdf](https://city2030.org.ua/sites/default/files/documents/Urban%20Review%20UA_0.pdf).
36. Youniss J. The nature of social development: A conceptual discussion of cognition. *Issues in childhood social development*. London : Routledge, 2017. P. 203—227.
37. Ziolo M., Filipiak M. Z., Bąk I., Cheba K. How to design more sustainable financial systems: the roles of environmental, social, and governance factors in the decision-making process. *Sustainability*. 2019. № 11 (20). P. 1—34.
38. Андрощук Г. О. (2020). Патентна активність Українських винахідників за кордоном: вплив на економічну безпеку. *Економіко-правові проблеми розвитку та сприяння господарській діяльності в сучасних умовах : зб. наук. пр. за матеріалами II Круглого столу, 17 травня 2019 року*. Харків : НДІПЗІР НАПрН України, 2019. С. 138—149.
39. Безродна О. С. Побудова нечіткої когнітивної карти впливу лагових показників у ЗСП на прибутковість банку. *Вісник Університету банківської справи Національного банку України*. 2013. № 1. С. 285—290.
40. Виступ Голови НБУ на Щорічній дослідницькій конференції Національного банку України та Національного банку Польщі «Ринок праці та монетарна політика» / Національний банк України. 2020. URL : <https://bank.gov.ua/ua/news/all/vistup-golovi-nbu-na-schorichnij-doslidnitskij-konferentsiyi-natsionalnogo-banku-ukrayini-ta-natsionalnogo-banku-polschi-rinok-pratsi-ta-monetarna-politika>.
41. Гожий О. П. Побудова динамічних моделей на основі нечітких когнітивних карт для вирішення задач сценарного планування. *Вісник Львівського державного університету безпеки життєдіяльності*. 2013. № (7). С. 13—17.
42. Інфраструктура регіонів України. Пріоритети модернізації. Аналітичне дослідження / Фонд імені Фрідріха Еберта. Київ, 2017. 108 с.
43. М'ячин В. Г. Алгоритм побудови когнітивної карти формування інноваційного потенціалу машинобудівного підприємства. *Науковий вісник Херсонського державного університету. Економічні науки*. 2014. № 9 (6). С. 91—95.
44. Міграція як чинник розвитку в Україні. Дослідження фінансових надходжень, пов'язаних з міграцією, та їхнього впливу на розвиток в Україні / Міжнародна організація з міграції. Київ, 2016. URL : [https://www.iom.org.ua/sites/default/files/mom\\_migraciya\\_yak\\_chynnyk\\_rozvytku\\_v\\_ukrayini.pdf](https://www.iom.org.ua/sites/default/files/mom_migraciya_yak_chynnyk_rozvytku_v_ukrayini.pdf).
45. Прохорова В. В. Науково-методичні аспекти розробки когнітивного підходу щодо моделювання управлінських впливів на розвиток підприємства. *Проблеми системного підходу в економіці*. 2011. № 1. URL : <http://www.nbu.gov.ua/ejournals/PSPE/index.htm>.

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#### References

1. Anderson, G. L. (2017). Social development and the evolution of civil society. *International Journal on World Peace*, 34 (1), 3—6.
2. Andreou, A. S., Mateou, N. H., & Zombanakis, G. A. (2003). Evolutionary fuzzy cognitive maps: A hybrid system for crisis management and political decision-making. *Conference Proceedings on Computational Intelligence for Modelling Control and Automation, 1*, 1—12.
3. Andreou, A. S., Mateou, N. H., & Zombanakis, G. A. (2005). Soft computing for crisis management and political decision making: The use of genetically evolved fuzzy cognitive maps. *Soft Computing Journal*, 9 (3), 194—210.
4. Azzopardi, P., Kennedy, E., & Patton, G. C. (2017). Data and Indicators to Measure Adolescent Health, Social Development and Well-being. *Innocenti Research Briefs № 2017-04*. UNICEF Office of Research — Innocenti, Florence.
5. Bąk, I., & Cheba, K. (2020). Fuzzy cognitive maps and their application in the economic sciences. *Ekonometria*, 24 (3), 20—36.
6. Bardy, R., Rubens, A., & Eberle, P. (2017). Soft Skills and Job Opportunities of Migrants: Systemic Relationships in the Labor Market. *Business Ethics and Leadership*, 1 (4), 5—21. [https://doi.org/10.21272/bel.1\(4\).5-21.2017](https://doi.org/10.21272/bel.1(4).5-21.2017).
7. Bilan, Y., Streimikiene, D., Vasylieva, T., Lyulyov, O., Pimonenko, T., & Pavlyk, A. (2019). Linking between renewable energy, CO2 emissions, and economic growth: Challenges for candidates and potential candidates for the EU membership. *Sustainability*, 11 (6), 1528.
8. Borella, C. A., & Rossinelli, D. (2017). Fake News, Immigration, and Opinion Polarization. *SocioEconomic Challenges*, 1 (4), 59—72. [https://doi.org/10.21272sec.1\(4\).59-72.2017](https://doi.org/10.21272sec.1(4).59-72.2017).
9. Boronos, V., Zakharkin, O., Zakharkina, L., & Bilous, Y. (2020). The impact of the COVID-19 pandemic on business activities in Ukraine. *Health Economics and Management Review*, 1 (1), 76—83. <https://doi.org/10.21272/hem.2020.1-07>.
10. Butko, M., Popelo, O., & Pishenin, I. (2019). Innovations in Human Resources Management in Eurointegration Conditions: Case for Ukrainian Agro-Industrial Complex. *Marketing and Management of Innovations*, 2, 74—82. <http://doi.org/10.21272/mmi.2019.2-07>.
11. Butkus, M., Maciulyte-Sniukiene, A., Matuzeviciute, K., & Davidaviciene, V. (2018). Society's attitudes towards impact of immigration: case of EU countries. *Marketing and Management of Innovations*, 1, 338—352. <http://doi.org/10.21272/mmi.2018.1-26>.
12. Cwerner, S. B. (2001). The times of migration. *Journal of Ethnic and Migration Studies*, 27 (1), 7—36.
13. Dave, H. (2018). Elementary investigation on Division of Labour. Part 2. *Financial Markets, Institutions and Risks*, 2 (4), 39—56. [http://doi.org/http://doi.org/10.21272/fmir.2\(4\).39-56.2018](http://doi.org/http://doi.org/10.21272/fmir.2(4).39-56.2018).

14. De Haas, H. (2014). Migration theory: quo vadis? International Migration Institute. Retrieved from [https://ora.ox.ac.uk/objects/uuid:45aacf94-8f24-4294-9c74-cbc8453fcbfb/download\\_file?safe\\_filename=WP100%2520Theory.pdf&type\\_of\\_work=Working+paper](https://ora.ox.ac.uk/objects/uuid:45aacf94-8f24-4294-9c74-cbc8453fcbfb/download_file?safe_filename=WP100%2520Theory.pdf&type_of_work=Working+paper).
15. Pudryk, D. (2021). International Migration As A Driver Of Country Development. *SocioEconomic Challenges*, 5 (1), 133—143. [https://doi.org/10.21272/sec.5\(1\).133-143.2021](https://doi.org/10.21272/sec.5(1).133-143.2021).
16. Dingle, H., & Drake, V. A. (2007, February). What Is Migration? *BioScience*, 57 (2), 113—121. <https://doi.org/10.1641/B570206>.
17. Gatsi, J. G. (2020). Effects of International and Internal Remittances on Financial Inclusion in Ghana. *Financial Markets, Institutions and Risks*, 4 (3), 109—123. [https://doi.org/10.21272/fmir.4\(3\).109-123.2020](https://doi.org/10.21272/fmir.4(3).109-123.2020).
18. Jafarzadeh, E., & He, Shuquan. (2019). The Impact of Income Inequality on the Economic Growth of Iran: An Empirical Analysis. *Business Ethics and Leadership*, 3 (2), 53—62. [http://doi.org/10.21272/bel.3\(2\).53-62.2019](http://doi.org/10.21272/bel.3(2).53-62.2019).
19. Kowo, S. A., Kadiri, B. I., & Zekeri, A. (2020). Correlate of Workforce Diversity and Organisational Performance of Multinational Food Producing Industry in Nigeria. *Business Ethics and Leadership*, 4 (1), 126—137. [http://doi.org/10.21272/bel.4\(1\).126-137.2020](http://doi.org/10.21272/bel.4(1).126-137.2020).
20. Kuzior, A., Grebski, M., & Grebski, W. (2021). Marketing of an Academic Program: Case Study of an Engineering Program. *Marketing and Management of Innovations*, 1, 56—64. <http://doi.org/10.21272/mmi.2021.1-05>.
21. Letunovska, N., Kwilinski, A., & Kaminska, B. (2020). Scientific Research In The Health Tourism Market: A Systematic Literature Review. *Health Economics and Management Review*, 1 (1), 8—19. <https://doi.org/10.21272/hem.2020.1-01>.
22. Liang, W., & Yang, M. (2019). Urbanization, economic growth and environmental pollution: Evidence from China. *Sustainable Computing: Informatics and Systems*, 21, 1—9.
23. Moniruzzaman, M., & Walton-Roberts, M. (2018). Migration, debt and resource backwash: how sustainable is Bangladesh-Gulf circular migration? *Migration and Development*, 7 (1), 85—103.
24. Novikov, V. (2021). Intercept of Financial, Economic and Educational Transformations: Bibliometric Analysis. *Financial Markets, Institutions and Risks*, 5 (2), 120—129. [https://doi.org/10.21272/fmir.5\(2\).120-129.2021](https://doi.org/10.21272/fmir.5(2).120-129.2021).
25. Papageorgiou, E. I., Markinos, A., & Gemtos, T. (2009). Application of fuzzy cognitive maps for cotton yield management in precision farming. *Experts Systems with Applications*, 36 (10), 12399—12413.
26. Papageorgiou, E. I., Spyridonos, P., Glotsos, D., Stylios, C. D., Groumpos, P. P., & Nikiforidis, G. (2008). Brain tumor characterization using the soft computing technique of fuzzy cognitive maps. *Applied Soft Computing Journal*, 8, 820—828.
27. Papageorgiou, K., Singh, P. K., Papageorgiou, E., Chudasama, H., Bochtis, D., & Stamoulis, G. (2020). Fuzzy cognitive map-based sustainable socio-economic development planning for rural communities. *Sustainability*, 12 (1), 305.
28. Pudryk, D., Legenkyi, M., & Alioshkina, L. (2021). Innovation Development and Migration: Panel Data Approach. *Marketing and Management of Innovations*, 1, 336—347. <http://doi.org/10.21272/mmi.2021.1-26>.
29. Shkarupa, O. V., Boronos, V. H., Vlasenko, D. O., & Fedchenko, K. A. (2021). Multilevel transfer of innovations: Cognitive modeling to management support in managing the economic growth. *Problems and Perspectives in Management*, 19 (1), 151—162. [http://doi.org/10.21511/ppm.19\(1\).2021.13](http://doi.org/10.21511/ppm.19(1).2021.13).
30. Song, H., Miao, C., Roel, W., Shen, Z., & Catthoor, F. (2010). Implementation of fuzzy cognitive maps based on fuzzy neural networks and application in prediction of time series. *IEEE Transactions on Fuzzy Systems*, 18 (2), 233—250.
31. Sysoyeva, L., & Kleinschmidt, H. (2017). Corruption and migration policy. EU crisis management revisited. *Socio Economic Challenges*, 1 (1), 48—53. <http://doi.org/10.21272/sec.2017.1-05>.
32. Tiutiunyk, I., Humenna, Yu., & Flaumer, A. (2021). COVID-19 impact on business sector activity in the EU countries: digital issues. *Health Economics and Management Review*, 2 (1), 54—66. <https://doi.org/10.21272/hem.2021.1-06>.
33. Vorontsova, A., Mayboroda, T., & Lieonov, H. (2020). Innovation management in education: impact on socio-labour relations in the national economy. *Marketing and Management of Innovations*, 3, 346—357. <http://doi.org/10.21272/mmi.2020.3-25>.
34. The World Bank. (n. d.). World Bank Open Data. Retrieved from <https://data.worldbank.org>.
35. *Ukraina: ohliad protsesiv urbanizatsii. Zvit Mizhnarodnoho banku rekonstruksii ta rozvytku № ACS15060 [Ukraine: Urbanisation Review. World Bank, International Bank for Reconstruction and Development Report № ACS15060]*. (2015). Washington. Retrieved from [https://city2030.org.ua/sites/default/files/documents/Urban%20Review%20UA\\_0.pdf](https://city2030.org.ua/sites/default/files/documents/Urban%20Review%20UA_0.pdf) [in Ukrainian].
36. Youniss, J. (2017). The nature of social development: A conceptual discussion of cognition. *Issues in childhood social development*. London: Routledge.
37. Ziolo, M., Filipiak, M. Z., Bąk, I., & Cheba, K. (2019). How to design more sustainable financial systems: the roles of environmental, social, and governance factors in the decision-making process. *Sustainability*, 11 (20), 1—34.
38. Androshuk, H. O. (2020). *Patentna aktyvnist Ukrainskykh vynakhidnykiv za kordonom: vplyv na ekonomichnu bezpeku. Ekonomiko-pravovi problemy rozvytku ta sprianniia hospodarskii diialnosti v suchasnykh umovakh: zb. nauk. pr. za materialamy II Kruhloho stolu, 17 travnia 2019 roku [Patent activity of Ukrainian inventors abroad: impact on economic security. Economic and legal problems of development and promotion of economic activity in modern conditions. Science. etc. based on the materials of the II Round Table, May 17, 2019]*. Kharkiv: NDIPZIR NAPrN Ukrainy [in Ukrainian].
39. Bezrodna, O. S. (2013). Pobudova nechitkoi kohnityvnoi karty vplyvu lahovykh pokaznykiv u ZSP na prybutkovist banku [Construction of a fuzzy cognitive map of the impact of lag indicators in the SSP on the profitability of the bank]. *Visnyk Universytetu bankivskoi spravy Natsionalnoho banku Ukrainy — Bulletin of the University of Banking of the National Bank of Ukraine*, 1, 285—290 [in Ukrainian].
40. Natsionalnyi bank Ukrainy. (2020). *Vstup Holovy NBU na Shchorichnii doslidnytskii konferentsii Natsionalnoho banku Ukrainy ta Natsionalnoho banku Polshchi «Rynok pratsi ta monetarna polityka» [Speech of the Chairman of the NBU at the Annual Research Conference of the National Bank of Ukraine and the National Bank of Poland «Labor Market and Monetary Policy»]*. Retrieved from <https://bank.gov.ua/ua/news/all/vistup-golovi-nbu-na-schorichniy-doslidnitskiy-konferentsiyi-natsionalnogo-banku-ukrayini-ta-natsionalnogo-banku-polschi-rinok-pratsi-ta-monetarna-polityka> [in Ukrainian].
41. Hozhyj, O. P. (2013). Pobudova dynamichnykh modelei na osnovi nechitkykh kohnityvnykh kart dlia vyrishennia zadach stsenarnoho planuvannia [Construction of dynamic models based on fuzzy cognitive maps to solve scenario planning

- problems]. *Visnyk Lvivskoho derzhavnoho universytetu bezpeky zhyttiediialnosti — Bulletin of Lviv State University of Life Safety*, 7, 13—17 [in Ukrainian].
42. Fond imeni Fridrikha Eberta. (2017). *Infrastruktura rehioniv Ukrainy. Priorityety modernizatsii. Analitychne doslidzhennia [Infrastructure of the regions of Ukraine. Priorities of modernization. Analytical research]*. Kyiv [in Ukrainian]
  43. Miachyn, V. H. (2014). Alhorytm pobudovy kohnityvnoi karty formuvannia innovatsiinoho potentsialu mashynobudivnoho pidpriemstva [Algorithm for constructing a cognitive map of the formation of the innovative potential of a machine-building enterprise]. *Naukovi visnyk Khersonskoho derzhavnoho universytetu. Ekonomichni nauky — Scientific Bulletin of Kherson State University. Economic sciences*, 9 (6), 91—95 [in Ukrainian].
  44. Mizhnarodna orhanizatsiia z mihratsii. (2016). *Mihratsiia yak chynnykrozvytku v Ukraini. Doslidzhennia finansovykh nadkhodzen, poviazanykh z mihratsiieiu, ta yikhnoho vplyvu na rozvytok v Ukraini [Migration as a factor of development in Ukraine. Study of financial income related to migration and their impact on development in Ukraine]*. Retrieved from [https://www.iom.org.ua/sites/default/files/mom\\_migraciya\\_yak\\_chynnyk\\_rozvytku\\_v\\_ukrayini.pdf](https://www.iom.org.ua/sites/default/files/mom_migraciya_yak_chynnyk_rozvytku_v_ukrayini.pdf) [in Ukrainian].
  45. Prohorova, V. V. (2011). Naukovo-metodychni aspekty rozrobky kohnityvnoho pidkhodu shehodo modeliuvannia upravlinskykh vplyviv na rozvytok pidpriemstva [Scientific and methodological aspects of developing a cognitive approach to modeling managerial influences on enterprise development]. *Problemy systemnoho pidkhodu v ekonomitsi — Problems of system approach in economy, 1*. Retrieved from <http://www.nbu.gov.ua/ejournals/PSPE/index.htm> [in Ukrainian].

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**Data and description of the concepts formalization of causal links between the level of net migration growth and the set of parameters of national economic development**

	EG1	EG2	EG3	FS1	FS2	FS3	FS4	FS5	FS6	H1	H10	H11	H12	H13	H14	H2	H3	H4	H5	H6
Mean	2478.2	22.24	26.86	44.56	447e7	12.87	185e8	19.94	3.78	5.89	12.44	69.59	1.35	15.35	9.81	16.07	85673.35	10.1	2.64	-0.56
Median	2478.2	22.24	26.86	44.56	447e7	12.87	185e8	19.94	3.78	5.89	12.44	69.59	1.35	15.35	9.81	16.07	85673.35	10.1	2.64	-0.56
Maximum	2591.8	21.72	25.81	47.13	454e7	11.46	199e8	17.81	1.84	3.00	12.00	69.19	1.37	15.30	10.20	12.60	61777.29	57.0	2.50	-0.51
Minimum	4029.7	32.83	32.42	62.04	107e7	48.70	346e8	41.53	20.43	21.70	18.30	71.78	1.53	16.60	11.40	42.90	321397321.0	3.50	-0.23	
Std.Dev.	635.70	12.60	21.73	18.59	-369t7	-0.24	148e8	13.90	-12.28	0.90	8.40	67.68	1.09	14.50	7.70	6.40	5154.02	166.0	2.50	-1.05
Skewness	1101.3	5.45	3.80	12.34	331e7	11.02	104e8	6.52	9.12	6.56	3.12	1.58	0.15	0.72	1.24	10.82	86537.16	50.6	0.31	0.25
Kurtosis	-0.28	0.24	0.15	-0.56	0.26	1.81	-0.13	2.23	0.13	1.42	0.39	0.12	-0.43	0.33	-0.38	1.43	1.50	1.79	1.91	-0.54
Jarque-Bera	1.86	2.69	1.40	2.37	2.06	6.78	1.84	7.50	2.26	3.61	1.93	1.22	1.70	1.68	1.70	3.95	4.28	4.51	5.20	2.19
Probability	1.34	0.27	2.21	1.39	0.97	22.75	1.18	33.51	0.51	5.26	1.47	2.56	1.91	1.72	1.80	5.66	8.90	12.55	14.55	1.51
Sum	0.51	0.87	0.33	0.50	0.61	0.00	0.56	0.00	0.77	0.07	0.48	0.28	0.38	0.42	0.41	0.06	0.01	0.00	0.00	0.47
SumSq.Dev.	49565.444	80537.17	891.23	894t7	257.34	371e8	398.88	75.51	88.40	248.80	1322.3	25.61	291.60	186.40	241.10	17134	70203	47.60	-11.27	
	H7	H8	H9	T1	T2	T3	T4	T5	T6	T7	T8	UD1	UD2	UD3	UD4					
Mean	15.62	69.27	7.48	37.62	5.71	6.87	48.91	6.69	52.22	5.85	82.91	8.79	68.38	11.35	80.09					
Median	15.62	69.27	7.48	39.56	5.34	6.23	48.30	6.81	52.36	6.46	82.56	8.84	68.55	11.42	79.50					
Maximum	15.71	69.35	7.20	45.05	11.72	12.02	62.44	8.52	57.41	8.66	95.13	9.64	69.47	12.20	84.88					
Minimum	16.70	70.17	11.20	25.67	0.97	3.32	41.17	5.00	45.95	3.07	71.97	7.89	67.15	10.43	77.03					
Std.Dev.	13.80	67.36	5.00	6.65	3.17	2.88	5.66	1.14	3.42	2.10	6.32	0.54	0.76	0.55	2.32					
Skewness	0.69	0.76	1.92	-0.58	0.10	0.69	0.88	-0.02	-0.19	0.01	0.26	-0.12	-0.29	-0.17	0.61					
Kurtosis	-1.26	-1.12	0.44	1.85	2.19	2.32	3.25	2.20	1.89	1.28	2.48	1.82	1.75	1.82	2.27					
Jarque-Bera	4.43	3.59	2.00	1.67	0.55	1.88	2.62	0.21	1.14	2.35	0.44	1.22	1.58	1.26	1.60					
Probability	6.97	4.47	1.47	0.43	0.76	0.39	0.27	0.90	0.56	0.31	0.80	0.54	0.45	0.53	0.45					
Sum	0.03	0.11	0.48	564.35	108.40	130.56	978.19	53.55	1044.47	111.09	1658.29	175.87	1367.58	227.00	1521.71					
SumSq.Dev.	312.49	1385.3	149.60	618.57	180.88	148.87	607.70	9.07	222.77	79.26	757.71	5.63	11.10	5.81	96.85					

Mean — the average value of the original data series; Median — the median of the original data series; Maximum — the maximum value of the original data series; Minimum — the minimum value of the original data series; Std. Dev. — standard deviation; Skewness — a measure of the asymmetry of the distribution of the original data series around its average; Kurtosis — a numerical characteristic of the probability distribution of the actual random variable of the original data series; Jarque-Bera — test statistics to check the normal distribution of the original data series; Probability — p-value test statistics Jarque-Bera; Sum Sq. Dev. — the sum of squares of deviations.

The continuation of the Appendix A

	I1	I2	I3	I4	M2	P1	PS1	PS2	PS3	PS4	PS5	PS6
Mean	50266,41	3291,501	95,16650	2009,352	12,16500	26,44706	52,64000	16,81158	33,11421	5,282500	35,48842	0,797647
Median	48562,00	3399,520	120,0100	108,2500	14,55000	26,00000	55,40000	17,29000	34,35000	4,960000	36,08000	0,760000
Maximum	76652,27	3662,440	144,2800	7867,200	152,2000	29,80000	57,30000	20,45000	37,49000	8,120000	43,54000	1,510000
Minimum	26859,00	2778,400	1,680000	12,36000	-133,6	24,00000	37,80000	12,07000	26,60000	3,280000	26,87000	0,140000
Std.Dev.	15125,46	314,9998	52,58358	2926,940	50,21635	1,918697	6,166476	2,564441	3,257389	1,588120	4,845995	0,410115
Skewness	0,046255	-0,487685	-0,922502	1,067302	-0,158603	0,499470	-1,392122	-0,345675	-0,681361	0,494614	-0,234605	0,283367
Kurtosis	1,985860	1,816506	2,104894	2,589988	7,393508	1,745279	3,618242	2,014158	2,377869	1,971441	2,096463	2,063196
Jarque-Bera	0,820988	1,470002	3,504376	1,968603	16,16961	1,821980	5,083896	1,147799	1,776544	1,697088	0,820591	0,849143
Probability	0,663322	0,479505	0,173394	0,373700	0,000308	0,402126	0,078713	0,563325	0,411366	0,428038	0,663454	0,654050
Sum	955061,7	49372,51	1903,330	20093,52	243,3000	449,6000	789,6000	319,4200	629,1700	105,6500	674,2800	13,56000
SumSq.Dev.	4,12E+09	1389148,	52535,62	77102822	47911,95	58,90235	532,3560	118,3745	190,9905	47,92038	422,7061	2,691106

	PS7	SD1	SD2	SD3	SD4	SD5	ST1	ST2
Mean	-2,32	8,585000	9,495789	1,004667	0,992000	28,46842	0,813158	6611,137
Median	-1,49	8,820000	8,220000	1,000000	0,990000	29,28000	0,850000	5963,760
Maximum	0,320000	11,71000	20,52000	1,020000	1,010000	34,98000	1,110000	10379,89
Minimum	-6,54	6,350000	5,330000	0,990000	0,950000	23,00000	0,450000	5293,690
Std.Dev.	1,928759	1,449365	3,524376	0,009155	0,014243	2,939352	0,206856	1329,238
Skewness	-0,762466	0,288483	1,545724	0,679257	-1,590666	-0,055043	-0,400735	1,467741
Kurtosis	2,514335	2,624860	6,059321	2,375129	6,246677	2,961654	2,080662	4,623230
Jarque-Bera	2,027688	0,394683	14,97556	1,397515	12,91362	0,010758	1,177632	8,907776
Probability	0,362822	0,820910	0,000560	0,497203	0,001570	0,994635	0,554984	0,011633
Sum	-44,08	171,7000	180,4200	15,07000	14,88000	540,9000	15,45000	125611,6
SumSq.Dev.	66,96200	39,91250	223,5821	0,001173	0,002840	155,5163	0,770211	31803705

Mean — the average value of the original data series; Median — the median of the original data series; Maximum — the maximum value of the original data series; Minimum — the minimum value of the original data series; Std. Dev. — standard deviation; Skewness — a measure of the asymmetry of the distribution of the original data series around its average; Kurtosis — a numerical characteristic of the probability distribution of the actual random variable of the original data series; Jarque-Bera — test statistics to check the normal distribution of the original data series; Probability — p-value test statistics Jarque-Bera; Sum Sq. Dev. — the sum of squares of deviations.