“Fundamentals of analytical assessment of the secondary sector of economy”

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ARTICLE INFO	Iryna Sierova, Hanna Svydlo, Viktoriia Derykhovska and Zine Barka (2020). Fundamentals of analytical assessment of the secondary sector of economy. *Economics of Development*, *19*(4), 1-11. doi:10.21511/ed.19(4).2020.01
DOI	http://dx.doi.org/10.21511/ed.19(4).2020.01
RELEASED ON	Tuesday, 15 December 2020
RECEIVED ON	Monday, 22 June 2020
ACCEPTED ON	Wednesday, 25 November 2020

JOURNAL	"Economics of Development"
ISSN PRINT	1683-1942
ISSN ONLINE	2304-6155
FOUNDER	Simon Kuznets Kharkiv National University of Economics

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
15	4	6

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FUNDAMENTALS OF ANALYTICAL ASSESSMENT OF THE SECONDARY SECTOR OF ECONOMY

Abstract

Current trends in the socio-economic development of the world community have predetermined a close relationship between the parameters of the dynamics of national economies and their structural proportions. Changes in the quantitative proportions and the qualitative state of the world economy as a system determine the trend in the dynamics of the sectoral structure of the national economy. Despite the post-industrial nature of the development of countries with market economies, the source of their structural changes remains domestic economic growth, which is caused by the redistribution of capital and labor in high-tech manufacturing industries. Therefore, the purpose of this study is to formulate a general scheme for the correct assessment of the secondary sector of the Ukrainian economy based on the possibility of using analytical generalizations. The object of research is the structure of the types of activities that form the secondary sector of the national economy. The dynamics of this sector is largely determined by price characteristics. Therefore, in the analysis of reproduction processes, structural proportions associated with different price elasticities are taken into account. Since the basis for the formation of the price of products is the cost of their production, and the quantitative proportions of the economy determine the setting of new strategic goals, the article traces the dynamics of the relationship of zones and states of balanced indicators that reflect the activities of an industrial group as one of the forms of business organization. Reduction of dynamics indicators to one base allows them to be compared at all levels of generalization of data and to track trends that more accurately reflect the real state of the secondary sector of the national economy.

Keywords secondary sector of the economy, dynamics of structure, comparative analysis, price characteristics, industrial group, balanced scorecard, management process

JEL Classification C10, D20, E23, E31, L60, O14

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ОСНОВИ АНАЛІТИЧНОЇ ОЦІНКИ ВТОРИННОГО СЕКТОРУ ЕКОНОМІКИ

Анотація

Сучасні тенденції соціально-економічного розвитку світового співтовариства визначили тісний зв'язок параметрів динаміки національних економік і їх структурних пропорцій. Зміни кількісних пропорцій і якісного стану світової економіки як системи, визначають тренд динаміки секторальної структури національної економіки. Незважаючи на постіндустріальний характер розвитку країн з ринковою економікою, джерелом їх структурних змін залишається внутрішній економічний ріст, який викликаний перерозподілом капіталу і праці в високотехнологічні галузі переробної промисловості. Тому мета даного дослідження - формування загальної схеми коректної оцінки вторинного сектора економіки України виходячи з можливості використання аналітичних узагальнень. Об'єктом дослідження є структура видів діяльності, які формують вторинний сектор національної економіки. Динаміку даного сектора в значній мірі визначають цінові характеристики. Тому при аналізі відтворювальних процесів враховані структурні пропорції, пов'язані з різною ціновою еластичністю. Оскілки основу формування ціни на продукцію становлять витрати на її виробництво, а кількісні пропорції економіки визначають постановку нових стратегічних цілей, в статті досліджено динаміку взаємозв'язку зон і станів збалансованості показників, що відображають діяльність індустріальної групи, як однієї з форм організації бізнесу. Приведення показників динаміки до однієї основи дозволяє провести їх зіставлення на всіх рівнях узагальнення даних і відстежити тенденції, які більш точно відображають реальний стан вторинного сектора національної економіки.

Ключові слова вторинний сектор економіки, динаміка структури, порівняльний аналіз, цінові характеристики, індустріальна група, система збалансованих показників, процес управління

Класифікація JEL C10, D20, E23, E31, L60, O14

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Received on: 22nd of June, 2020
Accepted on: 25th of November, 2020
Published on: 15th of December, 2020

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http://dx.doi.org/10.21511/ed.19(4).2020.01

INTRODUCTION

The economic system of any country is heterogeneous in composition. The heterogeneity of the system is determined by its structure and regularities that this structure reveals. In the study of structural patterns of economic development, the three-sector theory of Fisher and Clark became widespread. The sectoral structure of management is based on the combination of common features that allow the segmentation of the economic system. The essence of the theory of sectoral development is to increase the final product of the economic activity of all sectors of the economy.

Different sectors of the economy make a different contribution to the increase in the country's national product. The predominance of the secondary sector in the economy determines the industrial nature of its development. This sector is characterized by both a decrease in dependence on the conditions of extraction of natural resources and an increase in the importance of industrial innovation and the qualification of labor resources.

Under the prevailing conditions of the development of the world market, the economic growth of the national economies of many countries was determined both by the availability (or receipt) of cheap resources and by the expansion of foreign markets. The consequence of this is the formation of the specifics of the development of national economies. But, at the same time, the specifics of the national economy lead to a limitation of the involvement of national resources in the global economic turnover.

Therefore, the level of socio-economic development of both an individual country and the world economy as a whole determines the development of such managerial actions that, based on the interconnection of indicators characterizing the dynamics of changes in the national economy and its structural proportions, will allow identifying imbalances in the scale of global and national economies to obtain final results.

1. LITERATURE REVIEW

The issues of structural changes in the economy are reflected in the works of Mandibur, Geyts, Kolomoytsev, Khomenko.

Ensuring economic growth and the process of integration into a single global market are factors that determine, in modern economic conditions, long-term trends in economic development. The combined influence of these factors ensures the growth of industrial production. This position is reflected in the works of Stiglitz, Zveryakov (2017), Khojayan, Prushkovskaya (2013).

In countries with a developed system of market relations, the source of structural changes is the growth of the country's economy, which is caused by the redistribution of capital and labor in high-tech industries with higher added value, which increases the level of competitiveness of these countries. Based on the fact that the basic element of reproduction in the economic cycle is the production of goods, the most diversified industry, which contributes to innovative changes in the industry, is engineering.

Such scientists as Bartashevska, Vasyuk, Danylyshyn, Dovgan, Zarichna (2019), Kolisnyk, Lobach, Malashchuk, Sokolova (2019), Tarasova, Chumakova, Shapurov, etc. were engaged in the study of the development of the engineering in Ukraine and its analytical evaluation.

Economic growth in engineering can realize the economies of scale and manage production costs. The cost management process reflects the existence of a common scheme of the relationship of the results of production and economic activity by business entities. The works of domestic scientists are devoted to these issues: Butynets, Golov, Mnykh, Savchenko, Sopka, Chumachenko, Zborovska, Lebedev, Partyna, Pylypenko, Tsymbalyuk are devoted to these issues. Cherep, Bocharova, Lotova, Hovhannisyan, Svystun (2017), Stoyanova, Chuchulin, Shevtsiv (2016), as well as foreign scientists: Britton, Rain, Skown, Holt, Horngren, Foster.

http://dx.doi.org/10.21511/ed.19(4).2020.01

Despite the sufficient level of a solution to these issues, the existing system of analytical assessment of the secondary sector of the economy in the conditions of development of the engineering industry needs further elaboration taking into account the requirements of today.

2. AIMS

Aims to form a general algorithm for the study of the secondary sector of the economy under the conditions of compliance with the rules of analytical generalizations.

3. METHODS

The theoretical and methodological basis of the study was the fundamental provisions of systems theory, sectoral development theory, and probability theory, research of domestic and foreign scientists on the analysis of the sectoral structure of the economy.

To achieve the goal set in the work, the following general and special scientific methods were used: methods of analytical generalizations - for structuring and systematization of theoretical and practical material; economic and statistical methods - to determine trends in the development of engineering enterprises; probability theory - to study the states of the balance system of balanced indicators; method of analysis of hierarchies - for comparative analysis and formation of the general block of indicators on components of system of the balanced indicators; rationing - to bring all indicators to one dimension; data visualization - for a visual representation of the results.

4. RESULTS

The unevenness of the economic development of countries and the effectiveness of their integration into world space are determined by the modern theory of global transformations (Khodzhayan, 2008). The interdependence of economic growth and structural transformations is a complex process that can only be tracked in dynamics and implemented through the interconnection of structural elements of the system. The form of arrangement of elements of the system with a certain independence and the ability to self-regulation, defines the concept of structure. Then, given the specifics of the development of the national economy, the structure acts as both a result and a prerequisite for economic growth, and transformation reflects the regularities of changes in the economy.

The sectoral structure of the economy is not static. It involves the relationship of each subsequent sector with the previous one. Moreover, to obtain the final result, each sector works at the expense of the previous one. The absence of this relationship or the exclusion of any of the sectors leads to a decrease in the importance of the national economy and the loss of its competitiveness.

The existing unevenness and multidirectional change in the sectoral structure of the economy of Ukraine are consistent with global trends. The global transformation of the world economy has led to a rethinking of the role of industry in the structure of the national economy because, in the reproduction process, most states use the production of goods as a criterion of economic dynamics. "Strengthening the dependence of the country's economy on the external conjuncture, slow improvement of reproduction proportions in the structure of the industry, insufficient differentiation of production, low adaptability to changing the structure of the needs of the domestic market and an insignificant share of high-tech industries" (Prushkovskaya, 2013) determine the current state of national industry.

In the study of the sectoral structure of the national economy, the industry remains the dominant component of the secondary sector.

Let's consider the dynamics of structural changes by sectors of the economy of Ukraine for 2012–2018. This period is of interest from the standpoint of periodization of time series (State Statistics Service of Ukraine, n.d.), built taking into account the cyclical dynamics of socio-economic processes both in the world and in the national economy. To simultaneously monitor the dynamics of existing processes and achieve comparability of the studied indicators, we use 2012 as a comparison base.

The sectoral structure of the national economy reflects both the quantitative proportions of the development of the market structure of the economy and the qualitative characteristics of its changes. Based on the fact that the number and size of enterprises, initially determines the quantitative characteristics of economic development, and the qualitative changes include patterns of structural changes, we will conduct a comparative analysis of macroeconomic indicators characterizing the general state of the economy based on that the main source of GDP growth - the resulting added-value.

The main reason for the change in the share of industrial production in GDP is the determination of value-added by costs. Let's track the dynamics of structural changes in this indicator by sectors of the economy (Table 1).

Table 1. Dynamics of structural shifts in the Ukrainian economy by sectors of the economy

Source: Calculated by the authors (State Statistics Service of Ukraine, n.d.).

Period	Characteristics of the dynamics of the share of value-added cost by sectors of the economy			
	Deviation, %		Leading coefficient, times	
	Deviation by sectors of the economy			
	secondary - primary	secondary - tertiary	secondary - primary	secondary - tertiary
2012	+16.1	–15.0	–	–
2013	+13.8	–18.1	1.086	1.081
2014	+16.2	–13.9	1.006	1.029
2015	+13.0	–13.4	1.165	1.029
2016	+11.1	–16.3	1.241	1.047
2017	+12.0	–17.8	1.182	1.083
2018	+11.0	–20.4	1.219	1.159

Analysis of the basic characteristics of the dynamics showed that for the study period, the share of value-added by costs in the secondary sector of the Ukrainian economy has an ambiguous outstripping trend compared to the corresponding indicator of the primary sector. Concerning the tertiary sector of the economy, a similar but inverse trend is observed. Nevertheless, the ratio of the share of value-added to costs in the secondary sector of the economy compared with the primary is characterized by a decrease in the speed of this indicator by an average of 4.53%. The ratio of the relative characteristics of the dynamics by sectors of the economy allowed us to conclude that, concerning both the primary and tertiary sectors, the secondary sector is characterized by ambiguous dynamics. Thus, the growth rate of the share of value-added costs in the secondary sector was ahead of the corresponding indicator of the primary sector for the period from 2014 to 2016. The leading coefficient for this period had a steady trend from 1.006 times to 1.241 times, respectively. Outrunning of the secondary sector over the tertiary sector in the considered indicator took place in 2014 and 2015 by 1.029 times, respectively. The presented dynamics of the value-added indicator testifies to the process of de-industrialization of the Ukrainian economy, but so far, at its relative level.

The considered relationships give a general description of the development of the national economy and do not fully reflect the structural proportions. For quantitative and qualitative analysis, it is of interest to consider the contribution of manufacturing to the secondary sector of the economy according to the indicators discussed above.

Based on the fact that the market structure is quantitatively described by the number and size of the enterprise, and value-added is considered as an indicator characterizing current trends in the development of the economy, let's consider the characteristics of the dynamics of these indicators in the manufacturing, as the main activity of the secondary sector of the economy (Table 2).

http://dx.doi.org/10.21511/ed.19(4).2020.01

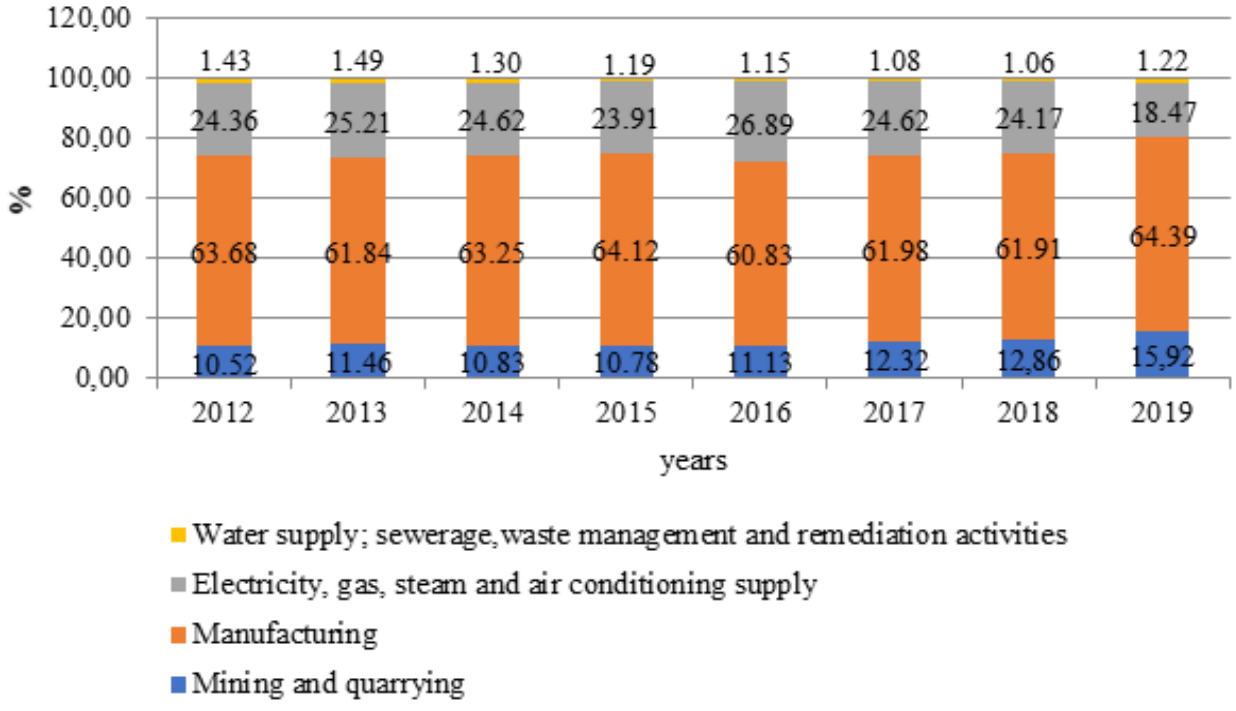
Table 2. Dynamics of structural shifts in the manufacturing of Ukraine

Source: Calculated by the authors (State Statistics Service of Ukraine, n.d.).

Period	Characteristics of the dynamics of indicators in the manufacturing industry				
	Deviation, %		The growth rate (decline), %		Leading coefficient, times
	specific gravity				
	business entities	value-added	business entities	value-added	
2012	-	-	100	100	-
2013	+0.08	–3.27	100.12	94.94	1.05
2014	+2.69	+0.85	104.14	101.30	1.03
2015	+2.02	+4.16	103.10	106.43	1.03
2016	+2.48	–2.42	103.82	96.25	1.08
2017	+1.57	+2.99	102.41	104.62	1.02
2018	+0.65	+3.71	101.00	105.74	1.05

Based on the analysis of Table 2, the share of business entities of manufacturing industries in the secondary sector of the economy, as well as the value-added indicator for the study period did not change significantly. Their variation was 2.69% and 6.98%, respectively. The specific gravity of the business entities has unstable, but positive dynamics, then the specific gravity of value-added has changed ambiguously over the entire period of the study. So, in 2013 and 2016, this indicator decreased by 3.27% and 2.42% compared to 2012, respectively, and in 2017 and 2018 there is an increase in the share of value-added by 2.99% and 3.71%. The use of the relative characteristics of the dynamics confirms the unstable and ambiguous trend over the years in outstripping the growth rates of these indicators. Nevertheless, the growth rate of the share of value-added outstripped the growth rates of the share of business entities in 2015 and for 2017 and 2018 by 1.03 and, –1.02 and 1.05 times, respectively. This situation indicates that despite the structural redistribution between sectors of the economy, the importance of manufacturing in the development of the secondary sector of the economy remains.

The noted trends in the value-added indicator in the manufacturing also confirm the process of de-industrialization of the national economy. The relative nature of existing trends is also evidenced by a slight variation in the indicator of the volume of sales (Figure 1).



Source: Calculated by the authors (State Statistics Service of Ukraine, n.d.).

Figure 1. Dynamics of the structure of the volume of industrial products sold by types of activity in Ukraine, %

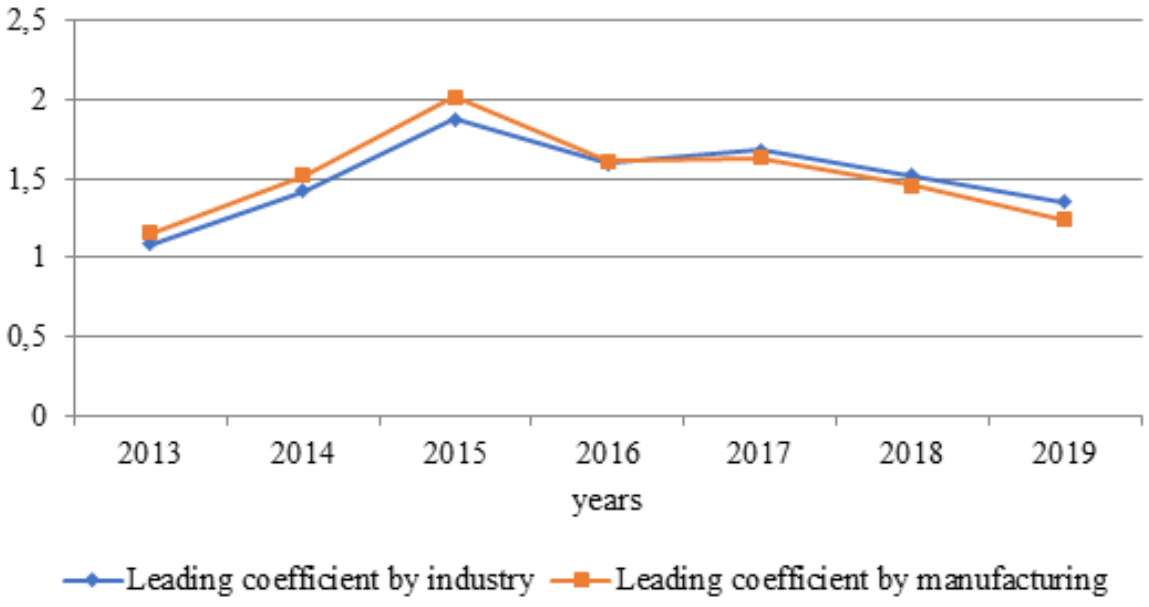
Based on the fact that the material basis of the economic cycle in a market economy is determined by the production of goods in kind and value terms, and the different sides of the market and the dynamics of macroeconomic indicators are reflected by the state pricing policy, it is advisable to conduct a comparative analysis of the producer price index of industrial products and the index of industrial production (Table 3).

Table 3. Dynamics of basic price characteristics for the industry of Ukraine

Source: Calculated by the authors (State Statistics Service of Ukraine, n.d.).

Period	Characteristics of dynamics			
	By industry		By manufacturing	
	Industrial production index	Industrial producer price index	Industrial production index	Industrial producer price index
2012	–	–	–	–
2013	88.40	96.34	84.60	98.02
2014	79.41	112.92	76.70	116.80
2015	69.80	131.15	66.73	135.08
2016	72.52	116.20	70.40	113.14
2017	72.50	121.89	74.00	120.45
2018	74.71	113.21	76.31	111.66
2019	74.32	100.39	79.70	98.81

As can be seen from Table 3 during the study period, the growth rate of the producer price index was ahead of the growth rate of the industrial production index both as a whole and in the manufacturing industry. If for the period from 2012 to 2016 the rate of change of this ratio was higher for the manufacturing, then from 2017 - for the industry as a whole. It is an interesting fact that 2016 is the year with the lowest specific gravity (60.83%) of the share of manufacturing in total industrial production, and almost the same values of the above indicators. That is, in general, it can be argued that 2016 reflects the real state of the manufacturing, taking into account the impact of prices. The analysis of the ratio of leading coefficients of price characteristics showed that the speed of leading of prices in comparison with production output for the period from 2012 to 2016 on the industry was ahead of the corresponding indicator on the manufacturing in the range from 1.064 to 1.074 times. Whereas since 2017, there has been a reverse trend in the ratio of these indicators, the range of change of which varied from 1.03 times in 2017 to 1.09 times in 2019 (Figure 2).



Source: Authors.

Figure 2. Dynamics of the ratio of leading coefficients of price characteristics in the industry of Ukraine

http://dx.doi.org/10.21511/ed.19(4).2020.01

Since value indicators are formed as the product of quantity and price, and in analytical practice, it is important to highlight the impact of each factor on the final result, let's will conduct a comparative analysis of the dynamics of output and sales, as well as the producer price index and value-added growth in manufacturing. The analysis (Figure 1-2, Table 2-3) showed that for the entire period of the study, the rate of change of the industrial production index is higher than the rate of change of the share of manufacturing enterprises. This is a positive, though not unambiguous in time, moment in assessing the development of this activity. The minimum value of this indicator was observed in 2013 and was 1.18 times, the maximum - in 2015 (1.46 times). The rate of change in the index of industrial production was clearly, albeit slightly, higher than the rate of change in the share of sold products. It can be stated that the manufactured products found their consumer. Throughout the study period, the rate of change of the producer price index was higher than the rate of change in the share of value-added, which once again confirms the effect of price variation on indicators characterizing the level of development of this activity.

The most progressive structuring industry in the manufacturing is engineering. Since engineering determines the possibility of implementing an innovative component in the value-added of goods and services, consider the characteristics of its dynamics (Table 4).

Table 4. Dynamics of relative characteristics of engineering development in Ukraine

Source: Calculated by the authors (State Statistics Service of Ukraine, n.d.).

Period	The volume of engineering products in the total volume of manufacturing, %		The growth rate of the volume of industrial products sold in engineering, %	Leading coefficient, times
	specific gravity	growth rates		
2012	16.13	–	–	–
2013	13.93	86.36	81.16	1.06
2014	11.28	69.93	72.52	1.04
2015	10.12	62.74	82.02	1.31
2016	10.01	62.06	93.47	1.51
2017	10.34	64.10	119.75	1.87
2018	11.07	68.63	148.49	2.16
2019	11.77	72.97	133.83	1.83

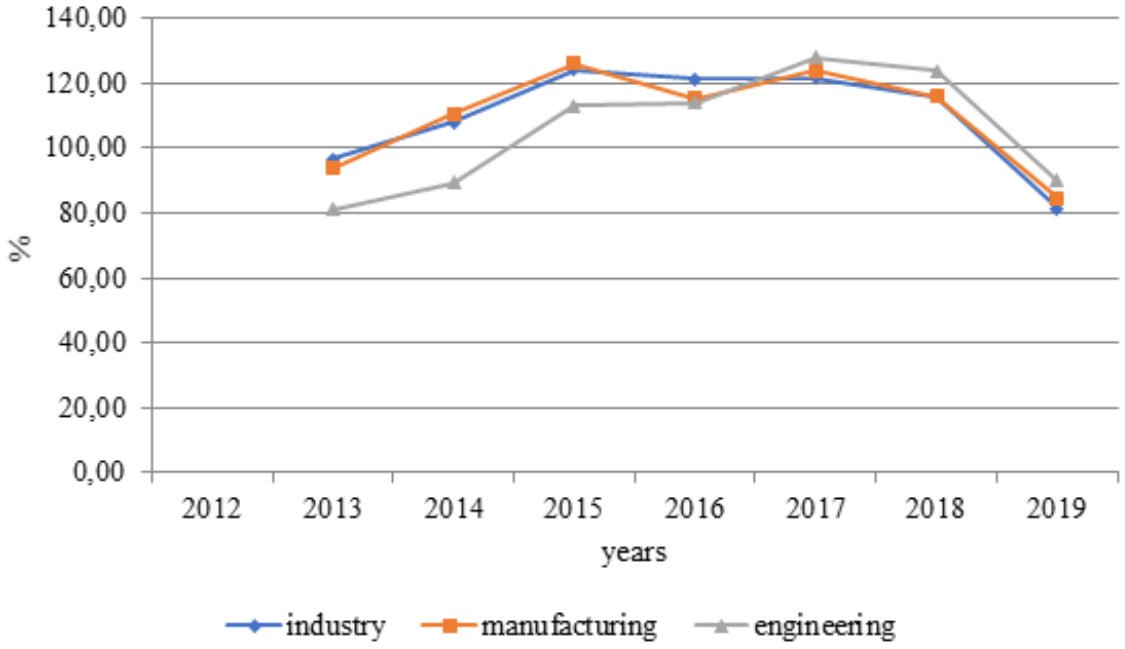
Analysis of Table 4 indicates a reduction until 2017 of the share of engineering products in the total volume of manufacturing products in Ukraine. But, since 2018, there has been an increase in this indicator by 5.6%. A comparative analysis of the growth rate of the share of engineering products with the growth rate of sales in this industry showed outstripping growth trends of the latter indicator. Despite the decrease in the specific gravity of engineering products compared with 2012, the growth rate of the volume of industrial products sold in engineering is ahead of its specific gravity in the range from 1.04 to 2.16 times. This fact confirms that the development of engineering, even at its existing pace, remains in demand in the structure of the national economy.

A comparative analysis of the dynamics of the volume of industrial products sold by types of activity is presented in Figure 3.

In the context of globalization, the economic limit for achieving the growth of the national economy is obtaining superprofits. One of the options for diversifying sources of profit, concentrating financial resources on the most necessary areas, increasing management mobility is to create modern forms of business organization - financial and industrial group.

In the Kharkiv region, the industrial group "Ukrainian Industrial Energy Company" (UPEC) was created.

UPEC is a holding-type structure that unites several engineering enterprises: Kharkiv Machine-Tool Building Plant, PJSC (Kharverst, PJSC); The Kharkov Electrical Engineering Plant "Ukrelectromash" (HELZ); Kharkov Bearing Plant (HARP); Lozova Forging-Mechanical Plant (LKMZ); The Ukrainian Casting Company (ULK).



Source: Authors.

Figure 3. Dynamics of structural characteristics of the volume of industrial products sold, by Ukraine's industry

Distinctive features of this industrial group are that: the activities of all enterprises are associated with engineering and metalworking; they have various areas of production activity, producing mass, serial and unique (one-time) products, and also provide production services; belong to the category of medium and large enterprises.

Let's analyze the activities of UPEC for the previously allocated period. To take into account the influence of price characteristics when comparing the dynamics of cost and consumer value of manufactured products, we will conduct a comparative analysis of the growth rate of the volume of products sold by UPEC with the growth rate of the producer price index of engineering products (Table 5).

Table 5. The dynamics of the comparative assessment of UPEC

Source: Calculated by the authors (State Statistics Service of Ukraine, n.d.).

Period	The growth rates, %		Leading coefficient, times
	The producer price index of engineering products	the volume of products sold by UPEC	
2012	–	–	–
2013	107.91	60.00	1.80
2014	116.02	35.07	3.31
2015	119.92	50.02	2.40
2016	110.06	70.26	1.57
2017	110.45	101.12	1.09
2018	113.38	106.49	1.06
2019	100.29	67.04	1.50

Analysis of Table 5 showed an unambiguous leading the growth rate of the producer price index of engineering products compared with the volume of products sold by UPEC. However, the speed of price changes does not provide a high level of competitiveness of products. The presented situation is more legitimate in reflecting the real state of the development of engineering.

http://dx.doi.org/10.21511/ed.19(4).2020.01

The lower price limit is production costs. The determination of the relationship between costs and the result of economic activity reveals a regularity that will ensure both the stability of the system at any level and stimulate a change in its structure. Based on this, let's consider the activities of UPEC from the standpoint of effective cost management.

The effectiveness of the management process is determined by the current system of interrelated or coordinated indicators that are aimed at obtaining a greater final result with a possible minimization of costs. The use of a balanced scorecard (BS) as an analytical base (Naumova, 2011) made it possible to determine the coherence of zones and the state of balance to form a cost management strategy. Based on the practical experience of experts, consistency of the essence of the problem and the variant of the requirement for its solution was achieved: achieving more efficient development of enterprises based on cost analysis by the components of the BS. The normalization process allowed us to combine indicators on the components of the BS into zones (negative zone: 0 - 0.33; neutral: 0.33 –0.67; positive: 0.67-1) and to trace the relationship of zones and states (Table 6).

Table 6. Dynamics of integral indicators for the components of BS UPEK

Source: Calculated by the authors.

The components of BS	Enterprise					
	Period	Kharverst, PJSC	HELZ	HARP	LKMZ	ULK
Financial	2012	0.30	0.38	0.35	0.23	0.39
	2019	0.33	0.23	0.3	0.18	0.33
Marketing	2012	0.33	0.32	0.39	0.38	0.40
	2019	0.33	0.30	0.29	0.33	0.34
Strategic decisions	2012	0.30	0.29	0.50	0.48	0.49
	2019	0.30	0.25	0.30	0.3	0.4
Innovation and investment	2012	0.15	0.18	0.16	0.17	0.10
	2019	0.15	0.13	0.15	0.14	0.10
The state of the enterprise	2012	Unbalanced negative	Unbalanced negative	Unbalanced neutral	Unbalanced neutral	Unbalanced neutral
	2019	Unbalanced neutral	Balanced negative	Balanced negative	Unbalanced negative	Unbalanced neutral

Based on the data table 6 it follows that in 2019, the BS of UPEC enterprises changed its condition for the worse for all enterprises except Kharverst and ULK. In 2019, the BS of the ULK enterprise remained in the same zone and condition as in 2012, but the integral indicators decreased in terms of the components of the system. BS of the Kharverst enterprise moved from a negative zone to a neutral one, while maintaining a state of imbalance. The transition to the neutral zone was facilitated by an increase in the integrated indicator for the financial component.

HELZ and HARP enterprises have reached a balanced scorecard, however, for all the components of the system, the indicators are in the negative zone, which indicates a deterioration in their financial condition.

As an element of managerial decision making, contributing to the improvement of the financial and economic situation of enterprises, the possible options for transition indicators from one zone to another were considered.

For Kharverst, it is advisable to leave the BS similar to the state of 2012. To ensure a way out of the negative zone in terms of the constituent elements of strategic decisions and innovation and investment, it is necessary to develop a strategy for the development of production activities taking into account the possibility of increasing own financial resources, primarily by reducing the rate of increase in production costs and expanding sales markets.

It is advisable for HELZ and HARP enterprises in this situation to focus their efforts on developing a strategy aimed at transition indicators from the negative zone to the neutral one to stabilize their activities. A significant drop in sales volumes was associated with filling the market niche with cheaper and, at the same time, lower-quality foreign goods. Under the current conditions, a way out can be found by revising the range of products, reducing the rate of increase in production costs, and finding new markets. A negative development option is the liquidation of enterprises.

The decrease in the integral indicator for the component of strategic decisions of the BS facilitated the transition in 2019 of LKMZ enterprises from the neutral zone to the negative. A return to the neutral zone is possible: by expanding the effectiveness of motivational measures, which will increase the component of strategic decisions; decrease in the growth rate of production costs, which will positively affect both the financial and innovation-investment component.

UPEC enterprises are the main consumers of ULK products. Thus, the deterioration in the overall financial condition of UPEC enterprises directly affects the corresponding integral characteristics of the ULK. Under the current conditions, it is not possible to change the state of the BS of the ULK.

5. DISCUSSION

The main goal of the analytical work is to obtain accurate and comparable data. Even within the same sector of the economy, diverse information on qualitative characteristics is used, which forms a system of indicators. From an economic point of view, a comparative analysis of indicators is possible in terms of value. But cost implies the influence of prices on the final result of economic activity. To eliminate the influence of prices, it is necessary to use constant prices. But their use is possible if, over some time, the same product is considered, the quality and price of which remains constant. At the same time, for unstable economies, the chain method is mainly used when tracking the price characteristics of macroeconomic dynamics. It assumes the existence of different periods and different count basis in time for comparative analysis.

Comparison of price indices by aggregated levels is possible under the following conditions (Yeliseyeva, 2020):

- absence of structural shifts within the product group in the period that is selected for comparison;
- absence of errors in the calculation of price indices for previous periods.

Fulfillment of even these basic conditions is not real in practice. The ability to carry out a comparative analysis gives the reduction of indicators to one basis. The obtained characteristics of the indicators are the basis both for the formation of correct conclusions and for making informed management decisions.

CONCLUSION

The stages of development and the quality of the economic system are determined by the proportions between its elements. Analysis of the structure of the national economy, carried out through the ratio of the individual elements of the subsystem, reveals the qualitative characteristics of these proportions, and the assessment of structural shifts - the features of changes in proportions in dynamics.

The correctness of the analytical assessment of the relationship between the individual subsystems is achieved by the availability of comparable information. Comparability should be understood as the unambiguity of the information source, the time base of comparison, and the system of estimated characteristics.

So, the use of data only from the statistical service of Ukraine made it possible to achieve unambiguity of multi-level assessments of the study through the relationship: the secondary sector of economy - manufacturing industry - mechanical engineering - a form of business organization in mechanical engineering.

The emphasis on cost indicators in assessing this relationship rightly determined their attribution to the main reason for the change in the share of production of a product produced.

Considering the price as the lower limit of production costs and as a tool to influence its result was the basis for choosing a method for effective cost management.

http://dx.doi.org/10.21511/ed.19(4).2020.01

Consideration of the BS as an analytical base made it possible to identify options for the consistency of zones and states of balance in order to form a cost management strategy at machine-building enterprises.

The presence of inconsistency in the collection, processing and subsequent aggregation of indicators reduces the accuracy of the research and, as a result, the formation of conclusions that reflect the real situation.

It is possible to achieve comparability of information in the most general approximation on conditions that the indicators under consideration are reduced to one basis. This approach is a prerequisite for analytical assessment. It will allow to compare the indicators characterizing the activities of an enterprise as an information base for assessing the structural proportions at a higher level of aggregation.

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“Sustainability of a firm’s market strategy”

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ARTICLE INFO	Anatolii Voronin, Olga Gunko and Lidiia Afanasieva (2020). Sustainability of a firm’s market strategy. *Economics of Development*, *19*(4), 12-23. doi:10.21511/ed.19(4).2020.02
DOI	http://dx.doi.org/10.21511/ed.19(4).2020.02
RELEASED ON	Tuesday, 29 December 2020
RECEIVED ON	Saturday, 23 May 2020
ACCEPTED ON	Thursday, 17 September 2020

JOURNAL	"Economics of Development"
ISSN PRINT	1683-1942
ISSN ONLINE	2304-6155
FOUNDER	Simon Kuznets Kharkiv National University of Economics

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
15	6	0

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SUSTAINABILITY OF A FIRM'S MARKET STRATEGY

Abstract

The work is focused on solving a set of problems related to the functioning of the enterprise (firm) in a competitive market environment. The stability of the firm in market conditions is determined by the ability to optimally manage available resources, effective planning for timely promotion of new products, the ability to adequately respond to challenges posed by sudden changes in market conditions. An important factor in achieving economic stability of the enterprise is the presence of the internal concept of self-development, which combines two main functions - marketing and management system (management). In this article the methodology of economic and mathematical modeling of a market condition of firm as process of interaction of functions of marketing and management has received the further development. A model is proposed, which is built in line with the paradigm of economic synergetics and is a system of two nonlinear ordinary differential equations. It is proved that in this situation the classical linear principle of superposition loses its relevance and does not allow the application of the traditional apparatus of econometric analysis. Therefore, the most important for the implementation of the practice of economic forecasting is the construction of areas of stability of the equilibrium of the firm. According to the results of the study, the emphasis is placed on the need to develop criteria for the proximity of system parameters to the dangerous limits of loss of stability by the firm, during the transition through which the economic system changes its dynamic mode catastrophically. A key place in the work is given to determining the parameters of cyclic processes, indicating the amplitude, frequency and nature of the stability of periodic trajectories. The presented results of numerical modeling have practical value and can be used for the analysis and forecasting of parameters at separate stages of the corresponding periodic modes of functioning of the enterprises with various types of stability.

Keywords firm stability, competitive market, marketing, management, limit cycle, self-oscillations, bifurcation

JEL Classification C62, D21, D92

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СТІЙКІСТЬ РИНКОВОЇ СТРАТЕГІЇ ФІРМИ

Анотація

Робота орієнтована на вирішення комплексу проблем, пов'язаних з функціонуванням підприємства (фірми) в умовах конкурентного ринкового середовища. Стійкість функціонування фірми в ринкових умовах визначається можливостями оптимального управління наявними ресурсами, ефективним плануванням щодо своєчасного просування на ринок нової продукції, умінням адекватно реагувати на виклики, що породжуються раптовими змінами ринкової кон'юктури. Важливим фактором досягнення економічної стабільності підприємства є наявність внутрішньофірмової концепції саморозвитку, що поєднує в собі дві основні функції – маркетингу і системи управління (менеджменту). У даній статті отримала подальший розвиток методологія економіко-математичного моделювання ринкового стану фірми, як процесу взаємодії функцій маркетингу і менеджменту. Запропоновано модель, яку побудовано в руслі парадигми економічної синергетики і являє собою систему двох нелінійних звичайних диференціальних рівнянь. Доведено, що в зазначеній ситуації класичний лінійний принцип суперпозиції втрачає свою актуальність, та не дозволяє застосувати традиційний апарат економетричного аналізу. Тому найбільш істотним для реалізації практики економічного прогнозування є побудова областей стійкості положень рівноваги фірми. За результатами дослідження зроблено акцент на необхідності вироблення критеріїв близькості параметрів системи до небезпечних меж втрати стійкості фірмою, при переході через які економічна система змінює свій динамічний режим катастрофічним чином. Ключове місце в роботі приділено визначенню параметрів циклічних процесів із зазначенням амплітуди, частоти і характеру стійкості періодичних траєкторій. Представлені результати чисельного моделювання мають практичну цінність і можуть бути використані для аналізу і прогнозування параметрів на окремих етапах відповідних періодичних режимів функціонування підприємств з різними типами стійкості.

Ключові слова стійкість фірми, конкурентний ринок, маркетинг, менеджмент, граничний цикл, автоколивання, біфуркація

Класифікація JEL C62, D21, D92

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Received on: 23rd of May, 2020
Accepted on: 17th of September, 2020
Published on: 29th of December, 2020

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http://dx.doi.org/10.21511/ed.19(4).2020.02

ВСТУП

Головними факторами функціонування підприємства у сучасних умовах є наявність необхідних ресурсів, кваліфікованих управлінців, сучасних засобів виробництва, прогресивної технології та конкурентноспроможної продукції. Стійкість функціонування поєднується як з необхідністю урахування динаміки змін зовнішнього ринкового середовища, так і з можливостями більш ефективного управління ресурсами підприємства та асортиментом випуску продукції. Існує низка факторів та заходів, які дозволяють підприємствам забезпечувати необхідну динамічну стійкість. Треба відзначити інноваційну діяльність у напрямку удосконалення виробничої технології для зменшення надлишкових втрат, створення нової продукції на відповідному ринку, вивчення нових потреб покупців з урахуванням демографічних, соціальних, економічних та політичних змін у державі і у світі у цілому, визначення ефективного розміру підприємства з точки зору ринкових потреб, розробка стратегії і тактики активного пристосування до вимог попиту потенційних споживачів з метою стабілізації або розширення частки підприємства у ринковому середовищі.

Фінансова стійкість підприємства (фірми) забезпечується функціонуванням усієї системи економічної діяльності, націленою на адаптацію до будь-яких зовнішніх викликів та створення стратегії саморозвитку за рахунок власної ініціативності. Також розгляд проблеми стійкості підприємств не є можливим без урахування часових змін, які характеризують динаміку розвитку фірми в умовах ринкового середовища.

1. ЛІТЕРАТУРНИЙ ОГЛЯД

Проблему стійкості підприємства, її оцінки на основі системи економічних показників досліджували вчені різних країн світу. Насамперед, треба відзначити монографії Холта [5], Баканова [1] та Портера [9], де викладені теоретичні і методичні засади та підходи до ключових питань вищеозначених процесів. Серед вітчизняних дослідників звертають на себе увагу праці Ткачової [11], Кононенко [7], Сисоєвої [10], в яких досліджено фактори стійкості промислових підприємств з позиції конкурентних переваг в умовах дії сучасних ринкових відносин. У статті Гордєєва [2] сформульовані ознаки стабільності підприємств в умовах конкурентної боротьби як складові питання економічної динаміки. Дана проблематика досліджувалась у статті Клебанової та ін. [6] і праці Гур'янової [3] за допомогою методології економетричного аналізу з відповідними аспектами процесів моделювання.

Слід зауважити, що в усіх вищезазначених наукових працях представлено достатній обсяг емпіричного матеріалу із зазначеної теми дослідження, але практично є відсутніми відповідні математичні моделі, які пристосовані для аналізу стійкості динамічних процесів в економічних системах. Як виняток, можна назвати статтю Кузнєцова і Фірсакової [8], де наведена модель нелінійної взаємодії функцій менеджменту та маркетингу у часовому просторі. Представлений математичний апарат в окремих аспектах отримав подальший розвиток у Вороніна [12, 13].

2. МЕТА ДОСЛІДЖЕННЯ

Полягає у отриманні за допомогою методології теорії динамічних систем умов параметричної стійкості моделі діяльності фірми з визначенням меж як безпечних так і небезпечних режимів функціонування досліджуваного об'єкту.

3. МЕТОДИ ДОСЛІДЖЕННЯ

У роботі застосовується методологія дослідження систем нелінійної динаміки, концептуально орієнтована на використання парадигми економічної синергетики [14].

4. РЕЗУЛЬТАТИ

Стан підприємства (фірми) на споживчому ринку визначається якістю планування маркетингу та ефективною структурою внутрішнього управління підприємством. Керівництво фірми повинно час від часу переглядати стратегії маркетингу своєї продукції або реорганізовувати систему прийняття

управлінських рішень, налаштовуючись на досягнутий рівень адаптації фірми до ринкового середовища (вплив конкуруючих структур, зміна соціально-економічних та політичних умов у суспільстві та міжнародній арені і т. д.). Звичайно, керівництво фірми іде на ці дії тільки у тих випадках, коли воно впевнено у стійкості стану фірми на споживчому ринку. Якщо ринкова кон'юнктура складається несприятливим чином і стан фірми втрачає стійкість, то актуальною стає проблема прогнозування майбутніх рівноважних станів фірми. Виникає питання – обов'язково буде стаціонарний стан рівноваги або реалізується стійкий циклічний режим? В останньому випадку може відбутися так, що ступінь адаптації фірми до ситуації, яка склалася на ринку, буде змінюватися у режимі автоколивань, періодичного руху відносно початкового, залишеного у минулому, стаціонарного рівноважного стану.

Припустимо, що діяльність фірми на споживчому ринку визначається двома функціями: *x(t)* - характеристика рівня адаптації до ринкової ситуації, залежної від прийнятого плану маркетингу (функція маркетингу у подальшому викладі); *y(t)* - є характеристикою управлінської структури, внутрішньофірмового менеджменту, яка визначає рівень корпоративної згуртованості керівництва та співробітників фірми для досягнення загальнофірмової мети (функція менеджменту). Зростання абсолютних значень $|x|$ і $|y|$ означає, відповідно, посилення стану фірми на ринку (успіх та реалізація тактичного та стратегічного планів маркетингу) або зріст рівня корпоративної згуртованості (вдала управлінська структура), а спадання цих змінних – послаблення позицій фірми на споживчому ринку (невдала реалізація тактичного і стратегічного планів маркетингу) або втрату корпоративної згуртованості (збурення внутрішньофірмових конфліктів).

Припустимо, що швидкість зміни функції маркетингу $\dot{x}(t)$ визначається зворотною реакцією керівництва фірми на ринкову ситуацію у вигляді прийняття управлінських рішень заради виконання плану маркетингу $f_x^1 = v_1 x$ та реакцією зворотного зв'язку, що являє собою ступінь взаємозалежності функцій менеджменту і маркетингу $f_y^1 = v_2 y$. Тоді маємо диференціальне рівняння:

$$\dot{x} = v_1 x + v_2 y, \qquad (1)$$

де $v_1 v_2$ - відносні параметри функцій маркетингу та менеджменту відповідно. З приводу маркетингового параметру v_1, треба відзначити, що коли $v_1 < 0$, це відповідає стратегії орієнтації на традиційну, яка користується стабільним попитом продукції фірми з виведенням на ринок її незначних модифікацій. В області $v_1 > 0$ зростання значень цього параметру визначає іншу стратегію виведення у ринкове середовище якісно нової модифікації продукції фірми.

Далі, швидкість змінення функції менеджменту $\dot{y}(t)$ визначається раніше введеною функцією $f_y^1 = v_2 y$ і кількісною характеристикою інерції управлінських рішень (ступенем запізнювання реакції на них співробітників фірми – $f_y^2 = -y \cdot \exp(-\alpha \cdot y)$, а також функцією обмежень, пов'язаних з оцінкою керівництвом фірми ринкових умов – $f_x^2 = -x \cdot \exp(-\beta \cdot x)$, таким чином:

$$\dot{y} = v_2 y - \exp(-\alpha \cdot y) - x \exp(-\beta \cdot x), \quad \alpha \geq 0, \beta \geq 0. \qquad (2)$$

Вибір такої форми запису функцій f_y^2 та f_x^2, обумовлений наступними обставинами. Чим вище рівень корпоративної згуртованості керівництва та співробітників (α>0), тим менше це впливає на необхідність зміни функції менеджменту. Випадок α=0 відповідає максимальному ступеню неузгодженості приймаємих керівництвом фірми рішень реальним діям співробітників, що потребує суттєвої перебудови системи прийняття управлінських рішень. Чим краще реальний стан фірми на споживчому ринку (β>0), тим менш це впливає на необхідність змін функцій менеджменту. У випадку β=0 має місце ситуація невідповідності оцінки керівництвом фірми її реального становища на ринку, що безумовно потребує кардинальних змін системи управління фірмою. Далі у наступному викладі будемо розглядати такі значення параметрів α, β, для яких припустимі наближені рівності:

$$exp(-\alpha \cdot y) \approx 1 - \alpha \cdot y, \quad exp(-\beta \cdot x) \approx 1 - \beta \cdot x. \qquad (3)$$

http://dx.doi.org/10.21511/ed.19(4).2020.02

У такому випадку диференціальні рівняння (1) і (2) з урахуванням рівностей (3) складають наступну систему нелінійних диференціальних рівнянь:

$$\begin{aligned} \dot{x} &= v_1 x + v_2 y, \\ \dot{y} &= -x + (v_2 - 1) y + \beta \cdot x^2 + \alpha \cdot y^2. \end{aligned} \qquad (4)$$

Якщо ліві частини (4) дорівнюють нулю, то легко отримати два особливих рішення системи диференціальних рівнянь:

$x_1^* = 0, \quad y_1^* = 0$ - тривіальний розв'язок;

$x_2^* = \dfrac{v_2 \left(v_2 + (v_2 - 1) v_1\right)}{\alpha v_1^2 + \beta v_2^2}$, $y_2^* = -\dfrac{v_1}{v_2} x_2^*$ - нетривіальний розв'язок.

Ці обидва ров'язки далі будемо іменувати, як відповідні рівноважні стани фірми у ринковому середовищі.

Розглянемо більш детально поведінку динамічної системи (4) у малому околі тривіального стану рівноваги $x_1^* = 0, \quad y_1^* = 0$. У цьому випадку лінійна частина системи диференціальних рівнянь (4) має характеристичний багаточлен другого порядку:

$$\lambda^2 + (1 - v_1 - v_2)\lambda + v_1 (v_2 - 1) + v_2 = 0, \qquad (5)$$

де λ_1 λ_2 - для знаходження власних значень.

Для того, щоб система (4) була стійкою навколо тривіального рівноважного стану, потрібно виконання умови додатності усіх коефіцієнтів квадратного рівняння (5), тобто:

$$1 - v_2 - v_1 > 0,$$

$$v_1(v_2 - 1) + v_2 > 0. \qquad (6)$$

Тип стійкості рівноваги при виконанні нерівностей (6) визначається дискримінантом квадратного рівняння (5):

$$D = (v_2 - v_1 - 1)^2 - 4v_2.$$

Якщо $D \geq 0$, то тривіальний рівноважний стан є стійким вузлом. У протилежному випадку має місце стійкий фокус.

Цікава ситуація спостерігається на лінії:

$$v_{2+}\ v_1 - 1 + \mu = 0,$$

де μ - малий знакозмінний параметр. У залежності від знаку параметру μ у системі (4) може відбутися втрата або надбання стійкості, тобто стійкий фокус може стати нестійким і навпаки.

Виберемо параметр v_1 у якості критичного для зміни стійкості (4):

$$v_1 = 1 - v_2 - \mu,$$

та виключимо цей маркетинговий параметр з квадратного рівняння (5):

$$\lambda_2 - \mu\lambda - v_2^2 + 3v_2 - 1 - (v_2 - 1)\mu = 0. \qquad (7)$$

Введемо позначення:

$$\omega^2(\mu) = \omega_0^2 - (v_2 - 1)\mu, \qquad \omega_0^2 = -v_2^2 + 3v_2 - 1.$$

Припускаємо, що $\omega_0^2 > 0$ за умовою $-v_2^2 + 3v_2 - 1 > 0$. Так відбудеться, якщо параметр менеджменту v_2 задовольняє нерівність:

$$\frac{3-\sqrt{5}}{2} < v_2 < \frac{3+\sqrt{5}}{2}. \qquad (8)$$

З урахуванням того, що параметр μ є малим , отримаємо розв'язок (7) у нових позначеннях:

$$v_{1,2}(\mu) = \frac{\mu}{2} \pm i\left(\omega_0 - \frac{\mu}{2}\frac{v_2 - 1}{\omega_0^2}\right), \quad i^2 = -1. \qquad (9)$$

При цьому існує похідна $\lambda(\mu)$, якщо μ=0:

$$\lambda'(0) = \frac{1}{2} - \frac{v_2 - 1}{2\omega_0^2} \cdot i. \qquad (10)$$

Цей факт означає, що при зміні знака μ дійсна частина $\lambda(\mu)$ також змінює свій знак і перетинає дійсну вісь комплексної площини з ненульовою швидкістю. Такий тип фокусу називається повільним. Таким чином, усі умови біфуркаційної теореми Хопфа виконані і має місце біфуркація народження граничного циклу з відповідним автоколивальним режимом [4, 15].

Для обчислення основних характеристик граничного циклу, таких як амплітуда, частота і період коливань, а також для визначення стійкості періодичних рішень, нам необхідно знайти нормальну форму системи диференціальних рівнянь відповідно до системи (4).

Введемо більш простіші позначення для параметрів (4) $k=v_2$-1, $\omega=\omega_0$ та при $\mu=0$ отримаємо нову форму системи диференціальних рівнянь:

$$\begin{cases} \dot{x} = -kx + (k+1)y, \\ \dot{y} = -x + ky + \alpha \cdot y^2 + \beta \cdot x^2. \end{cases} \qquad (11)$$

Заради побудови нормальної форми для системи (11) зробимо заміни $x=k\cdot x_1+x_2$, $y=x_1$. Після необхідних перетворень маємо систему:

$$\begin{cases} \dot{x}_1 = -\omega \cdot x_2 + (\alpha + \beta \cdot k^2)x_1^2 + 2\beta \cdot k\omega \cdot x_1 \cdot x_2 + \beta \cdot \omega^2 \cdot x_2^2 \\ \dot{x}_2 = \omega \cdot x_1 - \frac{k}{\omega}(\alpha + \beta \cdot k^2) \cdot x_1^2 - 2\beta \cdot k^2 \cdot x_1 \cdot x_2 - \beta \cdot k \cdot \omega \cdot x_2^2 \end{cases}. \qquad (12)$$

Систему (12), яка вже є нормальною формою Пуанкаре [4], зручно представити у вигляді одного комплексного диференціального рівняння першого порядку відносно змінної $z=x_1+i\cdot x_2$:

$$\dot{z} = i\omega \cdot z + g_{20}\frac{z^2}{2} + g_{11}z \cdot \bar{z} + g_{02} \cdot \frac{\bar{z}^2}{2}, \qquad (13)$$

де $\bar{z} = x_1 - i \cdot x_2$ - є спряженою змінною.

http://dx.doi.org/10.21511/ed.19(4).2020.02

Комплексно значні параметри g_{20}, g_{11}, g_{02} визначаються за допомогою формул:

$$g_{20}=\frac{1}{2}\left(\alpha-\beta\cdot\left(k^2+\omega^2\right)-i\frac{k}{\omega}\left(\alpha+\beta\cdot\left(k^2+\omega^2\right)\right)\right),$$

$$g_{11}=\frac{1}{2}\left(\alpha+\beta\cdot\left(k^2+\omega^2\right)\right)\left(1-i\frac{k}{\omega}\right),$$

$$g_{02}=\frac{1}{2}\left(\alpha+\beta\cdot\left(3k^2-\omega^2\right)-i\frac{k}{\omega}\left(\alpha+\beta\cdot\left(k^2-3\omega^2\right)\right)\right).$$

У результаті обчислення першої ляпуновської величини $l_1(0)=Rel_1(0)+i\cdot Iml_1(0)$ отримано вирази для дійсної і уявної частини відповідно:

$$\mathrm{Re}\,l_1(0)=\frac{\left(\alpha+\beta\left(k+1\right)\right)\alpha k}{4\omega^2},$$

$$\mathrm{Im}\,l_1(0)=-\frac{1}{12\omega^3}\left(\alpha^2\left(3k^2+2k+2\right)+5\alpha\beta\left(k+1\right)^2\left(k^2+k+1\right)+5\beta^2\left(k+1\right)^3\right).$$

Для нас є важливим знак дійсної частини $i_1(0)$. Від цього залежить стійкість періодичного автоколивального режиму. Пам'ятаючи про те, що $k=v_2$-1, тоді згідно з нерівністю (8) параметр k знаходиться у межах:

$$\frac{1-\sqrt{5}}{2}<k<\frac{1+\sqrt{5}}{2}.$$

Таким чином, спостерігається зміна знаку параметру k і можна зробити висновок, якщо має місце нерівність:

$$\frac{1-\sqrt{5}}{2}<k<0,$$

то граничний цикл є стійким. У випадку:

$$0<k<\frac{1+\sqrt{5}}{2},$$

маємо нестійкий періодичний режим.

Вочевидь, значення v_2=1 параметру менеджменту визначає напрямок стійкості граничного циклу. Коли v_2<1, цикл є стійким і автоколивальний режим вважається м'яким. З іншого боку, якщо v_2>1, отримаємо жорсткий режим виникнення періодичних процесів з катастрофічною втратою стійкості.

На Рисунку 1 і 2 надані чисельні результати моделювання динамічної системи (11) з параметрами α=0.3; β=0.4; x_0=0.01; y_0=0.02; k=–0.5. Від'ємне значення k=–0.5 відповідає структурним обмеженням стійкого граничного циклу. На Рисунку 1 і 2 відображені функції маркетингу *x(t)* та менеджменту *y(t)*. Рисунок 3 є ілюстрацією фазового портрету граничного циклу у змінних *y(t)* та *x(t)*.

Рисунки 4, 5, 6 є результатом моделювання характеристик нестійкості граничного циклу з IIпараметрами k = 0.5 (інші числові значення незмінні).

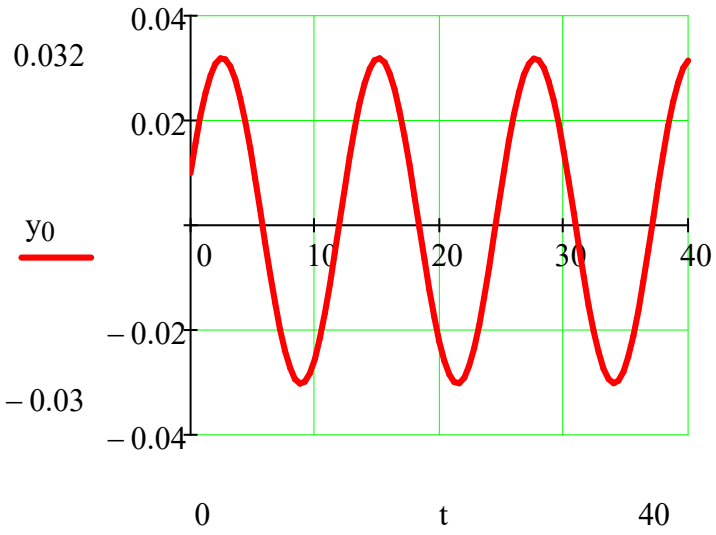

Рисунок 1. Коливальний режим функції маркетингу *x(t)*

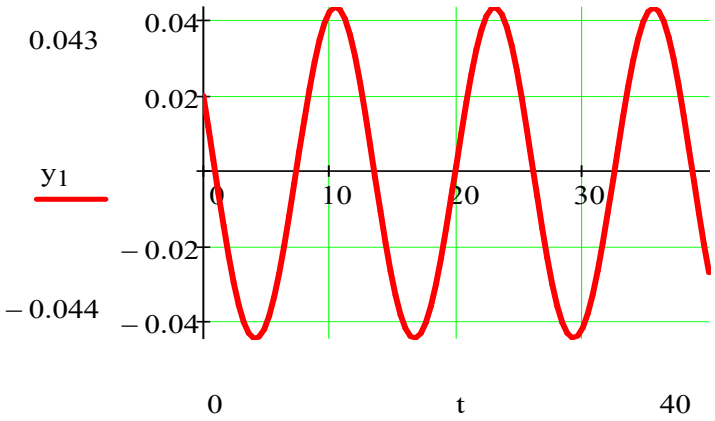

Рисунок 2. Коливання функції менеджменту *y(t)*

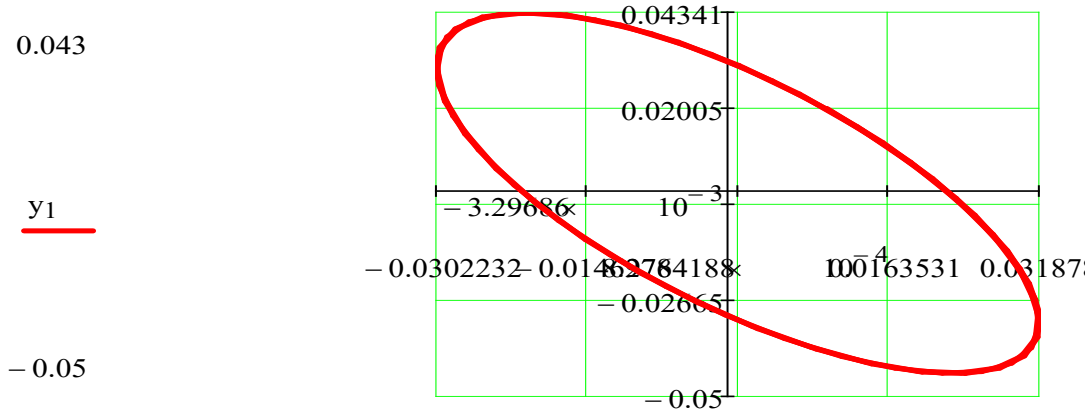

Рисунок 3. Фазовий портрет стійкого граничного циклу у змінних *x* та *y*. *K* = −0.5

Рисунки 4-6 є результатом моделювання характеристик нестійкості граничного циклу з параметрами k=0.5 (інші числові значення незмінні).

http://dx.doi.org/10.21511/ed.19(4).2020.02

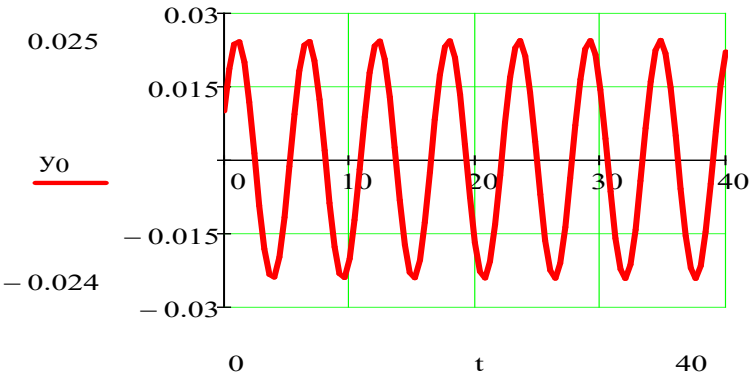

Рисунок 4. Коливальний режим функції маркетингу *x(t)*

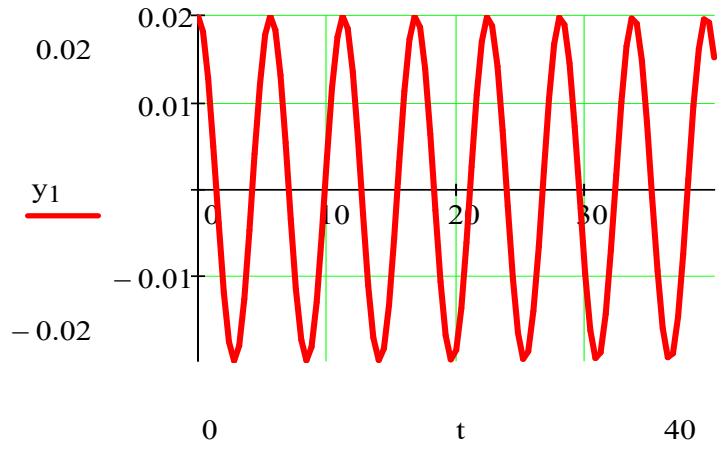

Рисунок 5. Коливання функції менеджменту *y(t)*

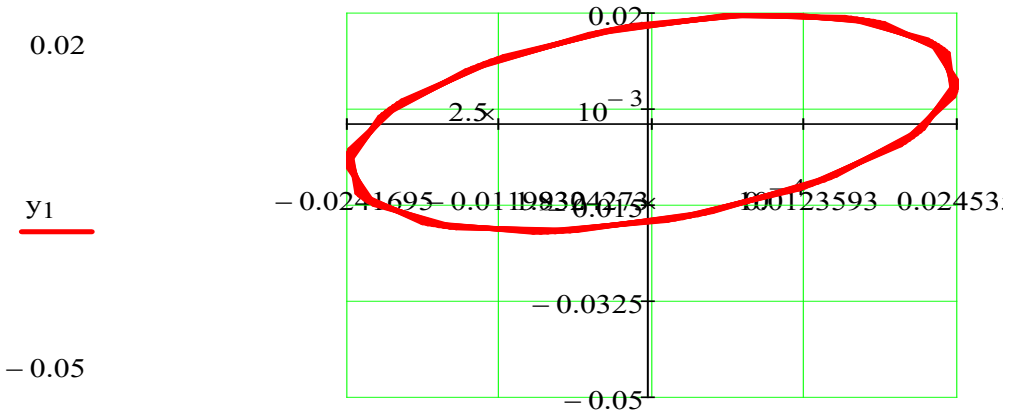

Рисунок 6. Фазовий портрет нестійкого граничного циклу у змінних *x* та *y*. *k* = 0.5

http://dx.doi.org/10.21511/ed.19(4).2020.02

Існування нестійкого граничного циклу доводить, що орієнтація у плані маркетингу на традиційну продукцію фірми при просуванні на ринок її незначної модифікації з'являється нестійкий автоколивальний режим періодичних змін функцій маркетингу та менеджменту відносно розглянутого рівноважного стану системи (4) і (11). При цьому рольове значення зовнішніх факторів (ринкового стану), тобто внесення збурень у систему, полягає в тому, що вони можуть вибити її зі стійкого стану рівноваги за межу області стійкості. Далі, перетин межі μ=0 відповідає зникненню області стійкості усередині нестійкого граничного циклу. Відповідні точки траєкторії «зриваються» з рівноважного стану і зникають за межу розглянутого окола цього стану. Важливо, що при зворотній зміні управляючого маркетингового параметру ці точки не повертаються у стан рівноваги, тобто спроба відмовитися від впровадження на ринок нової продукції шляхом повернення стратегії постачання традиційної продукції вже не забезпечує рівноважний стан фірми на споживчому ринку. Процес еволюції економічної системи має незворотній гістерезисний характер.

Це може означати, що стан фірми на споживчому ринку після її «зриву» при μ=0 може перейти до іншого стійкого стаціонарного стану рівноваги (успішне впровадження нової продукції) або до стрибкоподібного, катастрофічного переходу до своєрідного режиму усталеного руху, який якісно відрізняється від стану стаціонарної рівноваги і строго періодичних автоколивань – стан динамічної невизначеності. Перехід фірми на такий режим функціонування означає, що в ній відбуваються складні квазіперіодичні коливання, механізм яких є дуже чутливим до малих збурень початкових умов (діям релевантних факторів зовнішнього оточення), тоді як у цей час усереднені характеристики стану фірми достатньо стійкі. Такий процес діяльності фірми може бути названим турбулентним. Дійсно, якщо μ=0 граничний цикл «пристає» до стану рівноваги, який є складним (повільним) нестійким фокусом.

Нами досить докладно проаналізована проблема стійкості граничного циклу при усіх значеннях параметру менеджменту, окрім ν_2=1 (k=0). Сам по собі факт зміни стійкості граничного циклу в околі критичного значення параметру ν_2=1 викликає підозру у напрямку існування вторинної біфуркації Хопфа, при кій можуть одночасно існувати два граничних цикла – стійкий та нестійкий.

Нехай k = 0. Тоді система (11) приймає вигляд:

$$\begin{cases} \dot{x} = y \\ \dot{y} = -x + \beta x^2 + \alpha y^2 \end{cases}. \qquad (14)$$

Виключимо часову змінну і перепишемо (14) у вигляді диференціального рівняння першого порядку:

$$\frac{dy}{dx} = \frac{-x + \beta x^2 + \alpha y^2}{y}. \qquad (15)$$

Рівняння (15) може бути явним чином про інтегроване відносно функції $y^2(x)$:

$$\frac{d(y^2)}{dx} = 2dy^2 + 2(\beta x^2 - x). \qquad (16)$$

Диференціальне рівняння (16) є лінійним і має достатньо очевидний розв'язок:

$$y^2 + \frac{\beta}{\alpha}x^2 + \frac{2(\beta-\alpha)x}{2\alpha^2} + \frac{\beta-\alpha}{2\alpha^3} = C \cdot e^{2\alpha \cdot x}, \qquad (17)$$

де C - довільна стала, залежна від початкових умов x_0, y_0.

Якщо підібрати x_0, y_0 таким, що C=0, тоді отримаємо:

$$\alpha \cdot y^2 + \beta \cdot x^2 + \frac{2\beta-\alpha}{2\alpha}x + \frac{\beta-\alpha}{2\alpha^2} = 0, \qquad (18)$$

Рівняння (18) є еліпсом, оскільки α і β є додатні, тобто мають однаковий знак.

http://dx.doi.org/10.21511/ed.19(4).2020.02

Перетворимо (18) до вигляду:

$$y^2+\frac{\beta}{\gamma}\cdot\left(x+\frac{1}{2}\left(\frac{2\beta-\alpha}{\alpha\beta}\right)\right)^2=\gamma^2, \qquad (19)$$

де число $\gamma>0$ існує, якщо $\frac{\beta}{\alpha}<2\sqrt{2}-\frac{1}{2}$. Таким чином, система (14) має перший інтеграл і є по суті консервативною. Тому біфуркація двократного циклу у такій системі не може існувати. Якщо підставити (19) у перше рівняння системи (14), то з'явиться диференціальне рівняння першого порядку для *x(t)*.

$$\frac{dx}{dt}=\sqrt{\gamma^2-\frac{\beta}{\alpha}\left(\tilde{o}+\frac{1}{2}\left(\frac{\beta-\alpha}{\alpha\beta}\right)\right)^2}, \qquad (20)$$

Рівняння (20) є диференціальним рівнянням першого порядку з відокремленими змінними і має розв'язок:

$$x(t)=-\frac{1}{2}\left(\frac{\beta-\alpha}{\alpha\beta}\right)+\gamma\sqrt{\frac{\alpha}{\beta}}\sin\left(\sqrt{\frac{\alpha}{\beta}}t+K^*\right), \qquad (21)$$

де $K^*=\arcsin\left(x_0+\frac{1}{2}\left(\frac{\beta-\alpha}{\alpha\beta}\right)\right)$.

Користуючись формулою (19), маємо:

$$y(t)=\gamma\cos\left(\sqrt{\frac{\alpha}{\beta}}t+K^*\right), \qquad (22)$$

Задаючи різні початкові умови x_0 є можливість знайти безліч розв'язків консерва-тивної системи (14). На цьому біфуркаційна поведінка системи (4) з характеристичним рівнянням (5) не вичерпується. Якщо припустити, що коефіцієнти квадратного рівняння (5) можуть незалежно один від одного змінювати знаки, то будемо вважати їх малими величинами в околі нуля:

$$\nu_2+\nu_1-1=\mu_2,$$

$$\nu_1(1-\nu_2)-\nu_1=\mu_1, \qquad (23)$$

де μ_1, μ_2 – малі знакозмінні величини.

У такому випадку маємо незалежність управляючих параметрів функцій маркетингу та менеджменту. У такому форматі система (4) була розглянута у роботі [13].

Якщо у (23) прирівняти нулю праві частини, то легко знайти розв'язок для критичних значень параметрів ν_1, ν_2:

$$\nu_1^*=\frac{\sqrt{5}-1}{2},\quad \nu_2^*=\frac{3-\sqrt{5}}{2}. \qquad (24)$$

Вочевидь, що розв'язки для ν_1^*, ν_2^* у (24) зв'язані співвідношенням «золотого перерізу».

З урахуванням малих параметрів μ_1, μ_2 знайдемо вирази для ν_1, ν_2 із системи алгебраїчних рівнянь (23):

$$\begin{aligned} \nu_1 &= \nu_1^* + \frac{1}{\sqrt{5}}\mu_1 + \frac{1}{2}\left(1+\frac{1}{\sqrt{5}}\right)\mu_2, \\ \nu_2 &= \nu_2^* - \frac{1}{\sqrt{5}}\mu_1 + \frac{1}{2}\left(1-\frac{1}{\sqrt{5}}\right)\mu_2. \end{aligned} \qquad (25)$$

Введемо позначення відхилень параметрів маркетингу і менеджменту від своїх критичних значень $\nu_1 = \nu_1^* - \nu_1$, $\nu_2 = \nu_2^* - \nu_2$ і вирахуємо з (25) малі параметри μ_1, μ_2. Після необхідних перетворень маємо формули:

$$\begin{aligned} \mu_2 &= \tilde{\nu}_1 + \tilde{\nu}_2, \\ \mu_1 &= \frac{\sqrt{5}-1}{2}\tilde{\nu}_1 + \frac{\sqrt{5}+1}{2}\tilde{\nu}_2. \end{aligned} \qquad (26)$$

У [3] зазначено, що система (4) топологічно еквівалентна наступній системі:

$$\begin{aligned} u_1 &= u_2, \\ u_2 &= q^2\mu_1 u_1 + q\mu_2 u_2 + u_1^2 + u_1 u_2, \end{aligned} \qquad (27)$$

де $q = \frac{\sqrt{5}-1}{4}\left(1+\frac{3-\sqrt{5}}{2}\frac{\beta}{\alpha}\right)$.

У системі (27) відбувається біфуркація Богданова-Такенса «двократного нуля» [12], властивості якої будуть розглянуті далі.

За наявності дослідження топологічних властивостей системи (27) у роботі [13] є повний біфуркацій ний аналіз на площині малих параметрів μ_1, μ_2. Вважаємо доцільним розглянути дані висновки у термінах ν_1, ν_2. У результаті перетворень отримаємо:

1. Лінія сідло вузлової біфуркації $F = \left\{(\tilde{\nu}_1, \tilde{\nu}_2) : \tilde{\nu}_2 = \frac{3-\sqrt{5}}{2}\tilde{\nu}_1\right\}$.
2. Лінія біфуркації Хопфа $H = \left\{(\tilde{\nu}_1, \tilde{\nu}_2) : \left(2 - q\left(\sqrt{5}+1\right)\right)\tilde{\nu}_2 + \left(2 + q\left(\sqrt{5}-1\right)\right)\tilde{\nu}_1 = 0\right\}$.
3. Лінії глобальної гомоклітичної біфуркації

$$P = \left\{\left(\tilde{\nu}_1, \tilde{\nu}_2\right) : \left(7 + 3\left(\sqrt{5}-1\right)q\right)\tilde{\nu}_1 + \left(7 - 3\left(\sqrt{5}+1\right)q\right)\tilde{\nu}_2 = 0\right\}.$$

Таким чином, нами встановлено, що у малому околі критичних значень параметрів маркетингу ν_1^* та менеджменту ν_2^* динамічна система (4) демонструє складну поведінку з відповідним каскадом змін стійкості рівноважного стану.

ВИСНОВКИ

Важливість дослідження параметрів стійкості нелінійної динамічної системи за допомогою методології синергетичної економіки не викликає ніяких сумнівів. Отримані результати щодо аналізу стійкості моделі ринкового становища фірми підтверджують складність поведінкових властивостей досліджуваного об'єкту. Своєчасне й адекватне інформування про управляючі параметри функцій маркетингу та менеджменту, забезпечують стійкість екологічних процесів по відношенню до зовнішніх збурень, що дозволяє відпрацьовувати ефективні стратегії щодо недопущення потрапляння фірми у небезпечні межі областей параметричної стійкості та реалізувати комплекс управлінських заходів з запобігання катастроф у майбутньому. Реалізація усіх зазначених заходів сприятиме своєчасній адаптації внутрішньофірмовій системі управління до викликів мінливостей економічних реалій.

http://dx.doi.org/10.21511/ed.19(4).2020.02

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“Smart sustainability ranking system within local budgeting”

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ARTICLE INFO	Pankaj Srivastava, Saurabh Srivastav, Tetiana Zhyber and Denys Hryzohlazov (2020). Smart sustainability ranking system within local budgeting. *Economics of Development*, *19*(4), 24-34. doi:10.21511/ed.19(4).2020.03
DOI	http://dx.doi.org/10.21511/ed.19(4).2020.03
RELEASED ON	Monday, 15 March 2021
RECEIVED ON	Friday, 13 November 2020
ACCEPTED ON	Tuesday, 15 December 2020

JOURNAL	"Economics of Development"
ISSN PRINT	1683-1942
ISSN ONLINE	2304-6155
FOUNDER	Simon Kuznets Kharkiv National University of Economics

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
19	0	12

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SMART SUSTAINABILITY RANKING SYSTEM WITHIN LOCAL BUDGETING

Abstract

The study focuses on the need to update tools for making local governance decisions using modern information technology in an environment of unpredictability added by the pandemic. Policy formulation by the authorities, especially local governments, is faced with the demand for sustainable development due to the obstacles and risks that have arisen. The purpose of the paper was to create a model for an intelligent information system to rank input qualitative information as an object in accordance with sustainability criteria for determining the local government's policy on budgetary support for entrepreneurial activity. Fuzzy informatics methods used in soft computing based on fuzzy logic improve estimation potential.

The activity in community-based tourism (CBT) was chosen as a basis for simulating the "Intelligent Ranking System" for local budgeting. In the paper, the system ranks four factors of sustainability according to the importance of local government activity by nine criteria, whose fuzzy values are calculated based on expert judgments within the framework of six linguistic variations. Simulation of future directions of budgeting was developed using unified answers from the example of India for applying in local tourism. The basis of the system matrix is formed through the subsequent analysis of deviations from the limiting variations of the maximum positive and maximum negative impressions of experts. The model of this ranking system will be useful for service-oriented activities where consumer impressions are an important development requirement.

Keywords public budgeting, local governance, fuzzy logic, community based tourism, ranking intelligent system

JEL Classification C60, H11, H61, R51

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РОЗУМНА СИСТЕМА РЕЙТИНГУВАННЯ СТІЙКОСТІ ПРИ МІСЦЕВОМУ БЮДЖЕТУВАННІ

Анотація

Дослідження фокусується на необхідності модернізації інструментів для прийняття рішень органами місцевого самоврядування з використанням сучасних інформаційних технологій в умовах непередбачуваності, доданої пандемією. При розробці політики владою, особливо місцевими органами влади, посилюється необхідність у сталому розвитку через виклики перешкод і ризиків. Метою публікації є створення моделі для розрахунку інформаційної системи для ранжування ввідної якісної інформації як об'єкта за критеріями стійкості для визначення політики влади з бюджетної підтримки підприємницької діяльності. Використані методи нечітких методів інформатики в рамках обчислень на основі нечіткої логіки покращують потенціал оцінки.

Діяльність у сфері місцевого туризму була обрана як основа моделювання «Інтелектуальної системи рейтингу» для місцевого бюджетування. У статті системою класифіковано чотири фактори стійкості відповідно до важливості дев'яти критеріїв діяльності місцевого самоврядування, нечіткі значення яких обчислюються на основі експертних суджень в рамках шести лінгвістичних варіацій. На прикладі Індії для місцевого туризму було розроблено моделювання подальших напрямків бюджетування на основі уніфікованих відповідей. Основа матриці сформована через подальший аналіз відхилень від граничних варіацій максимально позитивного та максимально негативного експертного оцінювання. Модель цієї рейтингової системи буде корисною для діяльності, орієнтованої на послуги, важливою умовою для розвитку якої є оцінки споживачів.

Ключові слова державне бюджетування, місцеве самоврядування, нечітка логіка, туризм орієнтований на громаду, розумна система рейтингування

Класифікація JEL C60, H11, H61, R51

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Received on: 13th of November, 2020
Accepted on: 15th of December, 2020
Published on: 15th of March, 2021

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http://dx.doi.org/10.21511/ed.19(4).2020.03

INTRODUCTION

The sustainable public policy implementation was intensified among public budgeting tasks at the local level during the COVID-19 pandemic. The basic benchmarks of best budgetary funds redistributing in its limitation conditions because of risks (pandemic etc.) require the most modern methods and tools of applying public budgeting decisions at the local governance level. Local governance authorities are searching for the ways of combining familiar services and policy (Innes and Booher, 2010) with new criteria for the sustainable development in lockdowns bonding.

In developing countries, particularly in India, the uncertain conditions of the local budget revenues and expenditures raise the need to look for sustainability creation to balance follow-up. In large and crowded regions where people's activities are diversified, tourism industry indeed could provide many benefits to the communities that lack the knowledge and financial resources. Local tourism for community could reduce the negative impacts of new circumstances.

Therefore, local governance authority could develop regional businesses to provide budget revenue and improve the psychological state of the population at the time of shutdown by redistributing budget support within the target public budgeting on the community-based tourism (CBT) development example. As for the previous experience of the leading countries in efficient budgeting, EU residents spent 82% of their tourism expenditure on trips inside Europe (78% inside the EU) according to the Eurostat data. In this paper we propose to join the rhetoric about the indicators and its weak directions assessment to support local governors with the real decisions in budgeting concerning the problems which can be solved by qualitative estimation feedback applying soft computing tools.

The regions in developing countries are getting involved into the struggle against pandemic crisis without any external support. The general concept of sustainability is based on the ability to meet social needs with the available resources (Shrivastava and Berger, 2010). When access to resources or the necessities changes, sustainability changes its criteria. New sustainability development principles are introduced to encourage and empower the communities. Soft computing methods allow calculating data based on the current impact evaluation in the changing environment in addition to hard-calculated quantitative indicators. With the purpose of determining directions to budget resource allocation for the local authorities during the policy implementation in the unfamiliar conditions, the design of an Intelligent Sustainability Ranking System simulation is proposed. It is based on four pillar factors such as Economic Sustainability (ES), Social Sustainability (SS), Environmental Sustainability (ENS), and Cultural Sustainability (CS).

1. LITERATURE REVIEW

Budgeting, for now, is provided under constraints of financial resource, with the impact of environmental and pandemic risks for public budgets. Khan (2019) points out the necessity for a government or local authority to "carefully evaluate its allocation decisions" (p. 8). Since budgeting deals with the allocation of the budget revenues by the local governors, the researchers should provide the decision-makers with set of tools and techniques that are useful for the further budget support inner evaluating. Chohan and Jacobs (2018) pointed out that sometimes the government uses the term "sustainability" without actually taking politically costly budget decisions (p. 1225). Sustainable tourism is one of the most important topics in the global tourism industry nowadays (Giampiccoli et al, 2020). CBT gives the possibility for the local community authorities to be involved in the local business support outcome. With the steady employment and taxation that means fiscal sustainability, budget deficits and public debt are smaller (Fuentes-Silva, 2020). The main product of tourism is the tourist's impressions who pay and create revenues for further taxes payment. Open Data for the budgeting, public budget support requirement along with the sustainability indicators ranking for the regional tourists and tourism workers create the ground for prompt local government reaction and activity correction during real-time evaluation of the tourist's impressions. In the current economic situation considering the regional policy implementation, the CBT is a way of developing social, economic, environmental, cultural requirements of local communities as pointed by Han at al. (2019).

In India it has been seen that the tourism industry can provide many benefits to the communities that lack the knowledge and financial resources to get involved in the development of tourism without any external support. Promotion "Vocal for Local" motto of the Prime minister of India in 2020 is described by Srivastava (2020).

"The beneficial effects of technical achievements in budgeting could have been weakened by the temptations to manipulate financial information for short-term political advantage" as pointed by Heald and Hodges (2020, p. 4), and openness of data evaluating could help to prevent it. The authority's explanation of local governance sustainability for the community is a key factor in policymaking and strategic management as it promotes the local's activities growth in the region. The local budgeting could rely on managerial accountability and multi-sector assessment of certain criteria. Sustainable activity is a steadily growing process in the tourism industry. Lee and Farzipoor (2012) proposed to measure complex busines's sustainability management by introducing DEA technique. Their proposed model considers dual-role factors in across-efficiency context with the three result variations. Butnariu and Avasilcai (2015, p. 1234) pointed that "sustainability reports are formed to transform the sustainability aspects in quantifiable values of economic, environmental and social performance, with the main purpose to help to manage the key preoccupation for sustainability and to provide information on the way in which the activity contributes to sustainable development". The model proposed by the authors specifies the number of indicators by aggregation in a composite index. Beekaroo et al. (2019, p. 257) determined and unified the sustainability indicators' scores for the different types of activity. "The key dimensions for the assessment of sustainability were identified using the survey method and interview of opinion experts". The last sustainability index model differs from previous evaluation methods by providing an idea of the comparison platform for estimation participants. The composite resulting index, proposed by the authors too, combines economic, social, and environmental indicators in an indexing algorithm useful to rank even different spheres according to their performance. These approaches to defining sustainable activity formed the basis for the selection of two borders of sustainability indicators assessment in this study.

According to Verawati (2020), today internal evaluation and accountability are important issues in the implementation of the public budget as a motivational tool and an instrument for creating public space. Previously Srivastava and Srivastav (2020, p. 791) suggested a soft computing-based tourist's destination recommendation system for a particular region in India. The calculation was "based on Soft Computing tools with a sensitivity analysis approach to develop the ranks under the features of uncertainties to provide an appropriate platform for the convenience of experts under the Soft Computing knowledge domain".

2. AIMS

Create a model for calculating an information system for ranking input qualitative information regarding sustainability criteria to determine government policy for budgeting support of the entrepreneurial activity, while continuing to improve the assessment potential using fuzzy computer science methods within soft computing based on the fuzzy logics.

3. DATA AND METHODOLOGY

The entity's operations segregation and measurement combination are common to all previous estimations of sustainability in the literature review. These publications used a basic multidimensional approach to assess qualitative results in terms of economic, as well as social and environmental indicators of the region's development. Reviewed research elucidates the role of various aspects of sustainability, such as economic, social, cultural and environmental, in stimulating private activity.

To encourage and empower the communities' modern sustainability, development principles could be introduced by publishing the inner assessment indicators of future budgeting and policies. The local community activities involvement and self-sufficiency in tourism is one of the main features that have been reflected in the CBT development. The soft computing techniques based on fuzzy logic, in particular, fuzzy methods, allows creating a system to interpret tourist's (expert's) reactions to sustainability indicators changing. These changes could be prevented or managed from the very beginning with calculation and estimation of input data by Fuzzy sets.

http://dx.doi.org/10.21511/ed.19(4).2020.03

In order to develop the ranking system, we are using Fuzzy sets, which were described by Zadeh (1965) and further developed by Klir and Yuan (2015), and Fuzzy TOPSIS in respect to the publication by Chen (2000). Four key factors of sustainability in the case of CBT were determined and the resulting system was configured by attempts to apply two variations of the comparison.

To measure and rank the people's input suggestions we decided to construct five linguistic terms that will be valued as a variable. In the matrix simulation for this paper the two group expert's answers were combined into two input information sets.

Definitions are as follows:

1. Fuzzy Sets. A fuzzy set $\tilde{A}$ in a universe of discourse R is defined by a membership function $\tilde{\mu}_A(x)$ such that $\tilde{\mu}_A(x) \to [0,1] \forall x \in R$.
2. Fuzzy Numbers. A fuzzy number is a fuzzy subset in the universe of discourse, *R*. It is both convex and normal. Trapezoidal fuzzy numbers are shown below.
3. Trapezoidal Fuzzy Number. The trapezoidal fuzzy number (TrFN) is presented by $\tilde{A} = (a,b,c,d)$ and its membership function is given by:

$$\tilde{\mu}_A(x) = \begin{cases} \dfrac{x-a}{b-a}, & a \le x \le b \\ 1, & b \le x \le c \\ \dfrac{d-x}{d-c}, & c \le x \le d \\ 0, & elsewhere \end{cases}. \qquad (1)$$

4. Normalized Fuzzy Sets. A fuzzy set $\tilde{A}$ of the universe of discourse, R, is said to be normalized fuzzy set if an x ∋ R such that $\tilde{\mu}_A(x) = 1$.
5. Linguistic Variables. A variable whose values are linguistic terms. The linguistic values can also be expressed as fuzzy numbers. These linguistic values mean the state of tourism in the region by people's impressions, their preferences for the results of its development to the current moment and future prospects.

For example, "weight" in the simulation is a linguistic variable; its values are "very low", "moderately important", "important", "very important", "absolutely important" etc.

6. Distance between two trapezoidal fuzzy numbers. Suppose, there are two trapezoidal fuzzy numbers $\tilde{A} = (a_1, a_2, a_3, a_4)$ and $\tilde{B} = (b_1, b_2, b_3, b_4)$ with centroid points (α_A, β_A) and (α_B, β_B); left and right spreads are (L_A, R_A) and (L_B, R_B) respectively. Then the distance between two trapezoidal fuzzy numbers (Ebadi at al., 2013) is given by:

$$d(\tilde{A}, \tilde{B}) = \max\{|\alpha_A - \alpha_B|, |\beta_A - \beta_B|, |L_A - L_B|, R_A - R_B|\}, \qquad (2)$$

where, $\alpha_A = \dfrac{\left[a_1 + a_2 + a_3 + a_4 - \left(\dfrac{a_4 a_3 - a_1 a_2}{(a_4 + a_3) - (a_1 + a_2)}\right)\right]}{3}$; $\beta_A = \dfrac{\left[1 - \dfrac{a_3 - a_2}{(a_4 + a_3) - (a_1 + a_2)}\right]}{3}$

$L_A = a_2 - a_1,\ R_A = a_4 - a_3.$

A positive ideal solution and a negative ideal solution mean the key points of the system of opinions and create the variables field. The Fuzzy TOPSIS works on the concept of distance to positive ideal solution and negative ideal solution, the basic procedure of Fuzzy TOPSIS is given by a number of steps as.

Step 1. In order to develop the system, the steps of Fuzzy TOPSIS are given below in Table 1.

Table 1. Fuzzified scale for pairwise comparison

Source: Calculated by the authors.

Linguistic Variables	Fuzzy Scale
Equal Importance (Eq.I)	(1, 1, 1, 1)
Very Less Important (VLI)	(0, 0.5, 1.5, 2)
Less Important (LI)	(1, 1.5, 2.5, 3)
Important (I)	(2, 2.5, 3.5, 4)
Very Important (VI)	(3, 3.5, 4.5, 5)
Extremely Important (EI)	(4, 4.5, 5.5, 6)

Suppose, there are k decision-makers. If the fuzzy rating and weight of importance of kth decision-maker about ith alternative concerning jth criteria are $\tilde{x}_{ij}^k = (a_{ij}^k, b_{ij}^k, c_{ij}^k, d_{ij}^k)$ and $\tilde{w}_j^k = \left(w_{j1}^k, w_{j2}^k, w_{j3}^k, w_{j4}^k\right)$ respectively, where i=1,2,3, …,m and j=1,2,3,…,n.

Step 2. Aggregated fuzzy rating i^{th} alternative concerning j^{th} criteria are given by $\tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij}, d_{ij})$ such that:

$$a_{ij} = \min_k\{a_{ij}^k\},\ \mathrm{b}_{ij} = \min_k\{b_{ij}^k\},\ \mathrm{c}_{ij} = \min_k\{c_{ij}^k\},\ \mathrm{d}_{ij} = \min_k\{d_{ij}^k\}. \quad (3)$$

And the aggregated fuzzy weights of importance are $\tilde{w}_j = \left(w_{j1}, w_{j2}, w_{j3}, w_{j4}\right)$, where

$$w_{j1} = \min_k\{w_{j1}^k\},\ w_{j2} = \min_k\{w_{j2}^k\},\ w_{j3} = \min_k\{w_{j3}^k\},\ w_{j4} = \min_k\{w_{j4}^k\}.$$

Step 3. The fuzzy decision matrix of aggregate values is expressed by the following:

$$\tilde{D} = \begin{array}{c} \\ A_1 \\ A_2 \\ \cdots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \cdots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \cdots & \tilde{x}_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ \tilde{x}_{m1} & \tilde{x}_{m2} & \cdots & \tilde{x}_{mn} \end{bmatrix} \end{array}. \quad (4)$$

And the aggregate fuzzy importance weights are: $\tilde{W} = \left[\tilde{w}_1, \tilde{w}_2, \tilde{w}_3, \cdots, \tilde{w}_n\right]$, where each $\tilde{x}_{ij}, \tilde{w}_j\ \forall\ i$=1,2,3,…,$m$ and j=1,2,3,…,n are linguistic variables and which can be interpreted by trapezoidal fuzzy numbers $\tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij}, d_{ij})$ and $\tilde{w}_j = \left(w_{j1}, w_{j2}, w_{j3}, w_{j4}\right)$.

Step 4. The normalized fuzzy decision matrix is given by:

$\tilde{R} = \left[\tilde{r}_{ij}\right]_{m\times n}$, where i=1,2,3, …, m and j=1,2, 3,…, n, (5)

$$\left.\begin{array}{c} \tilde{r}_{ij} = \left(\dfrac{a_{ij}}{c_j^+}, \dfrac{b_{ij}}{c_j^+}, \dfrac{c_{ij}}{c_j^+}, \dfrac{d_{ij}}{c_j^+}\right) \\ where,\ c_j^+ = \max_i(d_{ij});\quad (\text{for benefit criteria}) \\ \tilde{r}_{ij} = \left(\dfrac{a_j^-}{d_{ij}}, \dfrac{a_j^-}{c_{ij}}, \dfrac{a_j^-}{b_{ij}}, \dfrac{a_j^-}{a_{ij}}\right) \\ where,\ a_j^- = \min_i(a_{ij});\quad (\text{for cost criteria}) \end{array}\right\}.$$

http://dx.doi.org/10.21511/ed.19(4).2020.03

In this normalization process, the ranges of normalized fuzzy numbers are located within the interval [0, 1].

Step 5. The weighted normalized fuzzy matrix $\tilde{V}$ can be evaluated by:

$$\tilde{V} = \left[\tilde{v}_{ij}\right] = [\tilde{r}_{ij} \otimes \tilde{w}_j]_{m\times n}, \qquad (6)$$

where i=1,2,3, …, m and j=1,2, 3, n.

Step 6. The fuzzy positive ideal solution (FPIS) and fuzzy negative ideal solutions (FNIS) were defined as given below:

$$\left.\begin{aligned} A^+ &= \left(\tilde{v}_1^+, \tilde{v}_2^+, \tilde{v}_3^+, \cdots, \tilde{v}_n^+\right) \\ v_j^+ &= \max_i \left(v_{ij4}\right),\ i = 1,2,3,...,m \text{ and } j = 1,2,3,...,n \\ A^- &= \left(\tilde{v}_1^-, \tilde{v}_2^-, \tilde{v}_3^-, \cdots, \tilde{v}_n^-\right) \\ v_j^- &= \min_i \left(v_{ij1}\right),\ i = 1,2,3,...,m \text{ and } j = 1,2,3,...,n \end{aligned}\right\}. \qquad (7)$$

Step 7. The distances d_i^+ and d_i^- of each weighted alternative from fuzzy positive ideal solution (FPIS) and fuzzy negative ideal solutions (FNIS) can be evaluated by the following equations:

$$\begin{aligned} d_i^+ &= \sum_{j=1}^{n} d_v(\tilde{v}_{ij}, \tilde{v}_j^+) \quad i = 1,2,3,...,m, \\ d_i^- &= \sum_{j=1}^{n} d_v(\tilde{v}_{ij}, \tilde{v}_j^-) \quad i = 1,2,3,...,m, \end{aligned} \qquad (8)$$

where $d_v(\tilde{v}_{ij}, \tilde{v}_j)$ is the distance between two trapezoidal fuzzy numbers $\tilde{v}_{ij}$, and $\tilde{v}_j$.

Step 8. The distance from fuzzy positive ideal solution (FPIS $\tilde{A}^+$) and fuzzy negative ideal solutions (FNIS $\tilde{A}^-$) are simultaneously represented by the closeness coefficient Cc_i:

$$Cc_i = \frac{d_i^-}{d_i^- + d_i^+}, \ i = 1,2,3,...,m. \qquad (9)$$

The highest value of closeness coefficient represents the best alternative, and it shows the best alternative is the closest one to the FPIS and the farthest one from FNIS.

Step 9. The alternatives are ranked with the help of the closeness coefficient. The intelligent ranking system could interpret the input answers and provide the evaluation of sustainability indicators rank importance for the tourists to allocate budget funding for preventing the problems or stimulate the additional activity with the most ranked sustainability pillars.

4. RESULTS AND APPLICATION OF FTOPSIS

The simulation of the intelligent ranking system was accomplished. A case study is performed to configure the sustainability factors for community-based tourism to develop further budgeting policy of the local government. Based on the previous research reviews we took four pillar factors which are listed below:

1. A_1 -Economic Sustainability.
2. A_2 -Social Sustainability.
3. A_3 - Environmental Sustainability.
4. A_4 -Cultural Sustainability.

As the first baseline for the system, the experts group's unified opinion was utilized as the input information. The line of the authorities activity evaluation criteria was built by the linguistic impressions among: AB – Attitude and Belief towards CBT, HC – Human Capital Development, CBTM – CBT Management, IN – Innovation, TR – Tourism Resource, TRM – Tourism Resources Management, TAP – Tourism Activities and Products, MDIMSI – Market Demand Identification and Marketing Strategy Development, VT – Values for Tourists. With the next criteria application, the experts are ranked by the previously obtained linguistic variations of each pillar factor.

The experts' ratings for each alternative corresponding to each criterion are shown in Table 2 and Table 3. In Table 2 the D1 indicator means the opinion of the first expert group's unified answers with a verified linguistic evaluation on each criterion.

Table 2. Ratings by First Expert Group Opinion

D1	AB	HC	CBTM	IN	TR	TRM	TAP	MDIMSD	VT
ES	VI	EI	LI	VI	EI	I	VI	I	VI
SS	LI	EI	LI	EI	VI	EI	VI	EI	I
ENS	EI	VLI	I	I	EI	VI	EI	EI	EI
CUL	VLI	LI	VI	VI	I	EI	I	LI	VI

Next in the Table 3, the indicator D2 stands for the second expert group's opinion within the criteria given below.

Table 3. Ratings by Second Expert Group Opinion

D2	AB	HC	CBTM	IN	TR	TRM	TAP	MDIMSD	VT
ES	EI	EI	EI	EI	EI	EI	EI	EI	EI
SS	EI	VI	EI	I	EI	EI	VI	I	VI
ENS	EI	EI	VI	I	EI	EI	VI	LI	I
CUL	EI	VI	EI	I	EI	EI	VI	I	VI

In Table 4 the comparison of the main criteria between each expert group's opinion in linguistic evaluation cross-scale was proposed for consideration.

Table 4. Pairwise comparison table for the main criteria

AB	ES	SS	EnS	CS
ES	(1,1,1,1)	(0,0.5,1.5,2)	(0,0.5,1.5,2)	(0,0.5,1.5,2)
SS	(0,0.5,0.666667,2)	(1,1,1,1)	(0.33333,0.4,0.666667,1)	(0.33333,0.4,0.666667,1)
EnS	(0,0.5,0.666667,2)	(1,1.5,2.5,3)	(1,1,1,1)	(0.33333,0.4,0.666667,1)
CS	(0,0.5,0.666667,2)	(1,1.5,2.5,3)	(1,1.5,2.5,3)	(1,1,1,1)

The result of the fuzzy conversion of linguistic ratings given by experts was the base of calculation. The aggregated decision matrix obtained by step 3 is presented by Table 4.

Normalized fuzzy decision matrix applied for the result is shown in Table 5.

http://dx.doi.org/10.21511/ed.19(4).2020.03

Table 5. Evaluation of Normalized weights

Alternatives	AB	$\tilde{w}_i = \tilde{r}_i \otimes S^{-1}$	W_i Using ATLAB	$N_i = \frac{W_i}{Sum}$
ES	(0, 0.594604, 1.355403, 1.681793)	(0, 0.091536, 0.297982, 0.5806)	0.2501	0.259763
SS	(0, 0.53183, 0.737788, 1.189207)	(0, 0.081872, 0.1622, 0.410)	0.173	0.179684
EnS	(0, 0.740083, 1.02669, 1.565085)	(0, 0.1139, 0.2257, 0.540355)	0.231	0.239925
CS	(0, 1.029884, 1.42872, 2.059767)	(0, 0, 0.032797, 0.320265)	0.3087	0.320627
SUM (S)	(0, 2.8964, 4.548601, 6.495852)	–	0.9628	–
Componentwise (S^{-1})	(0, 0.345256, 0.219848, 0.153944)	–	–	–
Increasing Order (S^{-1})	(0, 0.153944, 0.219848, 0.345256)	–	–	–

Further, we applied normalization described in Step 4. The normalized fuzzy decision matrix with the alternatives and pillar criteria was shown in Table 6.

Table 6. Normalized weights of each alternative corresponding to each criterion

Alternatives \ Criteria	AB	HC	CBTM	IN	TR	TRM	TAP	MDIMSD	VT
ES	0.25976	0.25	0.25	0.25	0.25	0.25	0.247283	0.261445	0.27758
SS	0.17968	0.25	0.25	0.25	0.25	0.25	0.202826	0.27758	0.208537
EnS	0.23992	0.25	0.25	0.25	0.25	0.25	0.347065	0.208537	0.261445
CS	0.32062	0.25	0.25	0.25	0.25	0.25	0.202826	0.252439	0.252439

The fuzzy weights of all criteria are obtained using the F-AHP method, which is shown in Table 7 given below.

Table 7. Fuzzy weights of each criteria

Criteria	Fuzzy weights
AB	(0.033402, 0.058508, 0.138045, 2.319587)
HC	(0, 0.076074, 0.187918, 3.481953)
CBTM	(0, 0.087107, 0.209953, 3.584952)
IN	(0, 0.07929, 0.202919, 3.3554)
TR	(0, 0.091476, 0.267681, 4.43481)
TRM	(0, 0.080467, 0.221766, 3.661457)
TAP	(0, 0.055233, 0.133518, 3.364852)
MDIMSD	(0, 0.05563, 0.126661, 2.978191)
VT	(0, 0.045939, 0.099535, 2.757431)

Now we will arrange the previously mentioned step 5 where a weighted normalized fuzzy decision matrix was obtained, that is shown in Table 8.

Table 8. Normalized weights of each alternative corresponding to each criterion

AB	HC	CBTM	IN	TR	TRM	TAP	MDMS	VT
0.088028	0.12991	0.134098	0.00818	0.165362	0.136701	0.12477	0.110697	0.102255

Further, we will obtain a fuzzy positive ideal solution (FPIS) and negative ideal solution (FNIS) described in step 6 and shown in Table 9.

Table 9. FPIS and FNIS of each criteria

Criteria	FPIS	FNIS
AB	(2.31,2.31,2.31, 2.31)	(0,0,0,0)
HC	(3.48,3.48,3.48,3.48)	(0,0,0,0)
CBTM	(3.6,3.6,3.6,3.6)	(0,0,0,0)
IN	(3.4,3.4,3.4,3.4)	(0,0,0,0)
TR	(4.4,4.4,4.4,4.4)	(0,0,0,0)
TRM	(3.7,3.7,3.7,3.7)	(0,0,0,0)
TAP	(3.4,3.4,3.4,3.4)	(0,0,0,0)
MDIMSD	(3,3,3,3)	(0,0,0,0)
VT	(2.8,2.8,2.8,2.8)	(0,0,0,0)

In the next step, we evaluated the distances of FPIS and FNIS using the method suggested by Ebadi et al. (2013), and Hamming distance, described by Chakraborty and Guha (2010), between two fuzzy numbers. Distance and closeness coefficient are shown in Table 10 and Table 11 given below.

Table 10. Final output obtained by Fuzzy TOPSIS using Ebadi et al. (2013) method

Factors	Distance from FPIS	Distance from FNIS	Closeness Coefficent	Ranks
ES	28.4829692	28.4829692	0.5	1
SS	28.01418879	27.50143077	0.49538158	2
ENS	28.16952654	26.8696423	0.48819128	3
CUL	27.45174549	25.47650164	0.481340362	4

Table 11 shows the results using the Hamming Distance.

Table 11. Final output obtained by Fuzzy TOPSIS using Hamming Distance

Source: Chakraborty and Guha (2010).

Factors	Distance from FPIS	Distance from FNIS	Closeness Coefficient	Ranks
ES	21.9999	7.9386	0.26516	1
SS	22.2779	7.6606	0.25587	2
ENS	66.27204	7.4745	0.10135	4
CUL	22.84729	7.0913	0.23686	3

The next discussion topic is the difference between the approach results. The first approach creates the intelligent system with the average "meaning" about the opinions, but the second approach shifts the rank in the system to the more radical position when experts' inputs ranks for the additional alternatives were more different. Comparison among the results obtained from Fuzzy TOPSIS are shown in the next Table 12.

Table 12. Fuzzy TOPSIS results of the simulation

Alternatives	Fuzzy TOPSIS (Using Ebadi et al.'s Method)	Fuzzy TOPSIS (Using Hamming Distance Method)
ES	1	1
SS	2	2
ENS	3	4
CUL	4	3

The Culture factor obtains lower rank by the first method because the opinions' ranks were widespread.

Created Intelligent Ranking System simulation are proposed to collect and process the opinions of tourists in the region or future consumers of tourism services from local residents. Local government should plan and redirect public budget funds on the basis of tourists' expectations and impressions to stimulate regional CBT.

http://dx.doi.org/10.21511/ed.19(4).2020.03

Based on the rating obtained in both cases of calculations, we should conclude that the factors of economic and social sustainability are the most important for tourism. Further decisions of local authorities should be primarily aimed at preserving the population's ability to pay and maintaining social balance, and afterward – at streamlining the environment and cultural traditions.

CONCLUSION

The Intelligent Sustainability Ranking System provides the most likely ranking for the four pillars of sustainability for community-based tourism, where the ability to pay off the authorities and citizens come first and the maintenance of cultural parity come last. Based on the results obtained by the system, the local government should first of all pay attention to economic well-being in order to meet the tourism expectations in the region. Using the ranking of four factors according to certain criteria within at least five people impressions allows creating a picture of fuzzy feedback formation for arranging further local governance policies. Thus, the system ranks more nuances and selects the most important ones, using not quantitative indicators, but human feelings and expectations in the provision of service-oriented activity.

Two methods of calculating the criteria assessment also allow us to reveal the width of the range of opinions on a particularly key factor with a further deepening of its assessment. The direction of further scientific development can be the issue of selecting and combining factors and criteria for assessing and stimulating the following promising activities by local authorities within the framework of budgeting in unpredictable conditions.

As CBT is very important part of the government's new campaign i.e., Vocal for Local in India, therefore, local government authorities can use the rankings of sustainability factors provided by the Intelligent Sustainability Ranking System to promote community-based tourism. Low ranking factors can be improved by the government's local budgeting. This system will act as a referral system of the policy among government authorities, respective tourism-related administrative bodies to make policies for sustainable development of community-based tourism and local budgeting which provides sustainability in uncertain conditions.

AUTHOR CONTRIBUTION

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http://dx.doi.org/10.21511/ed.19(4).2020.03

“Macroeconomic factors that influence the bank loans rate in international and Ukrainian practice”

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ARTICLE INFO	Sergiy Ivakhnenkov, Svitlana Hlushchenko and Kamilla Sverenko (2020). Macroeconomic factors that influence the bank loans rate in international and Ukrainian practice. *Economics of Development*, *19*(4), 35-47. doi:10.21511/ed.19(4).2020.04
DOI	http://dx.doi.org/10.21511/ed.19(4).2020.04
RELEASED ON	Wednesday, 31 March 2021
RECEIVED ON	Tuesday, 07 July 2020
ACCEPTED ON	Monday, 14 December 2020

JOURNAL	"Economics of Development"
ISSN PRINT	1683-1942
ISSN ONLINE	2304-6155
FOUNDER	Simon Kuznets Kharkiv National University of Economics

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
16	10	0

Sergiy Ivakhnenkov (Ukraine), **Svitlana Hlushchenko** (Ukraine), **Kamilla Sverenko** (Ukraine)

MACROECONOMIC FACTORS THAT INFLUENCE THE BANK LOANS RATE IN INTERNATIONAL AND UKRAINIAN PRACTICE

Abstract

The goal of the paper is to disclose the links between the dynamics of macroeconomic indicators and the level of bank loan rates based on international and Ukrainian practice. On the basis of the previous analysis, the paper also aims to identify the key trends in the formation of loan prices in the long run and identify problematic issues related to bank loan rates.

The main characteristics of bank lending rates in Ukraine are: a) their high rates; b) sharp changes in the weighted average bank loan rates from year to year; c) higher loan rates for households compared to the cost of bank loans for businesses; d) higher bank loan rates for short- and medium-term loans versus long-term ones; e) lower rates on loans in foreign currency compared to the loans in hryvnia; and f) high share of non-performing loans to households and businesses in bank portfolios.

In the context of world and Ukrainian practice, the paper demonstrates the reverse effect between macroeconomic indicators such as GDP per capita, the ratio of loans to GDP, the ease of doing business index and bank loan rates. The article also demonstrates a direct relationship between the dynamics of inflation rate in the country, the dynamics of non-performing bank loans and their rates.

Keywords loan price, bank loan rate, dynamics of bank loan rates, bank loans, macroeconomic factors

JEL Classification C82, D53, G21

С. В. Івахненков (Україна), **С. В. Глущенко** (Україна), **К. А. Сверенко** (Україна)

МАКРОЕКОНОМІЧНІ ЧИННИКИ ВПЛИВУ НА БАНКІВСЬКУ КРЕДИТНУ СТАВКУ В МІЖНАРОДНІЙ ТА УКРАЇНСЬКІЙ ПРАКТИЦІ

Анотація

Стаття має на меті висвітлити зв'язок між динамікою показників макроекономічного розвитку країни та рівнем банківських кредитних ставок на основі міжнародної та української практики та, виходячи з цього, виділити ключові тенденції формування цін на банківські кредити в довгостроковій перспективі та визначити проблемні питання у цій сфері.

Основними характеристиками ставок банківського кредитування наразі в Україні є: а) їх високий рівень; б) різкі зміни середньозваженої банківської кредитної ставки з року в рік; в) вища вартість банківських кредитів для домогосподарств порівняно з вартістю кредитів для бізнесу; г) вища вартість коротко- та середньострокових банківських кредитів проти довгострокових; д) нижчі кредитні ставки за кредитами в іноземній валюті порівняно з гривневими кредитами, е) висока частка непрацюючих кредитів домогосподарств та бізнесу у банківських портфелях.

У контексті світової та української практики в статті розкрито зворотний ефект між такими макроекономічними показниками, як ВВП на душу населення, співвідношення позик до ВВП, індекс легкості ведення бізнесу та банківська кредитна ставка. Показано також прямий вплив між динамікою рівня інфляції в країні, динамікою обсягів непрацюючих банківських кредитів та їх вартістю.

Ключові слова ціна кредитів, банківська кредитна ставка, динаміка банківських кредитних ставок, банківські кредити, макроекономічні чинники

Класифікація JEL C82, D53, G21

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Received on: 07th of July, 2020
Accepted on: 14th of December, 2020
Published on: 31st of March, 2021

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http://dx.doi.org/10.21511/ed.19(4).2020.04

INTRODUCTION

The distinctive features of the modern development of Ukrainian banks are the growing volumes of the banking business, increased competition and, at the same time, increased credit risks. All of that makes it difficult for banks to maintain financial stability and getting profits.

Pricing of banking products is a key element in determining the desired level of bank profitability. Moreover, interest rates on bank loans are a macroeconomic indicator and characterize the cost of borrowing for the real sector of the economy. A bank can vary prices in a wide range, using prices as an important tool of attracting customers and promoting services. Pricing is one of the most important aspects of the bank's marketing activities, as well as a control lever that allows you to generate the amount of the bank's profit.

Credit services are the main source of income for banks. In the context of pricing for credit services, banks develop a credit strategy and choose the method of estimating the interest rate on the loan. Identifying factors influencing the cost of bank loans, generalizing trends and directions of such influence in different countries and in Ukraine will facilitate the search for problematic areas that systematically restrain the rise or fall of interest rates on loans and hinder lending activity in the country. All this determines the relevance of the chosen research topic.

1. LITERATURE REVIEW

The theoretical and practical aspects of the banks functioning and pricing of banking services were described in the following works.

General issues of banks' activity are covered in the works of Dziubliuk et al. (2017), Hlushchenko (2015), Kovalenko (2016), Lutsiv (2018), Savluk and Moroz (2009), Mykhailyak and Mykhailyak (2018) and others.

The pricing issue in the banking sector is studied by such authors as: Kuznetsova; Zherdetskaya; Lepushinsky; Malakhova; Maslak and Kryklij; Mishchenko, Naumenkova; Ahrend; Catte, Price and others.

In their works are considered: the formation and development of the banking system of Ukraine with the allocation of a system of measures to improve risk management and corporate governance in banks (Mishchenko & Naumenkova, 2016); pricing of banking products, factors, methods and pricing mechanisms from a theoretical and methodological point of view (Maslak & Kryklij, 2010), (Ahrend, Catte & Price, 2006); management of the bank's loan portfolio, including determination of its profitability and methods of pricing on loans (Prymostka, 2012), (Kuznetsova & Zherdetskaya, 2016); the essence and types of interest rate policy of the bank at the macro- and micro- levels, the factors that determine it (Malakhova, 2015), (Lepushinsky, 2012), etc.

Researchers focus on the theory and methodology of pricing, or on the applied experience of a particular country (including Ukraine). At the same time, in our opinion, it is necessary to expand the scope of statistical analysis of the impact of various factors on the cost of bank loans to generalize the trends of such impact based on both international and Ukrainian practice.

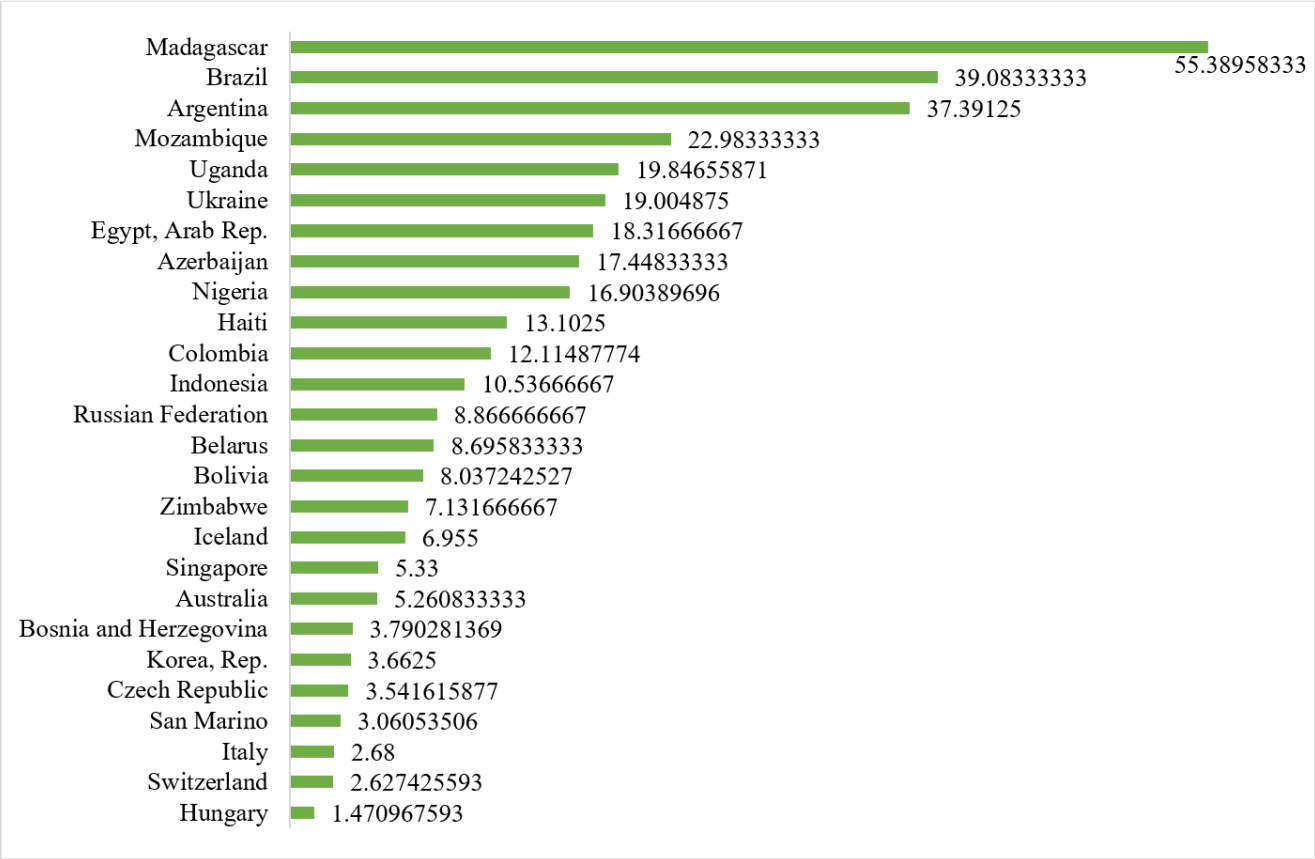
These reasons determine the relevance and the purpose of the article, which is to reveal the links between the dynamics of macroeconomic indicators and the level of bank lending rates in international and Ukrainian practice. This will help to identify the key trends in the formation of the price of loans in the long run and problematic issues that systematically restrain the growth or decline of interest rates on loans and hinder lending activity in Ukraine.

2. RESULTS

The bank loans rate can be considered as indicators of financial markets development in a particular country and in the particular region or globally. As a common rule, countries with low bank loans rates are more economically developed than countries with high bank loans rates.

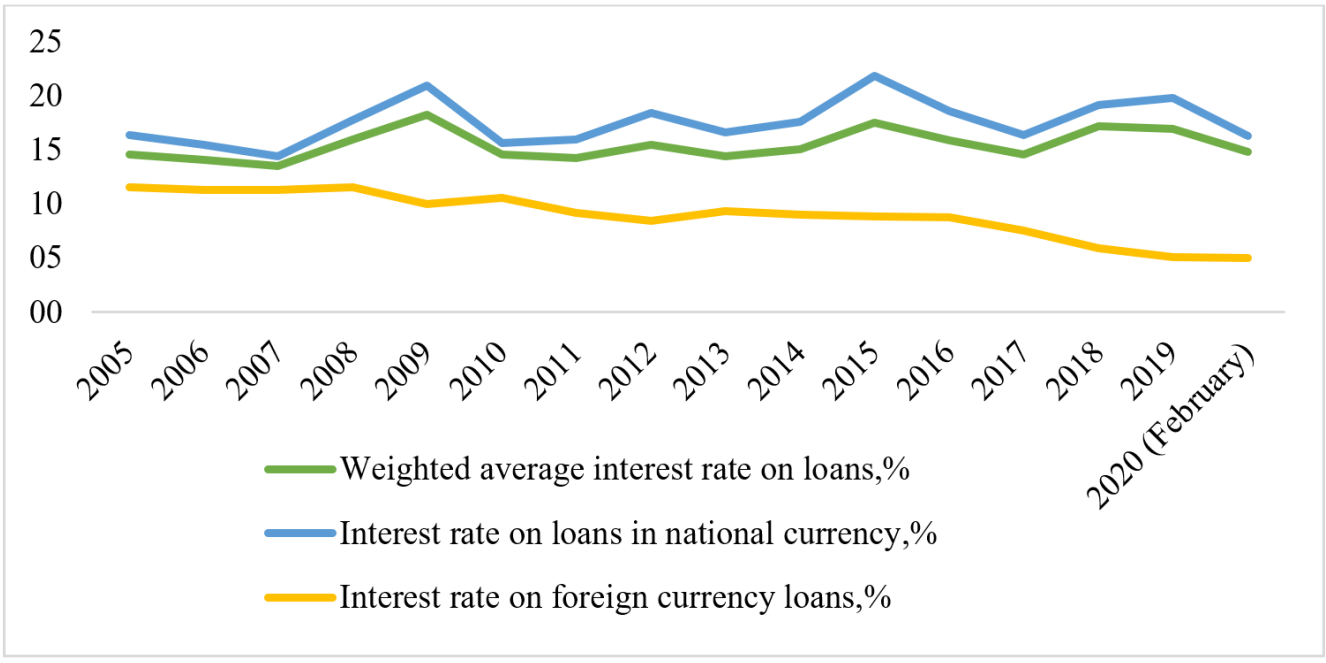
http://dx.doi.org/10.21511/ed.19(4).2020.04

Ukraine belongs to the group of countries with relatively high bank loans rates, along with Uganda, Egypt, Mozambique, and Azerbaijan. Countries such as Brazil (39%), Argentina (37%) and Madagascar (55%) have the highest bank loans rates in the world. Instead, the countries of Western Europe, such as Switzerland, Italy, Hungary and others have low bank loans rates (Figure 1).



Source: Based on the World Bank Group (n.d.).

Figure 1. Bank loans rates worldwide in 2018, %



Source: Based on the National Bank of Ukraine data (n.d.).

Figure 2. Dynamics of bank loans rates by currency for the period from 2005 to 2020, %

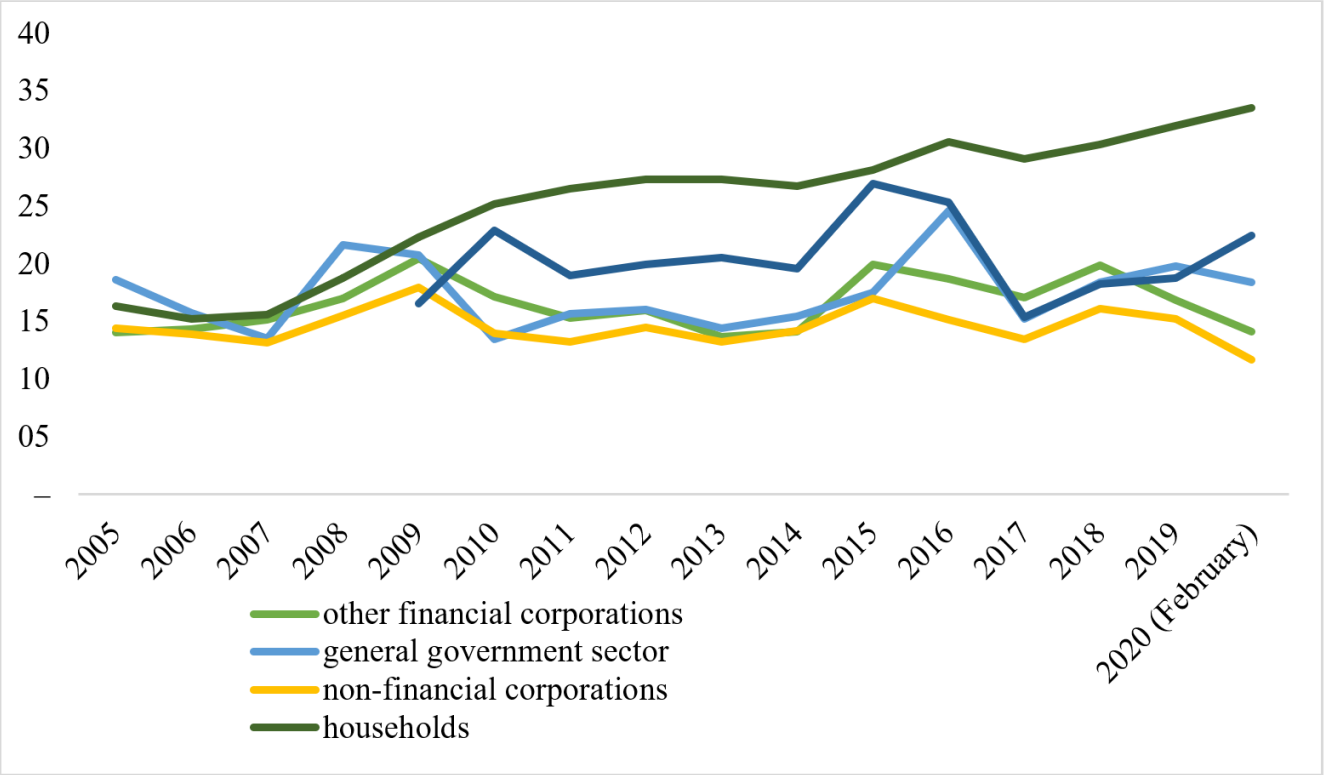
In Ukrainian practice, the weighted average bank loans rate changes quite sharply from year to year, depending on the period of development of the Ukrainian economy (see Figure 2). Moreover, the average weighted bank loans rate became relatively high during the crisis of 2008–2009 (18.3%) and the crisis of 2014 (17.5%).

Given the time fluctuations of bank loans rate and its dependence on the lending currency, it should be noted, that the dynamics of rates in national currency is significantly different compared to the dynamics of rates in foreign currency, usually US dollars (see Figure 2). In particular, there is a sustainable annual reduction in bank loans rates on foreign currency loans. Such tendency could have been caused due to several reasons:

- demand decline for foreign currency loans due to significant exchange rate fluctuations and devaluation of the hryvnia in 2008 and 2014;
- reduction of the foreign currency loans to individuals supply from the banks' side caused by the National Bank of Ukraine's (NBU) ban on such lending;
- reduction of the interest rate on foreign currency deposits.

Therefore, Figure 2 shows that the dynamics of the weighted average loans rate is similar to the dynamics of the loans rate in the national currency, which indicates that the lion's share of the loans is issued in the national currency. Each year the total loans contain fewer foreign currency loans in absolute terms. That is why the significant reduction in the loans rate on foreign currency loans has had a smaller impact on the weighted average loans rate throughout the banking system.

Exploring the loans rate dynamics by sectors of the economy (see Figure 3), it should be noted that the highest loans rate is offered by banking institutions to households – due to the high risk of insolvency of individual borrowers and the fact that banks (in the absence of collateral property) are forced to transform their potential risks into the form of additional interest (Prymostka, 2012). Instead, banks offer the lowest loans rates to the non-financial corporations' sector, namely to business entities operating in Ukraine.



Source: Based on the National Bank of Ukraine data (n.d.).

Figure 3. Bank loans rates by the economy sectors for the period from 2005 to 2020, %

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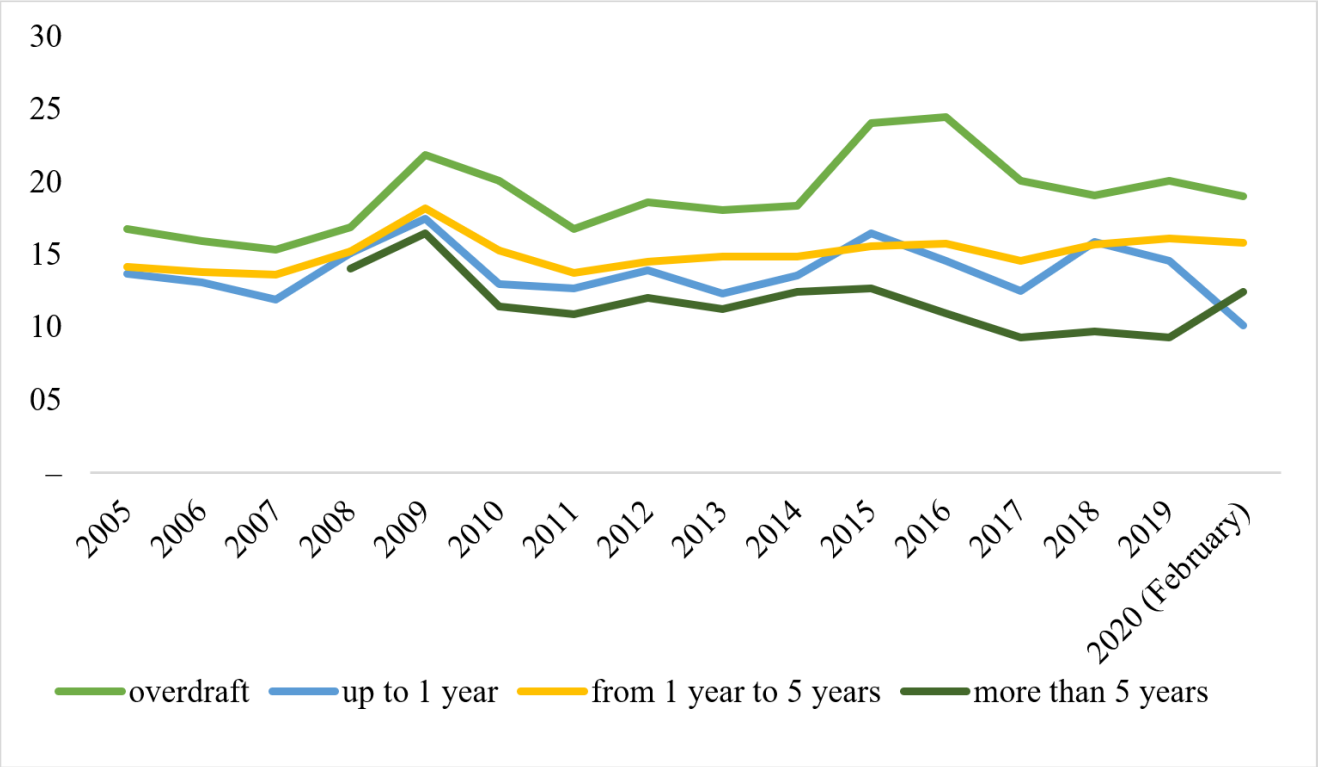
In the context of the loans rate dynamics by the loan maturity (see Figure 4) in Ukraine, the overdraft loans and loans from 1 to 5 years (except for certain time periods when the loan rate for loans up to 1 year exceeded the one for loans from 1 year to 5 years – in 2014-2015, 2018) have had the highest bank loans rates.

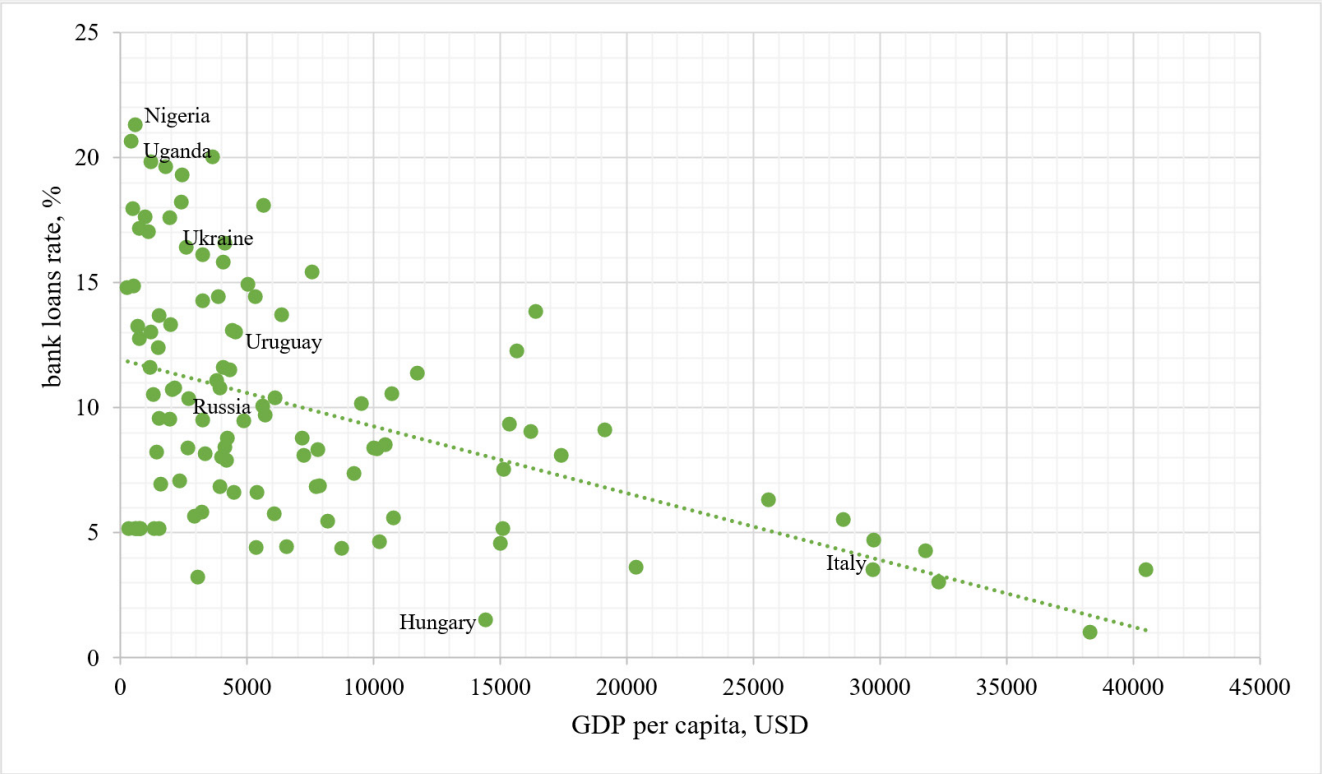


Source: Based on the National Bank of Ukraine data (n.d.).

Figure 4. Bank loans rates by maturity for the period from 2005 to 2020, %

Studying the individual characteristics of the level of bank loans rates in different countries, it should be noted that this indicator depends on many macroeconomic factors and institutional characteristics inherent for each country. However, if we consider the experience of many countries (122-127 countries in different phases of their development as of 2018) as a set of data, we can trace the patterns of price formation for bank loans for the future and identify problematic issues (that restrain the growth or decline of bank loans rates in Ukraine):

I. There is a relationship between the GDP per capita and bank loans rate (see Figure 5). The global trend indicates a negative correlation between the studied indicators. It means: the higher is the GDP per capita, the lower the loans rate is. This dependence is explained by a number of reasons. First, economically developed countries have a high level of capital accumulation, so, respectively, the marginal return on new investment is low, compared to developing countries (Kovalenko, 2016). Secondly, a high level of GDP per capita automatically carries information about the development of the financial system, social institutions of the country and so on.



Source: Based on the World Bank Group (n.d.).

Figure 5. Relationship between GDP per capita and bank loans rate (122-127 countries in different phases of their own development as of 2018)

The correlation coefficient between the proposed factors is -47.9%. But the final conclusions about the absence of relationship should not be made, because the graph shows a nonlinear connection. Instead, the correlation indicates a linear connection.

II. Figure 6 shows the correlations between the inflation and loans rate (according to the World Bank data on 127 countries). We observe a high density of the direct relationship between the analyzed factors – there are lower bank loans rates in countries with lower inflation.

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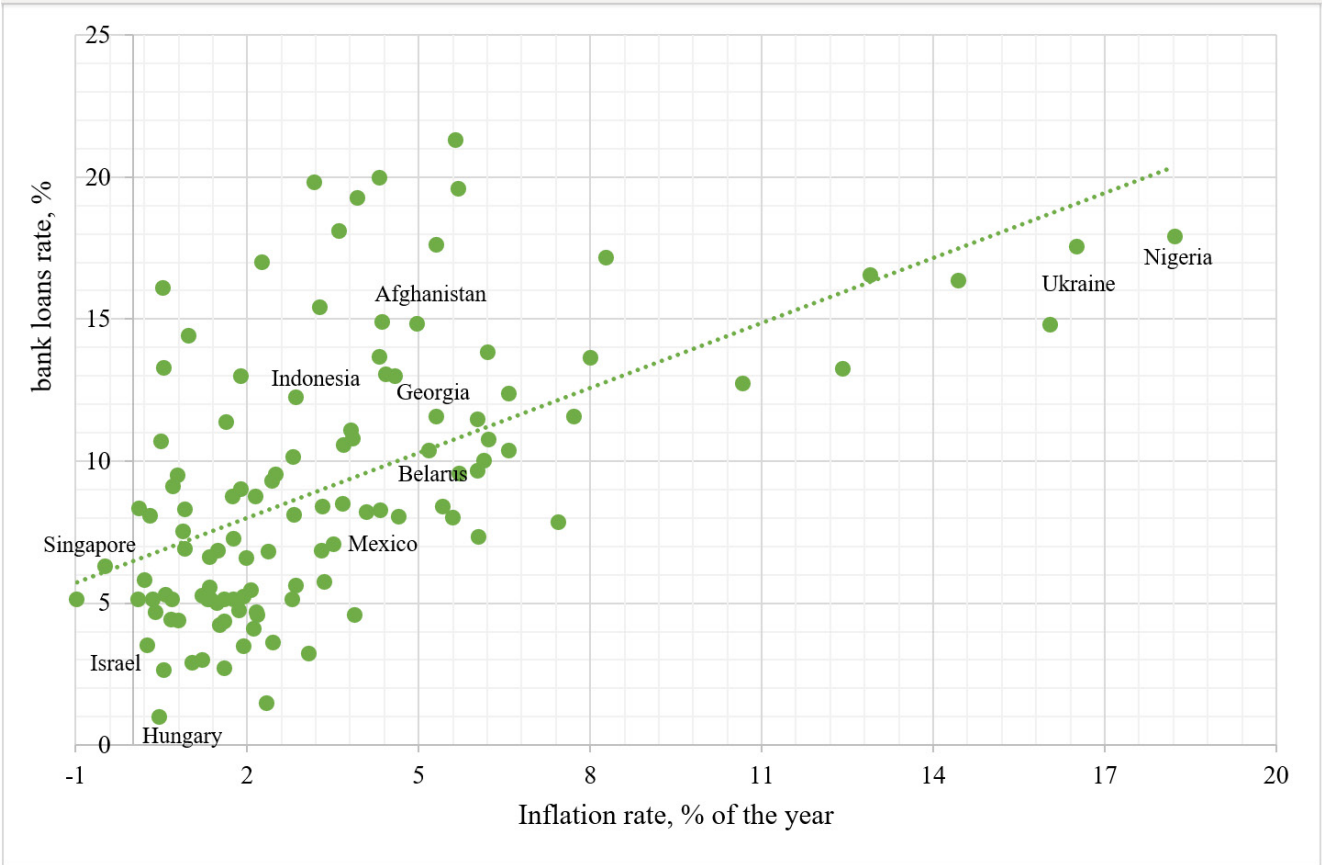
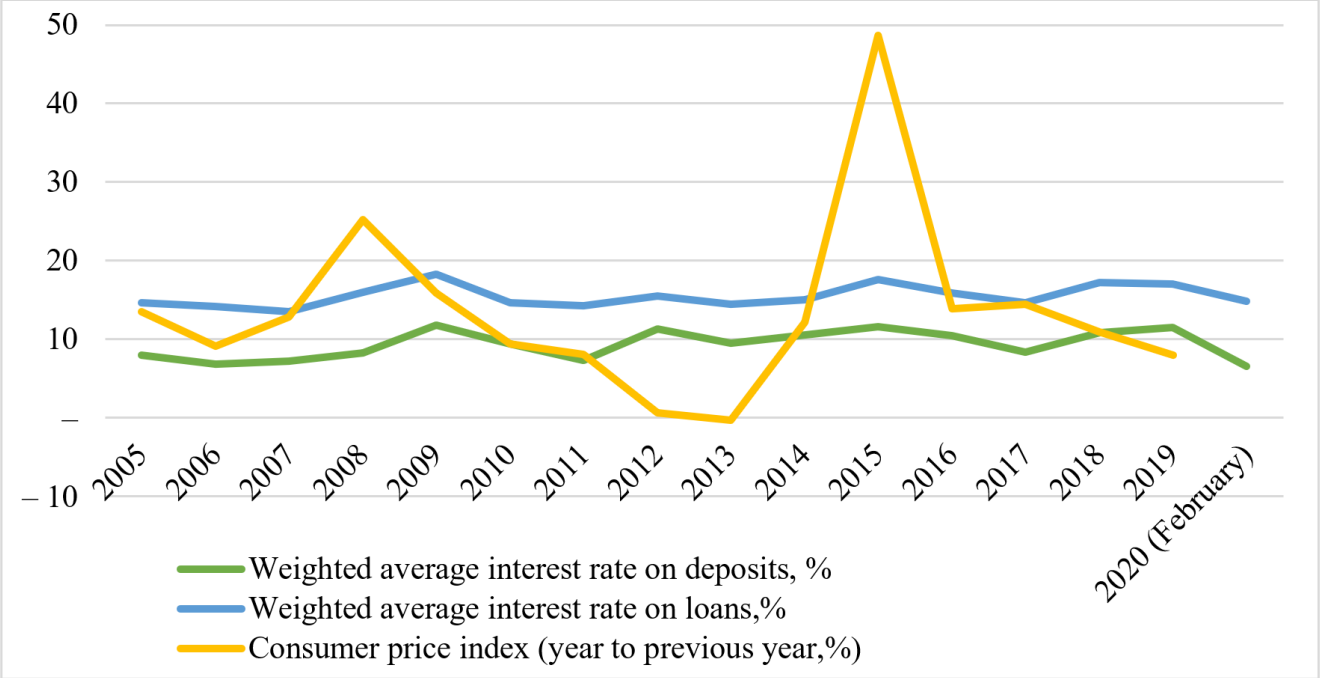


Source: Based on the World Bank Group (n.d.).

Figure 6. Relationship between the inflation rate and bank loans rate (122-127 countries in different phases of their development as of 2018)

This finding could be explained primarily due to the fact that inflation determines the value of money raised by banks as well as benchmarks for the desired level of banks' profitability in providing credit services. The correlation coefficient between the analyzed factors is 52.3%.

Ukraine itself belongs to the group of countries with high inflation and high bank loans rates. The dynamics of the relationship between inflation and bank loans rates in Ukraine in more details is shown in Figure 7.



Source: Based on the National Bank of Ukraine data (n.d.).

Figure 7. Dynamics of inflation bank loans and bank deposits rates in 2005–2020, %

After the implementation of the inflation targeting regime in Ukraine, inflation has become the main anchor of economic agents' expectations in Ukrainian business practice. Inflation also affects the decisions of commercial banks on the bank rates on credit services at the micro level when calculating the projected level of profitability. Figure 7 shows that the peak inflation rates took place in times of the 2008 and 2015 crises, and, at the same time, the price of loans was the highest. Now, due to the mitigation of inflationary pressures during 2018–2020, the NBU is easing monetary policy by lowering the discount rate, which will be transformed into lower loans rates. Ensuring price stability through the NBU's inflation targeting policy will continue to form the preconditions for the possibility of reducing the price of credit resources in Ukraine.

III. Another indicator of financial sector development is the ratio of total loans to GDP (Kuznetsova & Zherdetskaya, 2016; Lepushinsky, 2012). The study of the correlation between the ratio of loans to GDP and loans rates in 122 countries (see Figure 8) shows the inverse relationship between these indicators: the higher the level of creditworthiness of the economy, the lower the bank loans rates.

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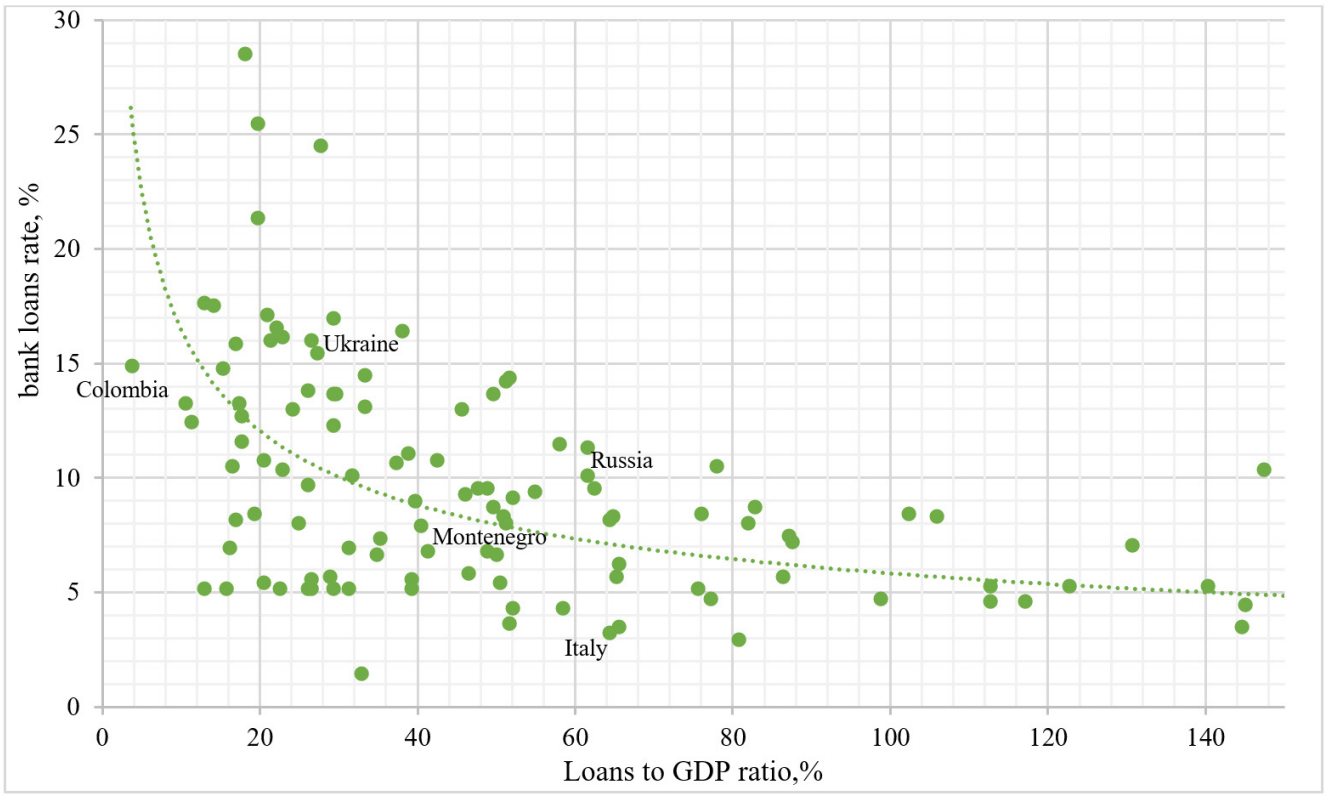


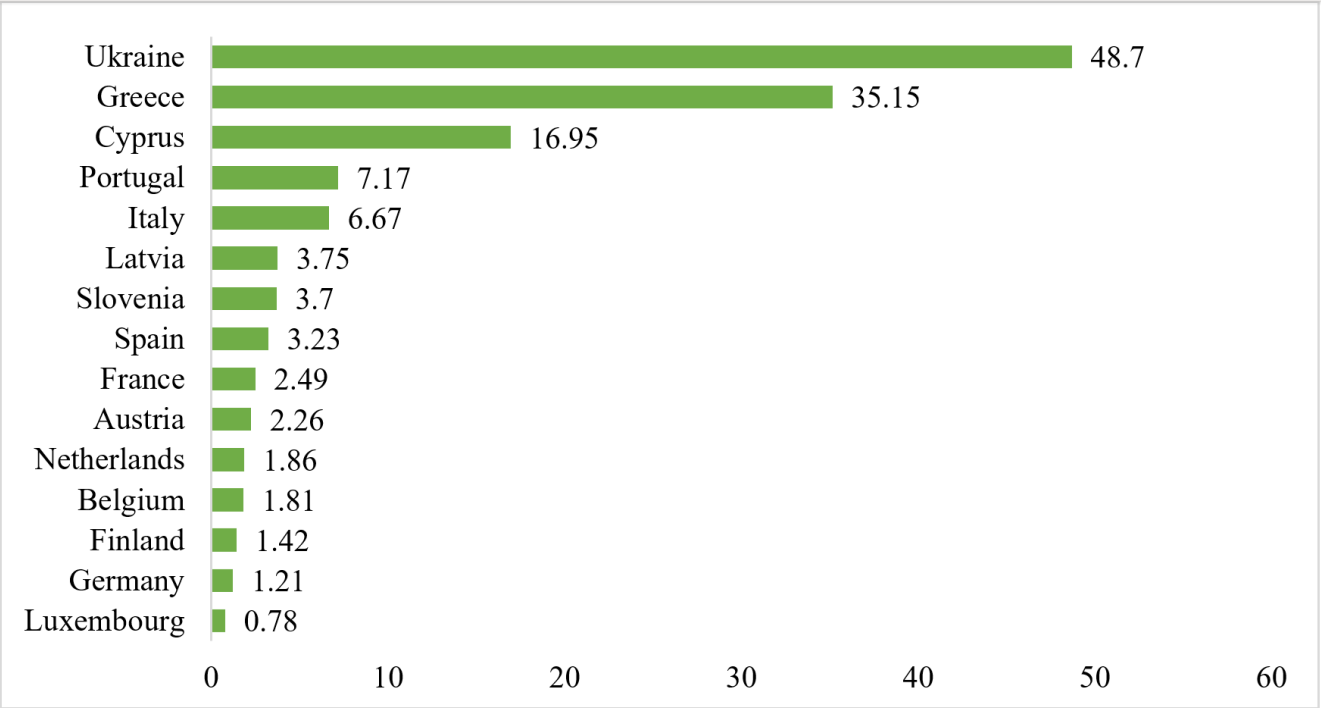
Source: Based on the World Bank Group (n.d.).

Figure 8. The relationship between the level of creditworthiness of the economy and bank loans rate (122-127 countries in different phases of their development as of 2018)

The results can be explained by the fact that better developed financial sector provides a high level of competition in banking services, which leads to lower market profitability of a bank, reflecting the interest margin and bank loans rate (Ahrend, Catte, & Price, 2006). The correlation coefficient between the proposed factors is -40.2%. However, the final conclusions about the lack of connection should not be made, because the graph shows some kind of a nonlinear connection, but the correlation indicates a linear connection.

Loans to GDP ratio remains relatively low in Ukraine (38% – the same as in Indonesia, Mexico and Egypt) due to weak public confidence in financial institutions (including banks) compared to highly developed countries (e.g., in the United States the volume of loans to GDP is 198%).

On the other hand, in Ukraine banks have a low level of confidence in borrowers, so banks' intention to lend to them is low due to high credit risks. In particular, the share of non-performing loans is a confirmation of the high level of credit risks on the part of borrowers for commercial banks (Figure 9).



Source: Based on the National Bank of Ukraine data (n.d.).

Figure 9. Share of non-performing loans in the total amount of loans issued at the end of 2019, %

Figure 9 shows that among European countries Ukraine has the highest share of non-performing loans (NPL). This situation increases the risk of the loan portfolio, affecting the price of lending resources for business entities. The slow decline in the share of non-performing loans does not allow a rapid reduction in bank loans rates to the desired level due to high systemic credit risk.

These trends restrain the rate of decline in bank loans rates.

IV. The size of the bank risk premium is determined not only by institutional factors in bank lending but also by the general business environment in a particular country. It is worth taking into account the fact that when granting loans banking institutions assess the borrowers' risk of doing business because his financial condition directly depends on it. Accordingly, countries with better business conditions should have lower bank loans rates. It is shown in Figure 10 that there is an inverse correlation between the index of ease of doing business and the bank loans rate.

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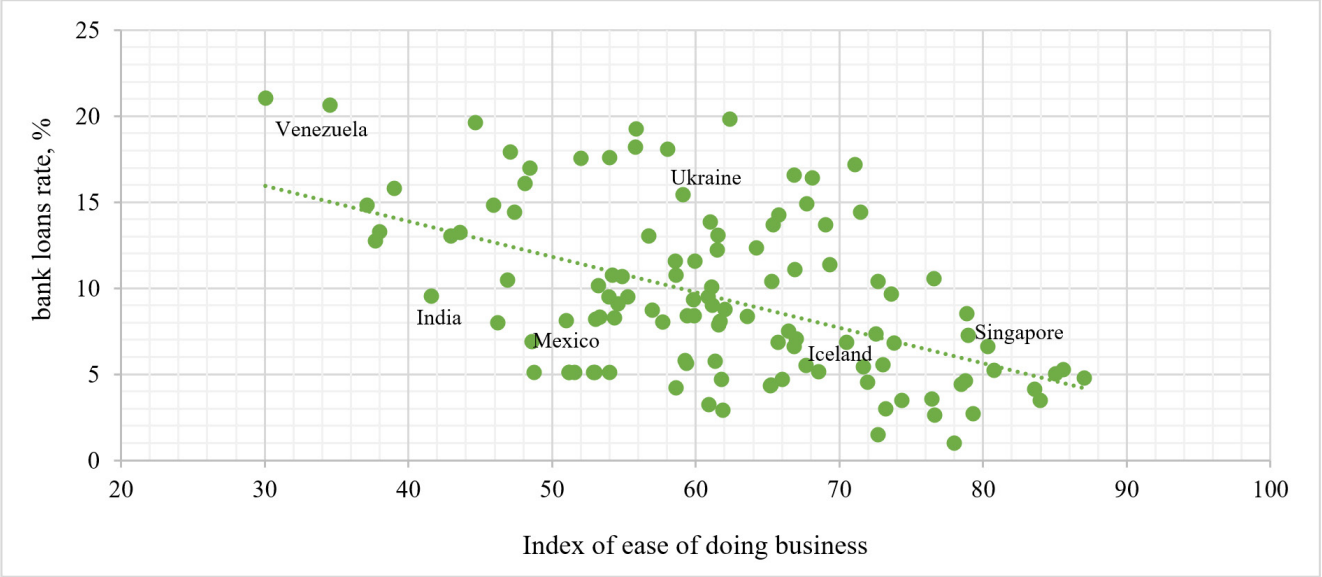

Source: Based on the World Bank Group (n.d.).

Figure 10. The relationship between the ease of doing business index and the bank loans rate (122-127 countries in different phases of their development as of 2018)

The correlation coefficient between the proposed factors is 51.5%. When calculating the ease of doing business index, the World Bank takes into account a number of institutional factors, which are mainly tied to the legislation of a particular country. It follows that the insufficient legal framework for the protection of investors' rights, obtaining loans, registration and protection of property rights, resolving insolvency problems, etc., are the factors of pressure on a possible reduction of bank loans rates in Ukraine.

CONCLUSIONS

Having researched the relationship between the dynamics of macroeconomic country's development indicators and the level of bank loans rates, based on international and Ukrainian practice, we conclude the following.

1. In the context of the Ukrainian experience, the main trends in the bank sector's loans rates are:
a) Ukraine belongs to countries with high bank loans rates;
b) there are instability and sharp changes in the dynamics of the weighted average bank loans rate from year to year;
c) bank loans rates for households are higher compared to the cost of bank loans for businesses;
d) bank loans rates for short- and medium-term loans are higher versus for long-term ones;
e) bank rates on loans in foreign currency are lower compared to the loans in hryvnia;
f) there is a high share of non-performing loans to households and businesses in bank portfolios.

2. In the context of the world and Ukrainian practice a direct and (or) reverse effect between the dynamics of macroeconomic and institutional indicators of the country's and the level of bank loans rates are revealed:
a) the reverse effect between macroeconomic indicators GDP per capita, loans to GDP ratio, and the ease of doing business index and bank loans rate is identified and statistically demonstrated;
b) the direct effect between the dynamics of the inflation rate in the country, the dynamics of non-performing loans (NPL) and bank loans rate is identified and statistically identified.

In general, the dependences that are shown in Figure 5, 6, 8, 10 and the correlation coefficients indicate a greater influence on the cost of bank loans is being made by factors such as inflation and ease of doing business, and a smaller influence of factors such as GDP per capita and the share of loans in relation to the country's GDP.

3. According to the above-mentioned relationships and trends, a significant "natural" reduction of loans rates in Ukraine could be expected, provided:
a) the introduction of the state regulation measures in the monetary and other sectors of the economy aimed at reducing inflation in the country;
b) the implementation of the structural reforms focused on general economic development and raising the standards of life in Ukraine. This will lead to the increasing of the number of potential reliable borrowers on the market of banking credit services (and as a result – to the reduction of the credit risk);
c) the intensification of banks' actions targeted to reduce the share of non-performing bank loans;
d) the simplification of the legal, infrastructural and institutional conditions for doing business in the country etc.

4. The study areas, which can become further research based on this article:
a) modelling and assessment of the intensity of influence between the dynamics of macroeconomic indicators and bank loans rates in Ukrainian and international practice; identification of the most and the least significant factors;
b) modelling and assessment of the intensity of influence between the banking system activities indicators and bank loans rates;
c) analysis of regulatory policies in the global and Ukrainian practice to intensify and reduce the cost of bank lending services.

AUTHORS CONTRIBUTIONS

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“Trends in the developing Ukrainian non-bank financial service markets assessed using a mixture separation method”

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ARTICLE INFO	Nataliya Vnukova and Robert Bacho (2020). Trends in the developing Ukrainian non-bank financial service markets assessed using a mixture separation method. *Economics of Development*, *19*(4), 48-60. doi:10.21511/ed.19(4).2020.05
DOI	http://dx.doi.org/10.21511/ed.19(4).2020.05
RELEASED ON	Tuesday, 18 May 2021
RECEIVED ON	Wednesday, 20 May 2020
ACCEPTED ON	Monday, 07 December 2020

JOURNAL	"Economics of Development"
ISSN PRINT	1683-1942
ISSN ONLINE	1683-1942
FOUNDER	Simon Kuznets Kharkiv National University of Economics

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
19	2	1

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TRENDS IN THE DEVELOPING UKRAINIAN NON-BANK FINANCIAL SERVICE MARKETS ASSESSED USING A MIXTURE SEPARATION METHOD

Abstract

Non-bank financial institutions play an important role in the non-bank financial service markets expressed in expanding the access to financial services for individuals and legal entities. The non-bank financial service markets demonstrate their performance peculiarities in the pre-crisis and post-crisis periods that bring up to date the need to form a scientific presentation of their development trends. Therefore, it is necessary to provide scientific background and identify the regress and progress processes in the non-bank financial service markets.

The research aim is to develop an analytical approach to determining the peculiarities of the development processes in the non-bank financial service markets. The research assesses the key indicators of the non-bank financial service markets in terms of quantity by dividing a set of values into groups by cluster analysis and multidimensional object clustering by a system of indicators, as well as identifying the progress and regress patterns in the non-bank financial service markets.

Achieving the research results requires taking into account the above-mentioned objectives fulfilled in seven stages.

The research results reflect the influence on the financial service markets exerted by the governmental regulation policy and the consumer protection level in these markets.

Keywords financial services, non-bank institutions, insurance, credit unions, regulation

JEL Classification G23, G28

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ОЦІНКА ТЕНДЕНЦІЙ СУЧАСНОГО РОЗВИТКУ РИНКІВ НЕБАНКІВСЬКИХ ФІНАНСОВИХ ПОСЛУГ УКРАЇНИ ІЗ ЗАСТОСУВАННЯМ МЕТОДУ З РОЗДІЛЕННЯ СУМІШІ

Анотація

Небанківські фінансові установи відіграють важливу роль на ринках небанківських фінансових послуг щодо розширення доступу фізичних та юридичних осіб до фінансових послуг. Враховуючи особливості функціонування небанківських ринків фінансових послуг у докризовий та посткризовий період, актуалізується необхідність формування наукової формалізації тенденцій їх розвитку.

Таким чином, дослідження, присвячені науковій аргументації та встановленню процесів регресу та прогресу на небанківських ринках фінансових послуг є необхідними.

Метою дослідження є розробка аналітичного підходу для визначення особливостей процесів розвитку небанківських ринків фінансових послуг. У дослідженні проведено кількісну оцінку ключових індикаторів розвитку небанківських ринків фінансових послуг шляхом розподілу показників на групи з використанням кластерного аналізу та багатовимірної кластеризації об'єктів за системою показників, а також виявлення закономірностей прогресу та регресу на ринках небанківських фінансових послуг.

Отримання результатів може бути досягнуто з урахуванням вищезазначених передумов з їх виконанням у сім етапів.

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Received on: 20th of May, 2020
Accepted on: 07th of December, 2020
Published on: 18th of May, 2021

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http://dx.doi.org/10.21511/ed.19(4).2020.05

Результати дослідженння визначають вплив політики державного регулювання на ринки фінансових послуг та рівень захисту прав споживачів на досліджуваних ринках.
Отримання бажаних результатів дослідження може бути отримано з урахуванням вищезазначених цілей та виконання їх у сім етапів.
Результати досліджень визначають вплив політики державного регулювання на ринки фінансових послуг та рівень захисту прав споживачів на досліджуваних ринках.

Ключові слова фінансові послуги, небанківські фінансові установи, страхування, кредитні спілки, регулювання

Класифікація JEL G23, G28

INTRODUCTION

In modern conditions of deepening economic relations, non-bank financial institutions play an important role in the markets of non-bank financial services (NBFS) displayed in expanding the access to financial services for individuals and legal entities. The functioning of these institutions helps to stimulate financial and economic relations between economic entities at the micro-, meso- and macroeconomic levels. Given the volatility of the basic factors influencing the non-bank financial service markets, there is a need to identify these factors as well as the trends in internal processes occurring in the NBFS markets. The global financial and economic crisis of 2008–2009 showed the vulnerability of domestic financial service markets and their dependence on external influences. Negative expectations of deteriorating economic conditions in the world and Ukraine, in particular, due to the negative impact of coronavirus disease, create new challenges for government regulation in the NBFS markets.

To establish clear recommendations by state regulators for non-bank financial service markets, the latter need to identify changing conditions in the studied markets in a timely manner. Therefore, the research works devoted to scientific argumentation and establishment of regress and progress processes in the NBFS markets are updated.

1. LITERATURE REVIEW

This research included the scientific works by Maliarets (2006), Maliarets (2008), Ponomarenko and Maliarets (2009) devoted to systematization and development of economic and mathematical models representing the development trends of the chosen research targets in retrospect.

Masciandaro and Quintyn (2009) as well as Čihák and Podpiera (2006) considered the possibility of introducing a single regulator (megaregulator) in the financial service markets with a view to a new financial architecture. Ingves (2011) studied the impact of the new Basel standards on the stability of banking financial institutions and confirmed the need to improve the existing banking regulation. Goodhart and Tsomocos (2012) explored the issue of ensuring financial stability in the financial service markets, assessing the regulatory impact on the development of the studied markets.

The development trends of the financial service market have been influenced by the reformed international AML system with the adaptation mechanism introduction in the state regulation sphere representing one of its elements. Ponomarenko et al. (2019) assessed the impact exerted by the level of state regulation and supervision on the development of the risk-oriented AML system based on a five-level hierarchical model applied to the development of this system using Saati's hierarchy analysis method.

The current transformation stage in the financial service market following the introduced risk-oriented approach in Ukraine is marked by changes in the financial monitoring system as evaluated by Vnukova et al. (2020) through to the probable determination of the connectivity among insurance companies using the graph theory tools and indicator markers.

Macroprudential features seen in the regulation of the financial service markets are revealed in Hirtle et al. (2009). Kolodiziev and Lozynska (2020) and other researchers explored current trends in the digital transformation (digitalization) of the financial service market and the peculiarities of changes in the banking system.

The works presented by the above-mentioned scientists do not provide means for determining the development features peculiar to the non-bank financial service markets taking into account the possibilities of the improvement dynamics or deterioration of the basic indicators which characterize the performance of the non-bank financial service markets. Therefore, it is necessary to develop a special analytical and information approach that will reflect the above patterns.

2. AIMS

The research is aimed at developing an analytical approach to determine the peculiarities of the development processes in the NBFS markets, which assesses the key indicators of the NBFS markets quantitatively by dividing the set of values into groups with the help of cluster analysis and multidimensional clustering of objects by a system of indicators, as well as identifying patterns of progress and regress in the non-bank financial service markets.

3. METHODS

The scientific advances in Ponomarenko and Maliarets (2009) formed a base for building the law of value distribution with regard to each of the studied indicators applicable to the NBFS markets. It is possible to confirm or refute the existing homogeneity or heterogeneity against an array of statistical samples while calculating the normal distribution for the selected indicators.

Summarizing the primary information collected and published on the official website of the body that carried out state regulation of the financial service markets in Ukraine for 2006–2018 provided a set of statistical information for the study.

A hypothesis about the simultaneous existence of several distribution laws is formed by solving a mathematical problem on the distribution of a mixture proposed by Pearson (1986). The differential and integral distribution functions of a mixture of two components are expressed as a linear combination of normal distributions, by determining certain parameters based on the method of moments. The set of values is divided into groups by means of cluster analysis using a centroid connection and Ward's method (Brucker, 1974). Finally, the multidimensional clustering of objects by a system of indicators (Anderberg, 1973) makes it possible to establish the course of two opposite processes, namely, progress and regress.

The desired research results can be obtained taking into account the above objectives and fulfilling them in the following sequence: analyzing scientific and statistical sources to choose the indicators applied for assessing the development of the NBFS markets while forming a system of indicators to assess their development; establishing laws for the distributed values of each studied indicator of the NBFS markets; forming a hypothesis about the simultaneous existence of several distribution laws for each of the indicators; dividing the set of indicator values into groups by solving the problem of mixture division; building laws of value distribution of an indicator in each cluster; calculating the centroid values in each cluster of indicator values; determining the type of development process for the specific indicators of the NBFS markets, namely, progress or regress, building a dendrogram that reflects the stratification of indicator values; grouping the indicators that characterize specific NBFS markets and carrying out cluster analysis, selecting clusters, determining the value of their centroids; determining the development process type for certain NBFS markets, building a dendrogram that reflects the stratification of objects by clusters.

4. RESULTS

The existing performance peculiarities of the non-bank financial service (NBFS) markets in the pre-crisis and post-crisis periods actualize the need to form a scientific presentation of their development trends. Given that the

http://dx.doi.org/10.21511/ed.19(4).2020.05

NBFS markets are described by the heterogeneity of characteristics (each of these markets has its own economic nature of operation) (Pukala et al., 2019) and a broad set of indicators (specific indicators for each of the markets differ from the economic content of the other market), and since the existing scientific approaches illustrate the lack of tools to identify the relationship building among various features aimed at determining the main factors (Maliarets, 2008) that drive the development of the NBFS markets, the need to specify approaches to the analytical presentation of such changes becomes urgent.

To represent the development trends of the NBFS markets in Ukraine as following from the scientific developments (Maliarets, 2006; Ponomarenko & Maliarets, 2009), the authors have formed an analytical approach, the use of which involves several stages.

Stage 1. Forming a system of indicators that characterizes the performance of the NBFS markets. The list of indicators with the assigned symbols that have been analytically processed is based on the existing data presented in Table 1.

Stage 2. Building a value distribution law for each of the selected indicators. Confirmation or refutation of the homogeneity or heterogeneity of the statistical sample array (Maliarets, 2006) while calculating the normal indicator distribution ($x_1 \ldots k_{14}$).

The calculation of the normal indicator distribution ($x_1 \ldots k_{14}$) provides means for confirming or refuting the existing homogeneity or heterogeneity of the statistical sample array (Maliarets, 2006). Confirmed or refuted, the heterogeneity of the statistical sample array (inhomogeneous arrays differ at least by a vector of averages) indicates the existence or absence of several normally distributed subsets, respectively.

Stage 3. Forming a hypothesis of several distribution laws that operate simultaneously. By confirming or refuting this hypothesis, the existence of different processes has been scientifically proved, which in turn leads to the conclusion about the presence/absence of structural changes in the respective NBFS market. For this reason, it is necessary to divide the present sets by solving a mathematical problem on the mixture division proposed by Pearson (Rissanen, 1986). The scientist suggests the representation of asymmetric distributions of the mixture by two normal laws (Ponomarenko & Maliarets, 2009), i.e. two separate normal distributions can be uniquely restored by the mixture distribution (Maliarets, 2006).

The differential and integral distribution functions of a mixture of two components are expressed as a linear combination of normal distributions containing 5 parameters (Maliarets, 2006):

$$f(x) = p_1 \cdot f_1(x) + p_2 \cdot f_2(x), \quad (1)$$

$$F(x) = p_1 \cdot F_1(x) + p_2 \cdot F_2(x), \quad (2)$$

where $f_i(x) = \frac{1}{\sqrt{2\pi} \cdot \delta_i} \exp\left\{-\frac{(x-a_i)^2}{2 \cdot \delta_i^2}\right\}$, $F(x) = \int_{-\infty}^{x} f_i(t)dt$, p_1, p_2 – probabilities by which the normall y distributed components are mixed, with $p_1+p_2=1$, a_i – mathematical expectations of individual distributions, δ_i – mean squared deviations of the individual distributions.

While determining the parameters of individual distributions, the method of moments was applied. The smoothed function for each of the studied indicators is represented in Figure 1. The obtained graphs of the smoothed functions prove the existence of several sets of features, which is confirmed by the pronounced "breaks" (waveform) of the built graphs for each of the studied parameters. In order to represent such changes numerically, it is necessary to separate the sets into corresponding groups by means of cluster analysis.

Stage 4. Dividing the set of values into groups by cluster analysis. It is proposed to use cluster analysis at this stage, which will offer a means for determining the number of components and their composition based on the mixture data. This approach rests upon the fact that over the last decades, significant progress has been made in cluster analysis, and some current varieties of analysis are credible in the classification objectivity. Within the scope of

cluster analysis, one of the main basic points of qualitative calculation and results presentation is the choice of the distance between the groups of objects (clusters), which may include about twelve different methods, the most common of which are centroid linkage and Ward's method. The first method is characterized by comparing the distance between their centers, and the second one determines the proximity of the two clusters by combining them and determining the minimum increment of the total variance. The advantage of using Ward's method to classify objects while measuring the feature size is expressed by the ability to identify clusters of nearly the same size (Ponomarenko & Maliarets, 2009).

Stage 5. Calculating the numerical characteristics for each subset of the indicator values. Given that the analytical potential of solving the mixture split problems is the ability to separate subsets in the aggregate of the statistical information set and calculate the statistical characteristics of individual subsets, it is necessary to study the magnitude of the characteristics shown by specific indicators and determine the levels of indicator values that characterize the NBFS markets. For this purpose, the obtained calculations have been summarized in Table 1 from which it is seen that the data set of each indicator can be represented by two clusters. At the same time, one can distinguish certain features inherent in the process of indicator clustering.

Firstly, several indicators are divided by cluster analysis into two clusters, and in a chronological framework this is continuous, otherwise speaking, the set of features (years of study) in Cluster 2 represents a continuation of the Cluster 1 set of features. Such indicators are as follows (see the data in Table 1): x_2 (non-bank financial institutions' assets), y_2 (a volume of the non-state pension insurance market), z_3 (a premium volume of the risk segment), z_7 (assets of insurance companies belonging to the risk segment), z_8 (a share of technical provisions in the total insurance reserves), z_9 (a share of the risk insurance companies' assets in the insurers' total assets), z_{10} (a share of the risk insurance companies' reserves in assets), v_2 (a volume of life insurance premiums), v_3 (a share of life insurance premiums in gross premiums), v_4 (a volume of insurance payments), v_5 (a volume of redemption amounts), v_6 (a volume of insurance indemnities and redemption amounts), v_8 (a volume of mathematical insurance reserves), v_9 (life insurance assets of the insurance companies), v_{12} (HHI of life insurance), g_1 (a number of the issued certificates of mandatory third-party insurance coverage), g_2 (total premiums derived from mandatory third-party insurance coverage), g_3 (total insurance indemnities derived from mandatory third-party insurance coverage), g_5 (an average value of mandatory third-party insurance coverage), g_6 (a number of settled cases of mandatory third-party insurance coverage), g_7 (an average compensation for mandatory third-party insurance coverage), and k_{12} (a share of the reporting credit unions).

Secondly, several indicators are characterized by the presence of one cluster within a chronological row, that is, in the time frames, the initial period and the end period of the chronological row create another cluster (see Table 1).

In this case, the smoothed function assumes an undulating form, and the graph ends imitate the initial representation, which indicates the recurrence of economic processes in the final years of the study and at the initial stage. The indicators characterized by these features are as follows: x_4 (a share of the NBF institutions' assets in GDP), y_3 (a volume of credit unions' services), z_{12} (a share of the first 50 insurance companies included in the risk segment), z_{13} (HHI of the risk segment), v_1 (a number of life insurance companies), k_1 (a number of credit unions), k_2 (a number of credit unions' members), k_3 (a share of the population covered by credit cooperatives), k_5 (a share of credit unions' productive assets), k_8 (total contributions made by credit unions' members), k_{11} (a number of reporting credit unions).

Thirdly, it is necessary to mention a group of indicators displaying trends that count in favor of a certain cyclicality, process repetitiveness in the respective NBFS markets. This repeatability is confirmed by the presence of two clusters that alternate in chronological order. Put in other words, the chronological row of Clusters 1 and 2 is divided by time. Such "breaking" of clusters in chronological rows testifies to the cyclicality of processes. These indicators (Poyda-Nosyk & Vdovenko, 2017) of the NBFS markets include v_7 (a level of life insurance payments), v_{10} (a market share of the first three life insurance companies), v_{12} (HHI of the life insurance market), and k_{13} (a ratio of credit union borrowers to depositors).

Stage 6. Comparing centroids in each group and determining the development process type. Clustering and identifying the periods that determine the chronological framework of clusters enables us to assess the nature of the development process shown by specific indicators. With this in view, the research compared the calculated values

http://dx.doi.org/10.21511/ed.19(4).2020.05

Table 1. Summarized results of cluster analysis for selected indicators of the NBFS markets in Ukraine for 2006–2018

Symbols that characterize the NBFS markets and their placement in clusters	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Quantity in the cluster		Share of clusters, %		Value of centroids	
k1,…, k13	1	2	2	2	2	2	2	1	1	1	1	1	1	7	6	53.8	46.2	–	–
k13	1	2	2	1	1	1	1	2	2	2	2	2	1	6	7	46.2	53.8	3.63	5.79
k12	1	1	1	1	1	2	2	2	2	2	2	2	2	5	8	38.5	61.5	98.32	81.15
k11	1	2	2	2	2	1	1	1	1	1	1	1	1	9	4	69.2	30.8	511.56	761.75
k8	1	1	1	2	2	2	1	1	1	1	1	1	1	10	3	76.9	23.1	1.206	3.45
k5	1	1	1	1	1	1	1	1	1	1	2	2	1	11	2	84.6	15.4	88.73	79.1
k3	1	1	2	2	2	2	2	1	1	1	1	1	1	8	5	61.5	38.5	2.05	4.6
k2	1	1	2	2	2	2	2	1	1	1	1	1	1	8	5	61.5	38.5	0.92	2.12
k1	1	2	2	2	2	2	1	1	1	1	1	1	1	8	5	61.5	38.5	595.5	774.2
g1,…, g7	-	1	1	1	2	2	2	2	2	2	2	2	2	3	9	25.0	75.0	–	–
g7	-	1	1	1	2	2	2	2	2	2	2	2	2	3	9	25.0	75.0	5.3	8.93
g6	-	1	1	1	2	2	2	2	2	2	2	2	2	3	9	25.0	75.0	20.6	99.77
g5	-	1	1	1	1	1	1	1	1	1	1	2	2	10	2	83.3	16.7	232.05	459.2
g3	-	1	1	1	1	1	1	2	2	2	2	2	2	6	6	50.0	50.0	353.27	1,063.75
g2	-	1	1	1	1	1	1	2	2	2	2	2	2	6	6	50.0	50.0	998.77	2,679.12
g1	-	1	1	1	2	2	2	2	2	2	2	2	2	3	9	25.0	75.0	3,017.4	7,643.8
v1,…, v12	1	1	1	1	1	1	1	1	1	1	2	2	2	10	3	76.9	23.1	–	–
v12	1	2	1	2	2	2	2	2	2	2	2	2	2	2	11	15.4	84.6	1,455	1,131.1
v10	1	1	1	1	1	1	1	1	2	1	2	2	2	9	4	69.2	30.8	53.02	43.65
v9	1	1	1	1	1	1	1	1	1	1	2	2	2	10	3	76.9	23.1	3,648.47	10,147.8
v8	1	1	1	1	1	1	1	1	1	1	2	2	2	10	3	76.9	23.1	1,749.57	6,361.87
v7	1	1	1	1	1	2	1	1	1	1	2	2	2	9	4	69.2	30.8	8.42	29.47
v6	1	1	1	1	1	1	1	1	1	1	2	2	2	10	3	76.9	23.1	114.09	713.5
v5	1	1	1	1	1	1	1	1	1	1	2	2	2	10	3	76.9	23.1	62.46	330.5
v4	1	1	1	1	1	1	1	1	1	1	1	2	2	11	2	84.6	15.4	68.68	454.95
v3	1	1	1	1	1	1	1	1	2	2	2	2	2	8	5	61.5	38.5	3.7	8.06
v2	1	1	1	1	1	1	1	1	2	2	2	2	2	8	5	61.5	38.5	739.83	2,277.7
v1	1	1	2	2	2	2	2	2	2	2	2	1	1	4	9	30.8	69.2	44.5	64
z3,…, z13	1	1	1	1	1	1	1	1	2	2	2	2	2	8	5	61.5	38.5	–	–
z13	1	2	2	2	2	2	2	2	2	2	2	2	1	2	11	15.4	84.6	298.3	190.0
z12	1	2	2	2	2	2	2	2	2	2	2	1	1	3	10	23.1	76.9	84.63	75.78
z10	1	2	2	2	2	2	2	2	2	2	2	2	2	1	12	7.7	92.3	42.1	22.34
z9	1	1	1	1	1	2	2	2	2	2	2	2	2	5	8	38.5	61.5	93.84	87.36
z8	1	1	1	1	2	2	2	2	2	2	2	2	2	4	9	30.8	69.2	91.95	74.28
z7	1	1	1	1	2	2	2	2	2	2	2	2	2	4	9	30.8	69.2	22.88	47.39
z3	1	1	1	1	1	1	1	1	2	2	2	2	2	8	5	61.5	38.5	96.3	91.94
y2, y3	1	1	1	1	1	1	1	2	2	2	2	2	2	7	6	53.8	46.2	–	–
y3	1	1	1	2	2	2	1	1	1	1	1	1	1	10	3	76.9	23.1	3.28	8.13
y2	1	1	1	1	1	1	1	1	2	2	2	2	2	8	5	61.5	38.5	0.47	1.7
x2, x4	1	1	1	1	1	1	1	1	1	2	2	2	1	10	3	76.9	23.1	–	–
x4	1	1	1	1	1	1	1	1	1	2	2	2	1	10	3	76.9	23.1	6.21	8.6
x2	1	1	1	1	1	1	1	1	2	2	2	2	2	8	5	61.5	38.5	49.95	139.46
Year / Cluster number														1	2	1	2	1	2

http://dx.doi.org/10.21511/ed.19(4).2020.05

of the centroids (mean values) with regard to the selected clusters. The obtained values of centroids, when compared, make it possible to reach a conclusion on the progress or regress of the specified indicators.

It should be noted that the study examines two development types – progress and regress. Progress indicates a qualitative change in the indicator towards improvement, which in turn does not mean that the increase in the Cluster 2 centroid value compared to Cluster 1 testify to progress. Specific generalizations are in place to consider the economic nature of the indicator formation.

Comparisons of the calculated values of centroids derived from the studied indicators (see Table 1) allow us to form the following general conclusions:

1) regarding the indicators that are characterized by a chronological sequence of clusters:
- development regress is observed in indicators z_8 (a share of technical provisions in the total insurance reserves), z_9 (a share of the risk insurance companies' assets in the insurers' total assets), z_{10} (a share of the risk insurance companies' reserves in assets), v_2 (a volume of life insurance premiums), k_{12} (a share of reporting credit unions);
- development progress is stated in terms of x_2 (non-bank financial institutions' assets), y_2 (a volume of the non-state pension insurance market), z_3 (a premium volume of the risk segment), z_7 (assets of insurance companies belonging to the risk segment), v_2 (a volume of life insurance premiums), v_3 (a share of life insurance premiums in gross premiums), v_4 (a volume of insurance payments), v_5 (a volume of redemption amounts), v_6 (a volume of insurance indemnities and redemption amounts), v_8 (a volume of mathematical insurance reserves), v_9 (life insurance assets of the insurance companies), v_{12} (HHI of life insurance), g_1 (a number of the issued certificates of mandatory third-party insurance coverage), g_2 (total premiums derived from mandatory third-party insurance coverage), g_3 (total insurance indemnities derived from mandatory third-party insurance coverage), g_5 (an average value of mandatory third-party insurance coverage), g_6 (a number of settled cases of mandatory third-party insurance coverage), g_7 (an average compensation for mandatory third-party insurance coverage);

2) regarding the indicators that are characterized by one of the clusters present in the middle of the chronological row:
- development regress occurs in the middle of the sampling period at k_5 (a share of credit unions' productive assets);
- development progress is observed in the middle of the sampling period at x_4 (a share of the NBF institutions' assets in GDP), y_3 (a volume of credit unions' services), z_{12} (a share of the first 50 insurance companies included in the risk segment), z_{13} (HHI of the risk segment), v_1 (a number of life insurance companies), k_1 (a number of credit unions), k_2 (a number of credit unions' members), k_3 (a share of the population covered by credit cooperatives), k_8 (total contributions made by credit unions' members), and k_{11} (a number of reporting credit unions);

3) regarding the indicators characterized by process repeatability:
- progress follows the cyclical regress, and the chronological sequence ends with regress in the case of k_{13} indicator (a ratio of credit union borrowers to depositors);
- regress follows the cyclical progress, and the chronological sequence ends with progress for such indicators as v_7 (a level of life insurance payments), v_{10} (a market share of the first three life insurance companies), v_{12} (HHI of the life insurance market).

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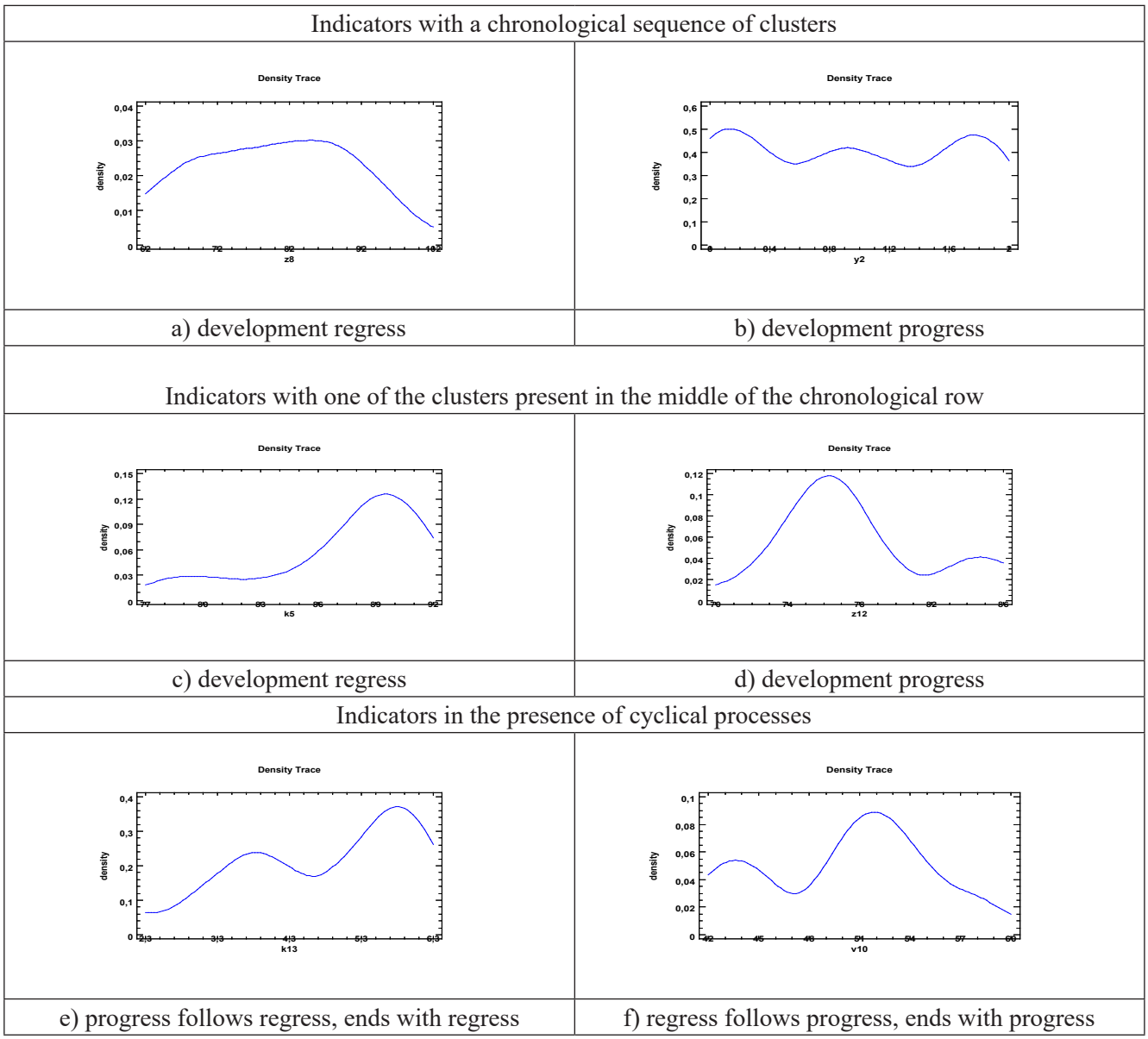


Source: Developed by the authors.

Figure 1. Examples of generalization patterns showing the development process of indicators by the cluster analysis method

Stage 7. Multidimensional clustering of objects (years) by the indicator system to determine the flow of the two processes.

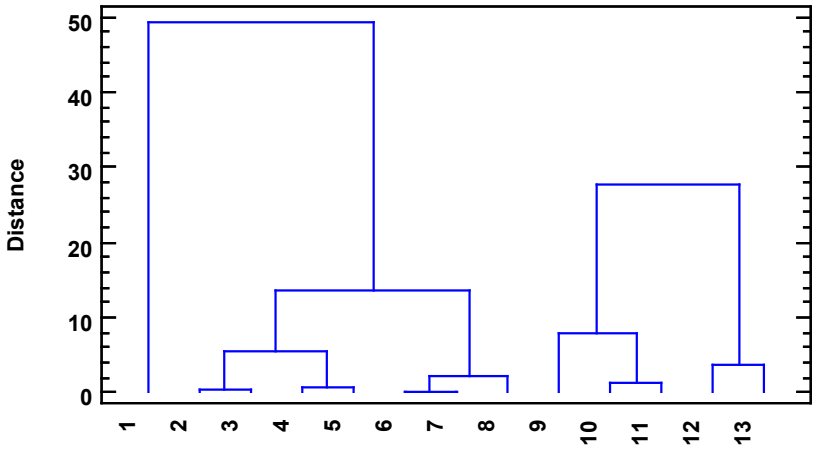
Within the study scope, cluster analysis addressed not only single indicators, but also a group (set) of indicators that share common characteristics, that is, characterize specific NBFS markets, or NBFS markets in general (Table 1). The use of cluster analysis for a specific set of indicators explains the development trends in the NBFS markets studied. According to the calculations (Figure 2), common trends are effective for the non-state pension insurance market and credit cooperation, since Cluster 1 covers 2006–2012 and Cluster 2 – 2013–2018.

Two periods are clearly distinguished in the risk insurance segment: 2006–2013 and 2014–2018; 2006–2015 and 2016–2018 are identified for life insurance; 2007–2009 and 2010–2018 display mandatory third-party insurance coverage. It should be noted that the credit cooperative market is characterized by the presence of Cluster 2 (covering the period of 2007–2012), which separates the chronological framework of Cluster 1 for 2006 and the period of 2013–2018.

Evaluating the indicators that characterize the assets of all non-bank financial institutions and the shares of all NBFS markets in GDP, the authors find a certain trend recurrence in 2018 with the trends for the period of 2006–2014, forming Cluster 1 as opposed to Cluster 2 (covering the period of 2015–2018).

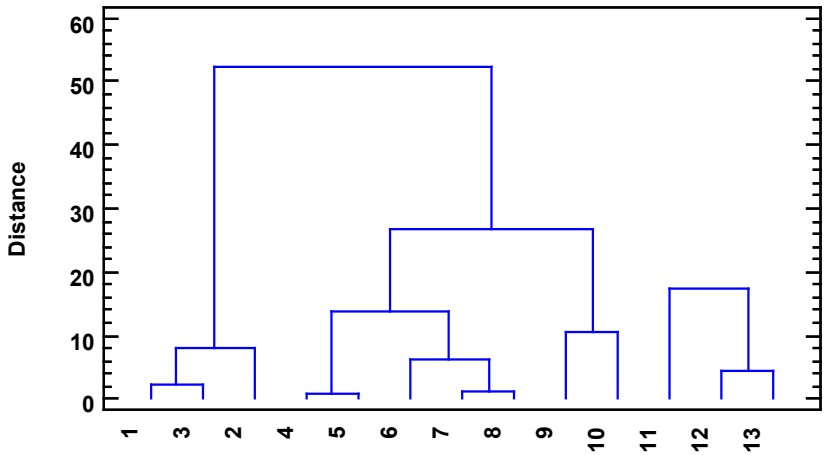
At the same time, the impossibility of obtaining the cluster analysis results for the whole set of indicators underlines the authors' thesis about the existence of its own development trends for each of the studied NBFS markets and the need to study each of them separately.

Based on the developed analytical approach, it has been established that the NBFS markets are characterized by several periods distinguished by opposite development trends (Figure 2).



Cluster	z_3	z_7	z_8	z_9	z_{10}	z_{12}	z_{13}
1	96.3	31.39	86.55	92.21	25.4	76.71	200.88
2	91.94	53.38	68.78	86.08	21.4	79.6	215.88

a) Risk insurance market

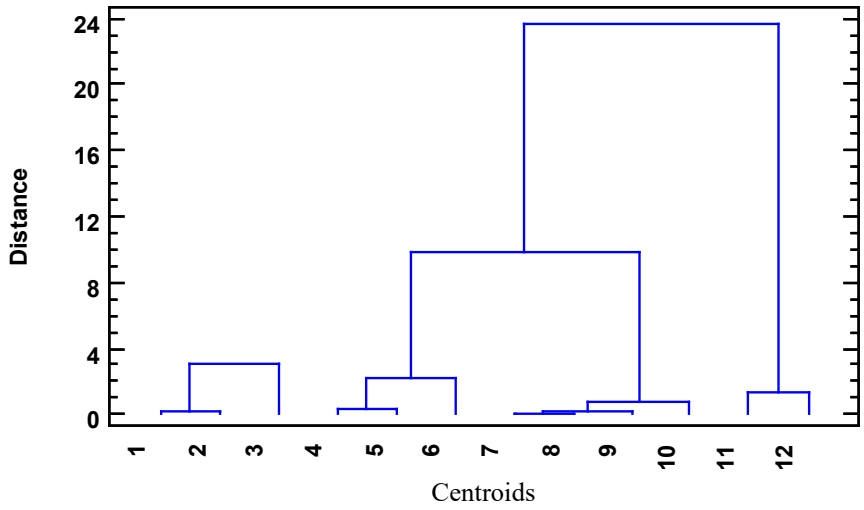


Cluster	v_{12}	v_1	v_2	v_3	v_4	v_5	v_6	v_7	v_8	v_9	v_{10}
1	1,234.3	60.9	1,020.48	4.66	51.63	62.46	114.09	10.2	1,749.57	3,648.47	52.12
2	1,003.0	48.3	2,367.5	7.77	383.03	330.47	713.5	30.57	6,361.87	10,147.8	43.53

b) Life insurance market

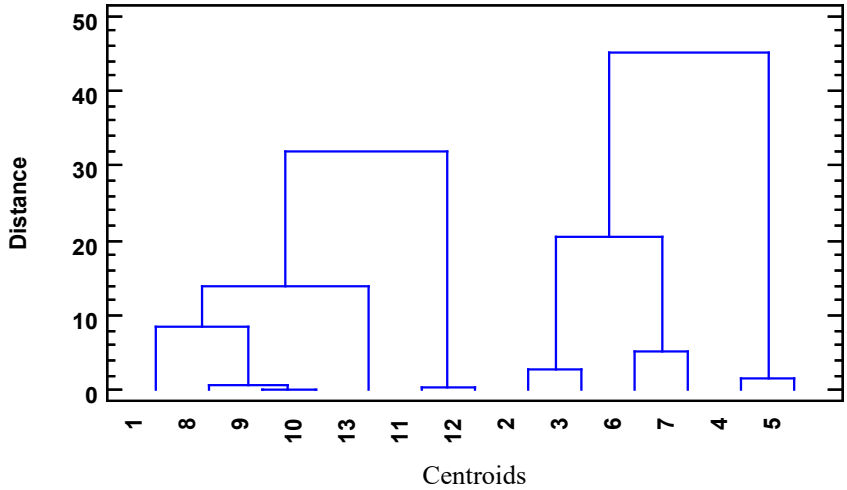
Figure 2. Results of the analytical approach applied to define the development processes in the NBFS markets

http://dx.doi.org/10.21511/ed.19(4).2020.05



Cluster	g_1	g_2	g_3	g_5	g_6	g_7
1	3,017.43	552.633	111.1	182.87	20.6	5.3
2	7,643.81	2,267.71	907.64	298.92	99.77	8.93

c) Market of mandatory third-party insurance coverage



Cluster	k_1	k_2	k_3	k_5	k_8	k_{11}	k_{12}	k_{13}
1	586.43	0.88	1.97	85.04	1.01	481.14	82.03	5.26
2	755.0	1.98	4.267	89.82	2.56	713.83	94.43	4.25

d) Credit cooperative market

Source: Developed by the authors.

Figure 2 (cont). Results of the analytical approach applied to define the development processes in the NBFS markets

As can be seen from Figure 2, the insurance market is characterized by the following features (Figure 2, a–c): positive growth trends in risk insurance in 2006–2013, and since 2014 there has been a setback; more steady development in life insurance in 2016–2018 as opposed to the 2006–2015 recession; enhanced trends of sustainable development in the mandatory third-party insurance coverage market as observed in 2010–2018, which is confirmed by higher values of centroids for each of the indicators characterizing this market compared to the period of 2007–2009.

2007–2012 was the most favorable period for the development of the credit cooperation market (Figure 2d), which is characterized by the division of the chronological framework into three periods with sequential processes of progress and regress.

Stage 8. Comparing the centroids in each group and determining the development process type by a system of indicators.

At the final stage of the analytical approach application, the results were summarized taking into account the aggregation of indicators and change directions in the numerical expression of the centroids of the formed clusters, as well as determining the process course in the NBFS markets.

Thus, the risk insurance market (Figure 2a) is characterized by two clusters: Cluster 2 (2014–2018) imitates Cluster 1 (covering 2006–2013), and the development progress is confirmed, which proves the increasing centroid values of the corresponding $z_{3,}$ z_7, z_{12}, z_{13} indicators. The decrease of the centroid values of z_8, z_9, z_{10} indicators did not affect the overall assessment of the growth in this market, which is explained by the estimated nature of their obtaining, as the decrease in the risk segment share means a simultaneous growth of the life insurance market, which is generally desirable for Ukraine and corresponds to the insurance market trends in the EU countries.

The life insurance market (Figure 2b) is characterized by similar trends as the risk segment. However, the chronological framework of Cluster 2 is 3 years (2016–2018), which indicates more favorable conditions for functioning and ensuring the recent development of life insurance in Ukraine. As is clear from the data presented in Table 1 and Figure 2b, a reduced number of life insurance companies did not result in an increasing market concentration, since a decrease in the centroid value of v_{12} indicator testifies to increased competition in the market.

The mandatory third-party insurance coverage market (Figure 2c) has had a clear positive upward tendency since 2010. The centroid values of Cluster 1 and Cluster 2, when compared, confirm the thesis that the centroid values of g_1, g_2, g_3, g_5, $g_{6,}$ and g_7 indicators in Cluster 2 are greater than the values of the similar Cluster 1 indicators.

A special situation is observed in the credit cooperative market (Figure 2d). The calculations prove that there are two clusters: Cluster 1 contains the chronological frames of 2006 and 2013– 2018, while Cluster 2 addresses the period of 2007–2012. Based on the compared centroids of the indicators peculiar to each cluster, the authors conclude that the development of the credit cooperative market in Ukraine was characterized by regress in 2006, progress in 2007–2012, and repetitive regress in 2013–2018.

CONCLUSIONS

Consequently, the research was based on the proposed analytical approach to determine the course of processes in the NBFS markets, which provides quantification of key indicators reflecting the NBFS markets' performance by dividing the totality of values into groups by cluster analysis and performing multidimensional clustering of objects by the system of indicators, as well as the implementation of qualitative characteristics of the development level for the selected indicators based on the determined limit values of the latter, using the methods of multidimensional cluster analysis, Pearson's criterion, Ward's method, mathematical statistics and techniques (generalization, grouping, comparison), which determines the patterns of progress and regress in markets under the implementation of the policy adopted by the National Commission for State Regulation of Financial Service Markets regarding the activity of non-bank financial institutions and the protection of the NBFS consumer rights.

With the help of the obtained calculations related to the non-bank financial service markets in Ukraine, the periods of progress and regress have been determined, which is a precondition for determining the cyclical development of the studied markets in the future. Further development of this scientific issue will include establishing the strength of the influence of regulatory functions exerted by the central government on the relevant indicators that characterize the development of the studied markets.

http://dx.doi.org/10.21511/ed.19(4).2020.05

AUTHORS CONTRIBUTIONS

Conceptualization: Nataliya Vnukova.
Data curation: Robert Bacho.
Formal Analysis: Robert Bacho.
Funding acquisition: Robert Bacho.
Investigation: Robert Bacho, Nataliya Vnukova.
Methodology: Robert Bacho.
Project administration: Nataliya Vnukova.
Resources: Robert Bacho.
Software: Robert Bacho.
Supervision: Nataliya Vnukova.
Validation: Robert Bacho.
Visualization: Robert Bacho.
Writing – original draft: Robert Bacho.
Writing – review & editing: Nataliya Vnukova.

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