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CHANGES IN UKRAINIAN BANKS 'BUSINESS MODELS IN TIMES OF MILITARY CRISIS

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ABSTRACT

The article analyzes changes in the business models of Ukrainian banks using the author's method of structural and functional groups of banks (SFGB). The method's basis is the processing, systematization, and visualization of the system's values of banks' financial indicators using Kohonen's self-organizing map (SOM). Depending on the level distribution of a large number of indicators that characterize the structure of assets, liabilities, income, expenses, and other qualitative indicators that describe the business models of each bank on successive reporting dates, homogeneous groups of banks are formed. The purpose of this study is to compare the key features of the banking system as of January 1 and September 1, 2022, and the corresponding changes in business models.

Over the eight months of 2022, the number of banks with corporate lending increased slightly, but the resource base of these banks gradually changed. The number of banks with retail financing decreased at the expense of banks with current resources. During an increase in the discount rate and in the price of refinancing loans, banks' business model that attracts resources on the interbank market and places them in securities has shrunk. At the same time, the number of banks with an increased level of securities in assets and corporate financing increased. The quality of the portfolio indicates the increased credit risks of the respective large state banks.

The drawback of the proposed method is the dependence of conclusions on official banks' statements that do not always reflect nuances of financial position. Within small banks, we can sometimes observe that current changes in clients' account balances affect the position in SFGB. The SFGB method can be applied to analyze trends and estimate the probability of subsequent structural changes. For each bank, one can observe the trajectory change on the map and investigate the reasons for the change in business strategy.

Keywords: banking risks, business models of banks, banking system, cluster analysis, Kohonen maps, structure of bank assets, structure of bank resources, sources of bank profit

JEL Classification: C45, G21, D21

INTRODUCTION

During full-scale military operations, Ukrainian banks are influenced by many stress factors affecting their business models. Publicizing bank statements published monthly by the National Bank of Ukraine allows for studying the impact of current political and economic conditions [22; 23] on the banking system and developing countermeasures against the loss of banks' financial stability.

The SFGB method has been successfully tested for the development of approaches to differentiated banking supervision, the study of Ukrainian banks' business models, and improvement analysis of complex economic systems described by numerous indicators [24; 25; 26]. By the structural-functional group of banks, we mean a homogeneous cluster of banks on the SOM, which includes elements with similar features and models of response to external shocks. The method is useful for understanding the business models of specific banks at the macro level. Also, an important area of application of

the SFGB method is the study of the general features of the banking system at the macro level. The paper research that. Influenced by huge negative factors, banks reduce credit programs and apply stabilization measures to compensate for realized credit risks. The resource base of banks is also experiencing significant changes. There is a reduction in fixed-term resources and a relative increase in public funds received in state payments related to military operations. Against the background of changes in the structure of assets and liabilities of banks, there is a redistribution of resources in favor of large state banks. All those changes directly affect the banks' business models.

Business models of banks are actively studied in scientific literature. The National Bank of Ukraine monitors banks' activities in developing an adequate and effective risk management system, determining the risk profile based on its business model. In recent years, Ukraine's banking system has been actively implementing the relevant guidelines of the European Bank for introducing SREP (Supervisory Review and Evaluation Process) supervisory tools. At the same time, specific tools for researching the features of business models, classification of banks, and studying current changes and their impact on the financial stability of the banking system remain an urgent problem.

LITERATURE REVIEW

Many publications by Ukrainian and international scientists are dedicated to the study of the peculiarities of the business models of modern banks (e.g.: [1; 4; 5; 7; 10; 17]). For instance, Osterwalder, Pigneur, and Tucci (2005) [21] note that the business model is an essential feature that distinguishes companies, unique parameters expressed in the relationship between the most critical success factors, describes the basic principles of creation, development and their successful work.

In the work of Ayadi (2019) [2], a large study of the business models of European banks, directions of their analysis, and regulation was carried out, the main business models of European banks at various stages of the economic cycle were highlighted, and the strengths and weaknesses inherent in the dominant business models were identified. The following business models are described (Ayadi et al., 2020) [3]: retail diversified, retail target, investment, and corporate banks.

Cavelaars and Passenier (2012) [6] understand the business model as a simplified representation of actions performed by a banking institution to obtain income. The business model should provide answers to the following questions: what products and services does the bank offer, and for which customer groups? How will the bank address its potential customers and distribute products and services? What is the driving force for the bank's profitability, and whether it is sustainable?

Lueg, Schmaltz, and Tomkus (2019) [15] consider the business model an important tool reflecting the essence of business practices that lead to profit. A well-defined business model provides the information needed to identify, compare, and strengthen certain business features. The bank's business model can be determined by understanding the defining variables: how it conducts business, what its financing strategy is, its scope of activity, and the nature of risks.

In the work of Onyshchenko (2020) [20], it is noted that the definition of business models of banking activity contributes to a better understanding of financial and economic indicators, risk behavior, and management structure at the system level. The business model facilitates monitoring banks' behavior [19] and their contribution to systemic risk, which can be useful for its regulation.

Lyubich, Bortnikov, and Panasenko (2016) [16] define business models based on the analysis of the strategy approved by the bank, the range of goods and services offered by it, the structure of assets and liabilities, the classification of profitability and profitability indicators. According to these scientists, the bank's choice of a specialized business model makes it sensitive to various types of crises in various sectors of the economy; at the same time, the choice of a universal business model and a certain differentiation of activities allows avoiding this, as it allows for to compensation for possible losses at the expense of income from alternative areas of business. The ability to assess its viability and stability at an early stage of problems, and identify its main weaknesses, depends on the correctness of the analysis of the bank's business model.

AIMS AND OBJECTIVES

The Purpose of this study is to compare the key features of the banking system as of January 1 and September 1, 2022, by the SFGB method and to assess their impact on the banks' business models. Significant changes in the structure of assets, liabilities, income, expenses, and other qualitative indicators of all banks negatively affect the viability of their business models, their ability to generate income, and the sustainability of their development strategy.

METHODS

Isolation of homogeneous groups of Ukraine's banks based on the reporting data of different dates is done by SOM [8; 9; 13]. The map construction algorithm provides simultaneous consideration of the values of all indicators, and therefore the position of each object on the map provides useful information about its properties, although it could be clearer and more predictable [11; 12; 14].

The SFGB formation occurs automatically by the Viscovery SOMine 7 software product, based on the values of financial indicators, by pulling the indicators of banks close in value to the centers of homogeneous groups. The SOM provides a convenient visualization of the features of banks and the system as a whole. With neural network technology, it is possible to simultaneously consider the values of large arrays and detect nearby objects. Objects close in position in 31-dimensional space are combined, and the result is displayed on a two-dimensional map. The distance on the map characterizes the common features of objects. Banks occupying a distant position, for instance, at a diagonal distance, have the biggest difference in the values of the indicators. Transformations in the system of structural and functional groups reveal trends that cannot be investigated only by the values of indicators.

In the study, we use 31 indicators for each bank for reports starting from 01/01/2018 to 01/09/2022. The values of the indicators for each bank at the beginning of each month of the study are accumulated over time.

To construct the Kohonen maps for a certain period, data from the statistical reports of banks, which are published on the website of the National Bank of Ukraine, were used [18]. A system of 31 structural indicators was calculated based on the financial indicators of the monthly reporting of banks, which reflects the peculiarities of the structure of assets, liabilities, income, expenses, and some qualitative indicators of each bank. The indicators reflect the important and dynamic components of the balance sheet, which share characterizes the business model of banks, banks' business model location of resources, and the business model.

RESULTS

The SFGB formation is determined by a set of indicators whose values affect the features of the business model. We selected 31 indicators, which can be divided into three groups: the structure of assets, the structure of liabilities, other indicators.

Asset structure indicators reflect the share of the largest aggregates in net assets: SAV – the ratio of cash and cash equivalents to net assets; SAMI – the ratio of funds in other banks in foreign currency to net assets; SAMN – the ratio of funds in other banks in national currency to net assets, SAUI - the ratio of loans of legal entities in foreign currency to net assets, SAUN - the ratio of loans of legal entities in national currency to net assets, SAFI - the ratio of loans of individuals in foreign currency to net assets, SAFN - the ratio of loans of individuals in national currency to of net assets, SACI - the ratio of the portfolio of securities in foreign currency to net assets, SACN - the ratio of the portfolio of securities in national currency to net assets. The indicators reflect the important components of assets, the share of which characterizes the banks' business model, the peculiarities of the allocation of resources, and the business model.

Equally important is the structure of bank liabilities, which is determined by the following indicators: SPMI - the ratio of funds of other banks in foreign currency to liabilities, SPMN - the ratio of funds of other banks in national currency to liabilities, SPUI - the ratio of funds of sub of economic entities in foreign currency to liabilities, SPUN - the ratio of funds of economic entities in national currency to liabilities, SPUP - the ratio of funds of economic entities on demand to liabilities, SPUS - the ratio of time funds of economic entities management to liabilities, SPFI - the ratio of funds of natural persons in foreign currency to liabilities, SPFN - the ratio of funds of natural persons in national currency to liabilities, SPFP - the ratio of funds of natural persons on demand to liabilities, SPFS - ratio term funds of individuals to liabilities. Each of the above aggregates of liabilities characterizes the strategy of attracting banks' resources and features of their business models.

Important structural indicators also include ROA - return on assets, RA - the ratio of total reserves for credit risks to net assets, CA - the ratio of balance sheet capital to net assets, VCA - the ratio of net assets in foreign currency to net assets, VL - open currency position, which is calculated as the difference between assets and liabilities in foreign currency, relative to net assets. To assess the current liquidity of banks, the L1 indicator is used, which is calculated as the ratio of cash and cash equivalents to liabilities on demand, that is, funds of legal entities and individuals on demand. The scale of each bank is evaluated using the as indicator, which is calculated as the share of a given bank's net assets to the system's total net assets.

The structure of banks' main income and expenses is important for describing business models. In order to determine the sources of bank profits, the following indicators are used: PM - interest margin, the ratio of net interest income to net assets, KD - the ratio of net commission income to net assets, TD - the ratio of trading results to net assets, VA - the ratio of administrative and other operating expenses to net assets, VR is the ratio of expenses for the formation of reserves for credit risks to net assets.

Based on the accumulated information for the period from 01.01.18 to 01.01.22, the Kohonen map, shown in Figure 1, was constructed.

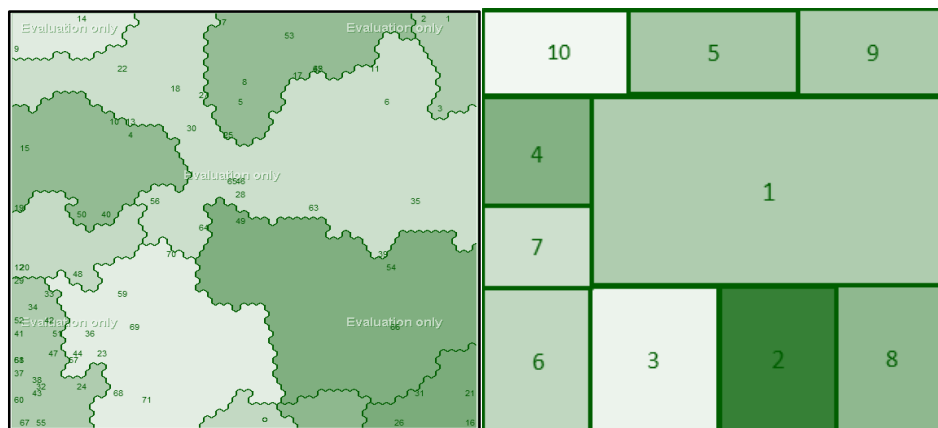


Figure 1. Map of Kohonen and schematic position of SFGB as of 01.01.22. (Sources: calculated/compiled/systematized by the authors based on the National Bank of Ukraine database [18] using the Viscovery SOMine 7 software product).

The left part of Figure 1 shows the Kohonen map, built according to the indicators calculated from the data of bank reports. Each point on the map is the location of one or more banks in a coordinate dimension of 31 indicators displayed on a two-dimensional plane. The close position of the banks indicates similar features in terms of the values of all 31 indicators considered simultaneously. Colored figures combine banks with similar characteristics; they define structural and functional groups of banks.

Our research focuses on groups with active banks and the number of banks in those groups as of the last reporting date. The numbers from 1 to 71 shown on the map are the banks' locations as of 01.01.22. Each number corresponds to the serial number of the bank in the list by size of assets. Most of the banks at the beginning of 2022 were in the southwestern part of the map, in the city of the figure that separates the corresponding structural and functional group. In the city of some groups, there are no banks from the current reporting. Such groups include only banks of last year's reports.

The right part of Figure 1 schematically repeats the geographical position of the Kohonen map groups and the number of each group. The names of groups, the number of banks included in them as of 01.01.22, the total assets of these banks, and a list of indicators whose extreme values influenced the formation of groups are given in Table 1.

Table 1. SFGB features as of 01.01.22. (Sources: calculated/compiled/systematized by the authors based on the National Bank of Ukraine database [18])

No	Groups	Extreme indicators	Number of banks	Assets, million hryvnias
1	Corporate with retail financing	SAUN, SAUI, SPFI, SPFS, VCA	15	312,324
2	Corporate with retail financing in national currency	SAUN, SPFI, SPFS, SPFN, SA	4	15,525
3	Securities with corporate financing	SACN, SPUP, SPUN, SA	8	10,927
4	Interbank assets with corporate financing	SAMI, SPUI, SPUP, SPUS, VCA	6	206,379
5	Corporate with current financing	SAUN, SPFI, SPFP, SPUP	8	401,919
6	Securities with interbank financing	SACN, SPMN	18	109,086
7	Interbank assets with corporate financing	SAMI, SAV, SPUI, SPUP, SPUN, ROA	3	40,690
8	Retail	SAFN, SPFN, SPFS, SPFP, RA, ROA	4	80,586
9	The biggest	As, SACI, SPFI, SPFN, RA, VL	3	836,198
10	Problematic	SAMI, SAUI, SPMI, VCA, RA	2	40,294
Total			71	2,053,928

For example, the largest group with a corporate business model with retail financing and number 1 occupies the northern part of the map, closer to the center. The largest size of the group indicates that from 01.01.18 to 01.01.22, many banks had the appropriate business model. Nevertheless, as of the beginning of 2022, only 15 banks were included in this group. The typical business model became less common than the Securities with Interbank Financing model, where 18 banks fell.

Let us consider in more detail the distribution of banks under the SFGB as of January 1, 2022, which allows for assessing the state of the banking system before the start of a full-scale war. The main group, numbered 1, with the Corporate business model with retail financing, demonstrates the migration of banks from the center of the map to groups where the portfolio of securities dominates assets. The aggregate assets of 15 banks of the group amount to UAH 312 billion, or only 15% of the system's total assets.

The corporate group with retail financing in national currency, number 2, has similar characteristics to the previous group, although this traditionally large group includes only four banks with assets of 16 billion hryvnias as of 01.01.22. The difference from the previous group is associated with a higher value of the SAUN indicator and a lower level of SAUI, i.e., a larger loan portfolio in national currency. In addition, the second group has a higher value of SPFN, the share of funds raised by individuals in the national currency.

Like the previous business models is a group of banks called Corporate with current financing. That group includes eight banks with assets of 402 billion hryvnias, equal to 20% of the system's total assets. In contrast to the two previous groups, banks have an increased share of the current funds of individuals' SPFP and liabilities of individuals in foreign currency SPFI. It can be observed that banks with an increased share of loans of economic entities in foreign currency have an increased level of VCA, the share of assets in foreign currency in net assets.

The above-mentioned three groups of banks describe some classic strategies - attracting funds of individuals and placing them in loans of legal entities. Groups 5, 1, and 2 occupy the central position on the map. As of January 1, 2022, there are 27 banks in the relevant segments with total assets of UAH 730 billion, which is 36% of total assets. Thus, at the beginning of 2022, most banks had a business model that did not meet the traditional rules of servicing the real sector of the economy. Let us consider the features of other business models.

According to Table 1, the maximum number of banks belongs to the Securities with the interbank financing group, where there are 18 banks with assets of UAH 109 billion, which is 5% of total assets. Banks with the appropriate business model have an increased share of involved interbank loans in the national currency SPMN and the share of the portfolio of securities in the national currency SASN. As a rule, this is the attraction of refinancing loans from the National Bank of Ukraine and the purchase of OVHZ, operations without participants from real sectors of the economy.

Next to the previous one is a group called Securities with corporate financing. Groups 3 and 6 have many common features. In the structure of obligations of group 3, the share of funds of legal entities has increased, unlike the previous group. The share of the portfolio of securities in assets exceeds half and is 55% for group 6 and 54% for group 3. The combined assets of the two groups focused on working with securities amount to UAH 120 billion, or 6% of total assets. The number of banks in the two groups is 26.

The maximum amount of assets belongs to the group of the largest banks, numbered 9. As of January 1, 2022, 3 banks with total assets of UAH 836 billion, or 41% of total assets, entered the largest group. The group is small; it is located in the southeast of the map, at a diagonal distance from group 6. 2-3 banks fell into this group at different periods, among which there are always the two largest state-owned banks. The share of the portfolio of foreign currency securities in the group's assets is the most important in the system. In addition, the group has the maximum level of the size indicator As and the minimum negative value of VL; the banks' liabilities in foreign currency exceed assets. The portfolio of securities in the national currency and the loan portfolio is, at most, the average indicator in the system. The quality of banks' assets is unsatisfactory, as evidenced by the high level of the RA indicator. Obligations of individuals in the national currency have an increased share among the funds involved.

Groups 7 and 4 are located on the map next to each other, in the western part of it, and have similar business models and the name Interbank assets with corporate financing. Banks have increased structural indicators SAMI, SPUP, and SPUI. The credit portfolio of banks has a smaller share in assets than the system average. The share of the portfolio of securities in the national currency has an average level. Additional extreme values of indicators that do not coincide in groups 7 and 4 emphasize the higher share of operations in foreign currency of banks in group 4. As of 01.01.22, these groups included nine banks with total assets of UAH 247 billion or 12% of total assets.

A separate sustainable group consists of 4 banks specializing in lending to individuals. The list of retail banks has stayed the same for several years. Their business model has clear long-term features, determined by the increased values of the

SAFN, SPFN, SPFS, RA, PM, and VA indicators. Banks mainly attract funds of individuals in national currency and have an increased share of term funds of individuals. Loans to individuals are provided in the national currency. Retail lending is traditionally associated with increased administrative costs held by servicing credit products. The level of the interest margin is also elevated. The quality of the loan portfolio is one of the worst, as evidenced by the increased level of the RA structural indicator. As of January 1, 2022, the assets of the group's banks accounted for 4% of the system's total assets.

Two banks from the aggressor countries, liquidated in February 2022, were included in the problem group. A group of problem banks is always an additional indicator of the deterioration of the system's financial condition. During the crisis, banks were mass migrating to this group. At the same time, not all problem banks are in the problem group because they have different risk profiles. The average values of individual structural indicators RA, L1, and CA significantly exceed the system level. The quality of assets could be better, and the activity of income transactions could be improved. In addition, problem banks accumulate a non-performing loan portfolio. For foreign banks, the level of loans in foreign currency, interbank active and passive operations, and the share of foreign currency in the assets of SAUI, SAMI, VCA, and SPMI has increased. As of January 1, 2022, the assets of these two banks make up only 2% of total assets and do not affect further system development.

Summarizing the analysis of the structure of the banking system as of 01.01.22, we will divide the banks into two groups that occupy the left and right sides of the map. Banks occupy the left western side of the map with the smallest share of the loan portfolio as part of assets. Among them, 26 banks have an increased specific weight of securities, whose assets comprise 6% of total assets. The corresponding banks occupy the southwestern part of the map. Above, in the middle of the left border, there is a group of banks whose assets interbank loans have an increased share. These banks are more than the previous group, so nine banks account for 12% of total assets. Finally, the northwestern part is occupied by troubled banks, where at the reporting date there were only two banks with assets of 2% of total assets. In general, the western part of the map accounts for more than half of 37 banks, with total assets of 20% of system assets.

Banks on the right side of the map are more related to servicing the real sector of the economy, although the share of the loan portfolio is limited, even for banks with a business model of corporate lending. From the composition of this so-called market-oriented group, a group of the three largest state banks with 41% of total assets should be singled out. The group is separated from the others at each reporting date due to the significant excess of the scope of activity and important differences in business models associated with a poor credit portfolio, an increased share of securities in foreign currency, and an open short currency position. The largest banks occupy the northeast of the map. The group of retail banks in the southeast of the map also has significant differences. As of the reporting date, as in recent years, the group consists of 4 banks with assets at 4% of total assets. Those banks aim at individual clients.

Finally, the classic business model represents 27 banks with assets amounting to 36% of system assets. At the same time, the loan portfolio of these banks is at most 44%, as shown in Table 2. The aggregate share of loans to legal entities in national and foreign currency is the largest in banks of groups 1 and 2 and amounts to 44%. Group 5 banks have 34% of the loan portfolio in assets. In banks with an increased share of securities, the loan portfolio in the structure of assets is from 13 to 30%. At retail banks, it is at most 5%. In the structure of assets of the largest state banks, corporate loans occupy only 22%.

As for lending to consumers, in all groups, except for retail banks, the combined share of these loans in national and foreign currency fluctuates at the level of 2-3%; in banks of the 5th group, it reaches 8% and only in retail banks it increases to 58%. We will remind that the share of retail banks in the system is 4%.

The configuration of the map presented in Figure 1 almost stayed the same before the middle of 2022, after which the position of the groups changed slightly, depending on the indicators' values. Gradual qualitative changes in the banks' business models accumulated until a certain time, until they received a quantitative manifestation, recorded by Kohonen's self-organizing map algorithm. At the same time, the movement of banks on the map has yet to take the form of mass migration; therefore, the current stage of development is not a turning point but only characterizes significant changes in the system.

Figure 2 shows the Kohonen map, formed based on bank reporting data from 01.01.18 to 01.09.22. Compared to the map shown in Figure 1, it is built on a matrix of indicators, which includes additional values for each bank for eight months of 2022. In the right part of Figure 2, the SFGB numbers and their schematic arrangement are also provided. Some features and names of the banks' business models have changed, and some groups have changed their position on the map. The reason for the changes is the new indicator values for each bank.

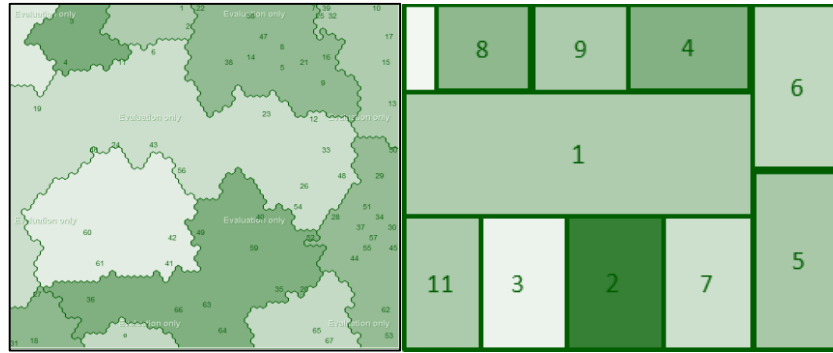


Figure 2. Map of Kohonen and the schematic position of SFGB as of 09/01/22. (Sources: calculated/compiled/systematized by the authors based on the National Bank of Ukraine database [18] using the Viscovery SOMine 7 software product)

Compared to Figure 1, the map has made a mirror reversal in the east-west plane so that retail banks have taken the place of buy-oriented securities and vice versa. Such a rotation by 180 from time to time occurs during the sequential formation of cards for reporting dates and is a consequence of the peculiarity of the algorithm of "pulling up" banks to the initial cents of the groups. Groups are formed in a 31-dimensional space based on the value of indicators, and the direction of orientation of the final map does not affect the result. The largest number of banks on the reporting date, indicated by numbers on the map, is on the right side of the map. In other words, the general picture of the leaving of banks from major groups is unchanged.

Table 2 presents the names of the groups formed on 01.09.22, a list of indicators with extreme values in the group, features of banks, and the size of their assets for each SFGB. It should be noted that the system's total assets for eight months of 2022, including six months of the war, increased by 103 UAH billion, or 5%. The growth of assets is related to inflation and the transfer of balances in currency due to exchange rate changes. As a result, the specific weight of the assets of banks with a high share of foreign currency increased slightly. Some banks decreased from 71 to 67, including two banks belonging to the aggressor country, which were withdrawn from the market.

Table 2. SFGB features as of 09/01/22. (Sources: calculated/compiled/systematized by the authors based on the National Bank of Ukraine database [18])

No	Groups	Extreme indicators	Number of banks	Assets, million hryvnias
1	Corporate with retail financing	SAUI, SAUN, SPFI, SPFS	12	258,357
2	Securities with corporate financing	SACN, SPMN, SPUN, SPUP	10	21,234
3	Corporate with retail financing in national currency	SAUN, SPUN, SPFN, SPFS	5	10,409
4	Corporate with current financing	SAUN, SPFI, SPFP, SPUP	11	584,562
5	Securities with interbank financing	SACN, SPMN	13	59,698
6	Interbank with corporate financing	SAMI, SPUI, SPUN, SPUP	7	100,904
7	Securities with corporate financing	SACN, SPUN	2	526
8	Big ones	SAUN, SAUI, VCA, RA, As	2	341,947
9	The biggest	SACI, RA, As, SPFI, SPFN, SPFP, SPFS, VL	2	757,222
11	Retail	SAFN, RA, SPFN, SPFS	3	22,564
Total			67	2,157,423

The largest group 1 banks with the Corporate model with retail financing decreased from 15 to 12 banks. Simultaneously, the group's total assets also decreased from 15 to 12% of the banking system's total assets. Meanwhile, there was an increase in the Corporate group with current financing, which as of January 1, 2022, had number 5, including eight banks with total assets of 20%. As of September 1, the corresponding group numbered four grew to 11 banks with total assets of 27% of the system's total assets. At the same time, the group of small banks called Corporate with retail financing in the national currency grew slightly. As of 01.01.22, the corresponding group with number 2 included four banks with less than 1% assets. As of September 1, 2022, the corresponding group numbered 3 includes five banks.

The three groups with corporate lending models have stayed the same volume and location on the map for eight months. At the beginning of 2022, the relevant groups covered 27 banks with assets of 36% of total assets. As of September 1, their number increased to 28, and their total assets to 40%. As part of this group, the number of banks with the advantage of current resources in liabilities has increased.

The credit portfolio of the banking system for eight months of 2022 slightly decreased from 37 to 36% of total assets. At the same time, the share of current funds in the liabilities of retail customers increased from 57 to 66%. This ratio does not contradict the structural changes in the business models of corporate lending: an increase in the number of banks in the Corporate with current financing group and a reduction in the Corporate with retail financing group, and an almost unchanged volume of the aggregate group.

At the beginning of 2022, the largest number of banks belonged to the group called Securities with interbank financing. The corresponding group with number 6 included 18 banks with aggregate assets of 5% of total assets. As of September 1, the number of banks in the corresponding group 5 decreased to 13, and the total assets decreased to 3%. Part of the banks moved to the Securities with corporate financing group.

It is appropriate to consider the banks' migration for two research dates in the middle of the group with the asset's allocation in securities. At the beginning of 2022, groups 6 and 3 collectively covered 26 banks with assets of 6% of the system's total assets. The largest group had an increased share of interbank loans in liabilities. As of September 1, groups 2, 5, and 7 with an increased share of securities in assets include 25 banks with 4% of assets. Twelve banks belong to groups 2 and 7 with the Securities with corporate financing business model. That is, the size of this group is gradually increasing due to the migration of banks from the Securities with the interbank financing group.

After the increase in the cost of refinancing loans, the banks' group with the corresponding business model has shrunk. Thus, there is a reduction in the volume of refinancing loan operations with the simultaneous purchase of government securities. It became possible to detect that tendency by the SFGB method.

Next, we consider other groups that only include a few banks. A group of the largest banks has a significant influence on the system. As of 01.01.22, group 9 included three banks with total assets in the amount of 41% of the assets of the banking system of Ukraine. The group occupied a corner position at a significant distance from the problem banks, as shown in Figure 1. On September 1, 2022, the group of the largest banks was divided into two subgroups. The group of the largest banks under number 9 is formed by state banks JSC CB "PrivatBank" and JSC "Oschadbank," with the largest balance currency in the system. Together, the assets of this group occupy 35% of the system's total assets. This group's properties and extreme indicators have mostly stayed the same compared to the beginning of the year. The group changed its location on the map and moved toward the troubled banks.

In addition, for the first time in the last few years, a group of large banks numbered eight has been formed near the group of the largest banks. The group includes the state banks JSB "UKRGASBANK" and JSC "Ukreximbank". The group's total assets account for 16% of the banking system's assets. Banks have increased indicators of SAUN, SAUI, VCA, and RA. Unlike the largest banks, the large Group 8 banks have a larger loan portfolio in national and foreign currency. An increased level of reserves for credit risks indicates poor quality. In addition, the extreme level indicates the share of assets in foreign currency VCA. Unlike the largest banks, Group 8 has a lower level of open short currency positions. The share of funds of individuals in the liabilities of banks of group 8 is also insignificant.

Thus, for the first time in several years of research, the group of large state-owned banks was divided into subgroups with different business models: large banks with corporate assets, mixed financing, and the largest with heterogeneous assets, an increased share of securities in foreign currency, and retail financing. The quality of the loan portfolio of the banks of both groups is insufficient, so they closely approach the group of problem banks. It should be noted that as of September 1, 2022, the problem group does not include any banks, and at the beginning of the year, it included two banks from the aggressor country. The group of 8 large banks is the closest to the problematic ones. Given the large share of the group's assets in the banking system's total assets, the respective movements are cause for concern.

The group of banks with the Interbank business model with corporate financing has slightly decreased over the past eight months. Most of the group consists of banks with foreign capital, which attract funds from legal entities and have an increased share of interbank loans in foreign currency in the structure of assets. In conditions of high credit risks, these banks keep part of the funds in the accounts of the parent structures. At the beginning of the year, the corresponding groups 4 and 7 included nine banks with total assets of 12%. As of September 1, 2022, their number dropped to 7, and the size of assets to 5%. Some of the group's banks chose the business model of placing funds in securities. The corresponding group 6 occupies a corner position on the map. The slight movement can be explained by reducing the share of foreign currencies in the average values of the group's indicators.

Finally, one of the smallest groups of retail banks remained almost unchanged over the period under study. As of 01.01.22, group 8 included four banks with assets of 4% of the system's total assets. As of September 1, 2022, group number 11 included three banks with assets of 1%. For many years, these banks have formed a group with clearly defined features of the preference of individuals' funds in assets and liabilities. For a long time before the crisis of 2009-2010, the group of retail banks was large and had the same qualitative features as in 2022. Retail banks have increased commission income, administrative expenses, and reserves for credit risks.

The structure of the map as of 01.09.22, shown in Figure 2, in general terms, repeats the structure as of 01.01.22, shown in Figure 1, considering the 180% reversal. The left, western part includes banks with an increased share of the loan portfolio in assets, compared to the right part. On the eastern side, there are banks with an increased share of interbank loans and securities in assets. The share of banks of the eastern group in total assets has significantly decreased, from 20 to 9%. During the studied period, the geographical pattern of distribution of larger banks in the north of the map and smaller banks in the south was maintained.

Thus, a comparison of the locations of banks on maps Figure 1 and Figure 2 shows that there is no mass migration of banks between SFGBs as of 01.09.22, although the change in map topology under the influence of negative factors indicates the likelihood of further structural changes.

DISCUSSION AND CONCLUSIONS

The SFGB method allowed the identification of changes in banks' business models associated with changes in the structure of assets, liabilities, income, expenses, and other financial indicators. Simultaneous consideration of the dynamics of these indicators allows for revealing hidden structural changes. For each bank, it is possible to examine the specifics of individual migration, its causes, and prospects.

The disadvantage of the SFGB method is the dependence on the indicators of officially published reports, which can hide the negative features of banks. In order to avoid measures of the influence of the National Bank of Ukraine, some banks use a system of artificial levers and counterweights and demonstrate good indicators in the presence of problems. Therefore, after evaluating the modeling results, additional information on the financial condition of banks should be used depending on the purpose of the research. At the same time, the SFGB method reveals changes in development trends that are not directly included in the system of indicators. For instance, changing the owner or strategy of a bank causes it to move on the map and go to another group.

Another disadvantage of the MFGB method is the unstable position of individual small banks, which move between groups depending on the features of the balance sheet at the reporting date. For some banks, receiving or withdrawing many funds from client accounts can affect the general structural features. In order to study the peculiarities of the models of such banks, the observation period should be extended, and the factors affecting the movement trajectory should be identified.

The results of using the SFGB method at the macro level and level of individual deviations provide a quantitative measure for evaluating qualitative changes. In eight months of 2022, the main business model of banks remains the classic model of corporate lending with retail financing, although the resource base of banks is moving towards the growth of demand funds.

The allocation model in securities of funds raised on the interbank market is gradually being reduced. For banks with an increased share of assets on the stock market, the resource base is the funds of legal entities.

The formation of a group of large state banks with an increased share of corporate loans in national and foreign currency is essential. Those banks' credit portfolios are not of high quality, as evidenced by increased reserves for credit risks.

The aforementioned macroeconomic challenges for the banking system's stability indicate the need for faster expansion of state support for credit products, such as the 5-7-9 programs. The investment funds to restore the economy of Ukraine should be implemented by modern risk management systems that are perfectly developed in the banking system. The development of credit operations and the expansion of the business models of corporate lending will be evidence of the banking system restoration.

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ЗМІНИ БІЗНЕС-МОДЕЛЕЙ БАНКІВ УКРАЇНИ В УМОВАХ ВОЄННОЇ КРИЗИ

У статті проведено аналіз змін бізнес-моделей банків України з використанням авторського методу структурно-функціональних груп банків (СФГБ). Основу методу складає обробка, систематизація та візуалізація значень системи фінансових показників банків за допомогою самоорганізаційної карти Кохонена (SOM). Залежно від розподілу рівня великої кількості показників, які характеризують структуру активів, пасивів, доходів, витрат, а також інших якісних показників, які описують бізнес-моделі кожного банку на послідовні звітні дати, формуються однорідні групи банків. Метою цього дослідження є порівняння ключових характеристик банківської системи за станом на 1 січня та 1 вересня 2022 року й відповідних змін бізнес-моделей.

За вісім місяців 2022 року кількість банків із корпоративним кредитуванням незначно зросла, але ресурсна база цих банків поступово змінювалася. Скоротилася кількість банків із роздрібним фінансуванням за рахунок банків із поточними ресурсами. В умовах підвищення облікової ставки та подорожчання кредитів рефінансування скоротилася бізнес-модель банків, які залучають ресурси на міжбанківському ринку та розміщують їх у цінні папери. У той же час розширилося коло банків, що мають підвищений рівень цінних паперів в активах та корпоративне фінансування. Якість портфеля свідчить про підвищені кредитні ризики великих державних банків.

Недоліком запропонованого методу є залежність висновків від офіційної звітності банків, яка не завжди відображає особливості фінансового стану. У малих банків іноді спостерігається вплив поточних змін залишків на рахунках клієнтів на місце в СФГБ. За допомогою методу СФГБ можна аналізувати тенденції та оцінювати ймовірність наступних структурних змін.

Ключові слова: банківські ризики, бізнес-моделі банків, банківська система, кластерний аналіз, карти Кохонена, структура активів банку, структура ресурсів банку, джерела прибутку банку

JEL Класифікація: C45, G21, D21