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CLUSTERING OF BANKS ACCORDING TO THEIR BUSINESS MODELS

The business models of banks were identified according to previously formed parameters. The authors distinguished business models of Ukrainian banks such as retail, universal, corporate, corporate with retail financing. The paper studies ranking method to analyze and compare banks business models in terms of financial and risk indicators.

Keywords: bank business model, clustering, k-means method, risk and financial performance indicators, ranking method, indicator rank.

Background. Banks of Ukraine differ especially in the composition of assets, liabilities, income, and expenses, the level of risk and profitability, etc. In its general form, the structure of assets, liabilities, and income of a bank reflects the business model. According to the SREP (Supervisory review and evaluation process), banks and supervisors should identify and analyze the business model. Different business models may affect the behavior of banks differently and have differences in their level of profitability and risk. The choice of business of the bank depends on the efficiency and stability of its operation, as well as its competitiveness in the market.

Analysis of recent research and publications. Scientific views on the interpretation of the term "bank business model", the choice of criteria and systems of indicators for the selection of business models types are identified in the works of L. Sachynska [1], I. Movchanenko [2], I. Kasatonova [3], P. Kutsyk [4], P. Alakozova [5], O. Lyubich, G. Bortnikov, G. Panasenko [6] etc. Ukrainian scientists and foreign scientists, among whom are the most famous A. Derkachenko and Y. Khudoliy [7], V. Rashkovan and D. Pokidin [8] R. Lug, M. Tomkus, K. Schmalz [9], M. Farne, and A. Vuldis [10], R. Roengpitya, N. Tarashev, K. Tsatsaronis, A. Villegas [11], M. Tsernov, T. Urbano [12], F. Mergaerts, R. Vennet [13] and others study theoretical and practical issues of using the tools of clustering and analysis of banks according to different business models.

The normative documents of the NBU consider the issues of business models identification, evaluation, and decision-making on the provision of emergency financing based on the results of their analysis. The regulator emphasizes the need to assess the business model, which should be consistent with the general risk appetite of a bank [14]. This issue remains debatable and unresolved, determines the relevance of the chosen research topic and its purpose.

The **aim** of the paper is to find out the essence of methodological approaches to the identification of business models of Ukrainian banks, as well as to give suggestions for their improvement.

Materials and methods. The theoretical and methodological basis of the study is the scientific works of foreign and domestic scientists. General scientific and special methods of cognition such as abstract-logical, grouping (theoretical generalization and formation of conclusions on the identification of business models), statistical (absolute and average values, clustering method) for distinguishing business models of Ukrainian banks were used in the paper.

Results. Today banks, like other businesses, operate in a highly turbulent economic environment, which is characterized by, on the one hand, an increase in the level of risk, on the other hand a decrease in margins. In such conditions, banks are looking for the most optimal option for managing assets and liabilities, which forces them to constantly improve their business models and strengthen the competitive position in the market and increase the market value.

There are different definitions of the term "business model" of a bank in the economic literature. For example, the business model is considered as a set of banking activities in the works of M. Farne and A. Vuldis) [10]. R. Lug, M. Tomkus and K. Schmalz [9] define this term a set of components (somewhat broader) used to overcome competition and achieve optimal profits in the financial market, where a similar product strategy is used, F. Mergaerts, R. Vennet [13] think that "business model" is the structure of assets, liabilities, capital and income.

We believe that in general, the business model is a systematization of assets and liabilities of a bank by their structure and volume, currencies, maturities, types of business, and banking products, types of customers and other criteria, the choice of which depends on the in-depth of the study. The background reflection of the bank's business model is its risk indicators and financial indicators.

We analysed existing scientific achievements and highlighted that the methodological approaches to the identification of business models differed in the list of indicators based on the public financial statements of banks and the qualitative characteristics of banks, expert assessments. Thus, the *cluster analysis* is often used for processing the received information.

The nature of the *cluster* is revealed in the etymology of this word. The English word *cluster* means a bunch, a bush. The meaning of the verb form is to grow in bundles, to form clots. The essence of the statistical interpretation of clustering is as follows: the data matrix $n \cdot m$ is fed to the input, where n is the number of banks; m is the number of variables by which they are grouped into separate clusters. Variables are the characteristics of banks, and the cluster of several of them is determined by the smallest distance between their values. Each cluster is a separate business model of the bank.

There are numerous studies on the identification of business models of banks based on cluster analysis in the domestic and foreign scientific studies. Scientists use neural networks and *k*-means methods to build clusters of banks on business models. L. Dolinsky, I. Miroshnychenko, V. Korchynsky [15], V. Rashkovan, D. Pokidin use self-organizing maps Kahonen, which are based on artificial neural networks [8] for the identification of banks business models. Clustering of banks by business models based on the method of *k*-means and construction of the dendrogram (hierarchical clustering) is considered in the papers of O. Primerov, G. Kiselyov [16].

This study is based on the use of the most common method of cluster analysis – *k*-means, which is a non-hierarchical and iterative method, which was proposed in the 1950s of the twentieth century mathematician G. Steinhaus and Stuart Lloyd. This method was very popular due to its simplicity, clarity of implementation, and fairly high quality of the results [17].

The clustering algorithm using the k-means method is traditionally performed in a certain *sequence*.

At the first stage, the choice of the number of k clusters is made, based on the method of the elbow (*Figure 1*), which calculates the Euclidean distance for any number of clusters from 1 to 10. The number of clusters is chosen, the difference between the previous number and the next is the largest.
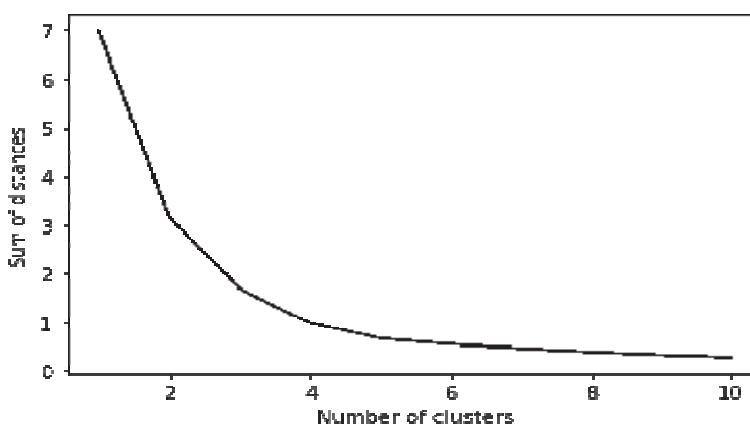

Figure 1. Elbow Method

Source: [17].

k centroid points which have an arbitrary location are formed at the second stage. Assignment of points to the centroid occurs by determining the Euclidean distance based on the formula:

$$p(x, y) = \left\| x - y \right\| = \sqrt{\sum_{p=1}^{n}(x_p - y_p)^2},$$

where $x, y \epsilon R^n$;

$x_p - x$ is axis value, $y_p - y$ is axis value.

The distance of all points to the centroids is calculated, new centroids are formed and the old ones are removed until the minimum distance of the points to the centroids is determined at the third stage.

In the course of this study, the clustering of Ukrainian banks was carried out as follows – parameters for cluster construction were selected; banks were grouped into clusters using the Python programming language and based on their description of business models; the indicators of business models were clarified, upon which the distribution of banks was adjusted.

The focus group has been formed to cluster Ukrainian banks, represented by 70 operating Ukrainian banks. The calculations of the coefficients are based on the data of the supervisory statistics of the NBU as of July 1, 2021.

It is necessary to form a system of indicators to identify bank business model. The review results of domestic and foreign studies show that scientists offer different approaches to the choice of indicators for building clusters of bank business models. For example, V. Rashkovan and D. Pokidin use the following indicators in the process of business model identification: assets/branches (UAH); average loan repayment period (in years); average loan amount (thousand UAH); share of equity and subordinated debt (shows the share of borrowed funds of the bank); the share of retail loans in income-generating assets; the share of retail financing in total liabilities without subordinated debt; the share of loans in assets [8]. Some of these indicators cannot be calculated based on public financial statements of individual banks, for example, the average maturity of loans (years), the average loan amount (thousand UAH).

A. Sinyuk identifies the following indicators (% of assets): bank loans, bank liabilities, loans to legal entities, liabilities to legal entities, loans to individuals, liabilities to individuals, trade assets [18] to form clusters of business models. This list is too cumbersome to identify business models. In addition, there is a close relationship between some of these indicators, leading to duplication of information.

O. Primerova, G. Kiselyova cluster banks by the following financial indicators:

return per unit of assets (ROA) – indicates how much net profit per unit of bank assets;

instant liquidity of the bank (H4) – reflects the ability of the bank to ensure the timeliness, completeness and continuity of all its monetary obligations;

capital adequacy (H2) – reflects the bank's ability to timely and fully pay its liabilities;

interest margin – determines how successfully the bank acts as an intermediary between bank depositors and borrowers [16].

M. Tsernov and T. Urbano propose to use a hybrid approach to highlight business models that uses both qualitative and quantitative indicators [12].

The National Bank of Ukraine provided the following list of indicators: loans to businesses; loans to individuals; funds placed in other banks; funds of business entities; funds of individuals; funds of other banks and international financial organizations [19] to identify bank business models. However, the NBU methodology does not specify exactly how the indicators are calculated (relative to the balance sheet currency or the share in the total volume of loans/deposits).

We considered the following provisions in research: calculations should be based purely on public financial statements; the indicator should be significant for the identification of business models; information should not be duplicated in determining individual indicators.

The article provides to use only two indicators to identify the Ukrainian bank's business models – deposits of individuals / total liabilities, loans to legal entities / total loans. The choice of these indicators is based on the following considerations: deposits of individuals are the largest in terms of both volume and share in the liabilities of banks, as well as a stable source of formation of the resource base of banks; the share of loans to legal entities in their total volume in the banking system of Ukraine is almost 80%, so this indicator is important for characteristic of the banks activities.

The article offers the calculations based on these indicators, the results of which are the basis for the separation of four clusters of banks in Ukraine. The authors calculated the average values of the parameters, as well as their range for each business model to determine which cluster the business models belong to.

The *first cluster* "Corporate Business Model with Retail Financing" is characterized by the average share of loans to legal entities in the loan portfolios of Ukrainian banks which is 94.2 %, the main share in liabilities is deposits to individuals, the average of which is 43.12 %. The *second cluster* "Universal Business Model" with average values of corporate loans/ total loans is 60.88 % and deposits of individuals/total liabilities are 38.97 %. The *third cluster* "Corporate Business Model" with average values of loans to legal entities/total loans is 93.94 % and deposits of individuals/total liabilities are 13.66 %. The *fourth cluster* is the Retail Business Model with 12.28 % of the average share of corporate loans/total loans and an average share of retail deposits/total liabilities is 76.77 %.

The results indicate that there are four business models, in contrast to the NBU methodology, which identifies five business models: *universal* – significant shares in assets and liabilities belong to transactions with legal

entities, individuals, other banks and non-banking financial institutions; *retail* – assets and liabilities are dominated by transactions with individuals; *corporate* – a significant share in assets are loans to legal entities, in liabilities – funds raised from legal entities; *corporate with retail financing* – the main share in assets belongs to loans granted to legal entities, in liabilities – funds raised from individuals; limited credit intermediation – the share of loans granted to legal entities and individuals is insignificant (less than 30 %) or the main share of loans granted to a limited number of persons, or active operations are financed with own funds [19].

The business model "limited credit intermediation" is inappropriate. Banks, which belonged to the business model "limited credit intermediation" according to the NBU classification, according to the author's methodological approach are classified into different business models according to the share of their credit operations with legal entities in the loan portfolio and deposits of individuals in total liabilities.

Author's clustering of Ukrainian banks according to four business models is presented in *Figure 2*.
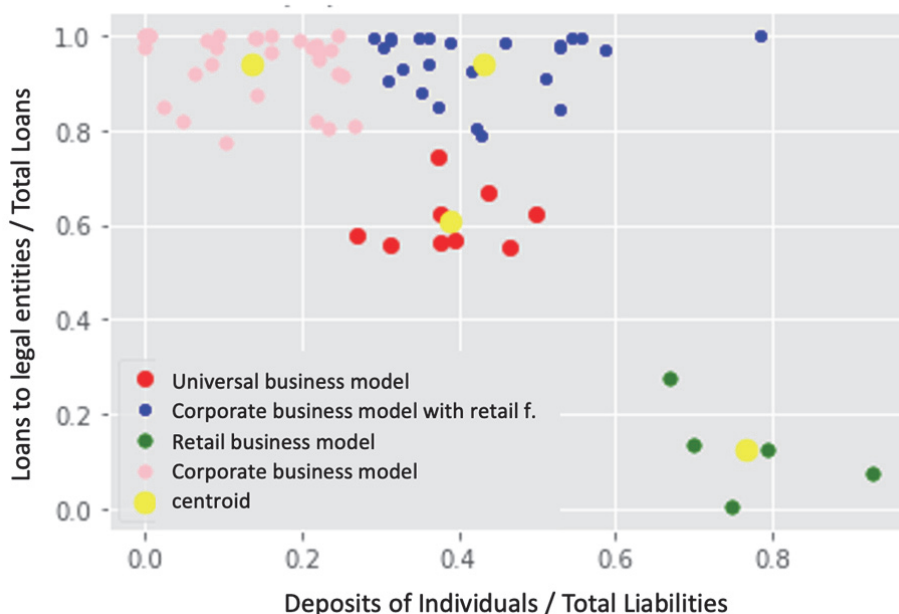

Figure 2. Clustering of Ukrainian banks according to business models as of July 1, 2021

Source: compiled by the authors on the basis of the supervisory statistics of the NBU [20].

The results of the clustering of Ukrainian banks show that 9 banks choose the universal business model (for example, JSC "ALFA-BANK", JSC "PUMB", JSC "KREDOBANK"); 26 banks prefer corporate models with retail financing (including JSC Oschadbank, JSC Raiffeisen Bank Aval, JSC UKRSIBBANK, JSC PROCREDIT BANK); 5 banks choose retail models

(JSC "UNIVERSAL BANK", JSC CB "PrivatBank", JSC "A – BANK" and others); 30 banks prefer corporate models (among them JSC "Ukreximbank", JSB "UKRGASBANK", JSC "CREDIT AGRICOLE BANK", JSC "ING Bank Ukraine", JSC "CITIBANK").

The authors offer methodological approach and conclude that the structure of the loan portfolio by type of borrowers significantly affects the formation of the bank's business model. The asymmetry of the location of banks by business models is presented in *Figure 3*.
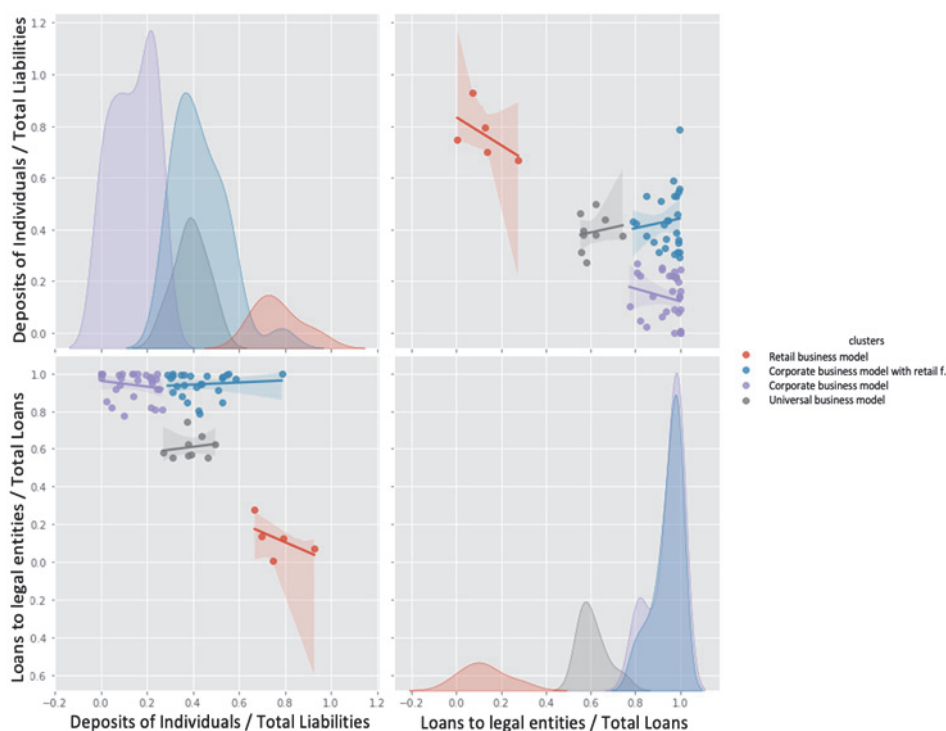

Figure 3. Clustering of Ukrainian banks according to business models and their asymmetry as of July 1, 2021

Source: compiled by the authors on the basis of the supervisory statistics of the NBU [20].

Another situation with asymmetry is in *Figure 3*, as for banks that belong to a corporate or retail business model, the share of loans granted to corporate and retail customers can reach 100 %. Such banks include ING Bank, JSC Deutsche Bank DBU, or JSC SEB CORPORATE BANK. Usually, a special asymmetry is formed in the direction of increasing the share of loans granted to the relevant types of customers in the loan portfolio of banks.

Each business model is characterized by a certain level of risk and financial performance [18]. To analyze them, it is important to select indicators of risk and financial performance of banks, which could be calculated on official financial statements. Such indicators should include authorized capital and reserves to the balance sheet currency, the share of cash and cash

equivalents in total assets, the ratio of loans to deposits, the ratio of loans to total assets, the ratio of operating expenses to total assets, return on assets, return on capital, rate of return (net profit / total income), measure of risk appetite (risk-weighted assets/total assets), the share of problem loans in the loan portfolio.

The average values on each business model are calculated according to the given list of indicators (*Table 1*).

Table 1

Average value on risk indicators and financial indicators on business models of the banks of Ukraine as of July 1, 2021

Business model	Authorized capital and reserves to total assets	The share of cash and cash equivalents in total assets	The ratio of loans and deposits	The ratio of loans to total assets	Share of non-performing loans	Measure of risk appetite	ROA	ROE	Rate of return	The ratio of operating expenses to total assets	Number of banks
Retail	0.2111	0.0367	0.7516	0.4818	0.29	0.7	0.0189	0.1869	0.284	0.0187	5
Corporate	0.2396	0.0617	4.4748	0.2357	0.2296	0.33	0.0068	0.0618	0.2447	0.0095	30
Universal	0.1848	0.0702	0.5768	0.3905	0.117	0.524	0.0048	0.0482	0.091	0.0098	9
Corporate with retail funding	0.1844	0.0758	0.7518	0.4413	0.178	0.584	0.0035	0.0302	0.0754	0.0123	26

Source: compiled by the authors based on the supervisory statistics of the NBU [20].

Data from *Table 1* (the deeper color, the better) show that the retail and corporate business model with retail financing, which specializes in serving mainly one type of customer, is characterized by the highest level of credit risk, the numerical value of which is 0.4818 and 0.4413, respectively.

The comparison of banks' business models in terms of risk and financial performance is based on the ranking method, the results of which are presented in *Table 2*.

Table 2

Ranks on financial indicators and risk indicators on business models of Ukrainian banks as of July 1, 2021

Business model	Authorized capital and reserves to total assets	The share of cash and cash equivalents in total assets	The ratio of loans and deposits	The ratio of loans to total assets	Share of non-performing loans	Measure of risk appetite	ROA	ROE	Rate of return	The ratio of operating expenses to total assets	Number of banks
Retail	3	1	3	1	1	1	4	4	4	1	5
Corporate	4	2	1	4	2	4	3	3	3	4	30
Universal	2	3	4	3	4	3	2	2	2	3	9
Corporate with retail funding	1	4	2	2	3	2	1	1	1	2	26

Source: compiled by the authors based on the supervisory statistics of the NBU [20].

The ranks of indicators are given in the *Table 2* (the deeper color, the better), which are determined in descending order (the better value of the indicator, the higher its rank). The amount of ranks is calculated separately for indicators of risk and financial performance.

Data from *Tables 1, 2* illustrate the following pattern: a riskier business model of banks generates higher financial performance.

Conclusion. The highest rank of *risk* (its lowest level) is observed in the *universal* business model, followed by *corporate*, *corporate with retail financing*, and *retail* business models, ranked from lower to a higher level of risk.

A similar ranking of banks' business models is based on *financial performance* indicators (the higher the rank, the better). The retail and corporate business models have the highest rank of financial efficiency. Lower ranks of financial performance are inherent in the corporate business model with retail financing (in 4th place) and the universal business model (in 3rd place). The most attractive is the corporate business model of the bank with an *integrated assessment* of the business model (considering both financial performance and risk).

The research results can be used by the National Bank of Ukraine for improving the methodology of banks' business models identification, as well as for deciding on the differentiation of regulatory instruments by the NBU, based not only on the size of a bank but also on the level of risk of its business model; when banks analyze their business models in terms of not only their risks and financial performance, but also a comprehensive assessment.

Banks' business models are not static due to the influence of exogenous and endogenous economic variables, such as the evolution of the banking system, macroeconomic and prudential restrictions, the competitive environment, financial and technological innovation, customer demand and business goals.

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Шульга Н., Омеленчук В. Кластеризація банків за бізнес-моделями.

Постановка проблеми. *Банки України суттєво різняться за складом активів, пасивів, джерел отримання доходів та витрат, рівнем ризиків та прибутковості діяльності тощо. В узагальненому вигляді структура активів, пасивів та доходів банку відображає його бізнес-модель. Відповідно до наглядового підходу – SREP (Supervisory review and evaluation process) банки та наглядові органи повинні проводити ідентифікацію та аналіз бізнес-моделей. Різні бізнес-моделі неоднаково можуть впливати на поведінку банків і мають відмінності в рівні їх прибутковості та ризиків. Від вибору бізнес-моделі банку залежить ефективність та стабільність функціонування, а також його конкурентоспроможність на ринку.*

Аналіз останніх досліджень і публікацій показав, що попри наявність суттєвих напрацювань з цієї проблематики, вона залишається дискусійною та до кінця не вирішеною. Це обумовило актуальність обраної теми дослідження та визначило його мету.

Метою дослідження є розкриття сутності методичних підходів до ідентифікації бізнес-моделей банків України, а також надання пропозицій щодо їх удосконалення.

Матеріали та методи. Теоретико-методологічну базу дослідження становлять наукові праці зарубіжних та вітчизняних учених. В основу дослідження покладено загальнонаукові та спеціальні методи пізнання: абстрактно-логічний, групування; статистичні.

Інформаційною базою дослідження є матеріали НБУ щодо деяких показників ризиків та фінансових показників банків України; фінансова звітність окремих банків; наукові публікації з досліджуваної теми.

Результати дослідження. За результатами дослідження виокремлено чотири бізнес-моделі, на відміну від методики НБУ, згідно з якою ідентифіковано п'ять бізнес-моделей. Кожну бізнес-модель можна оцінити за показниками ризику та ефективності.

Висновки. Найменш ризиковою є універсальна бізнес-модель, за якою слідують корпоративна, корпоративна з роздрібним фінансуванням та роздрібна бізнес-моделі, що проранжовані від нижчого до вищого рівня ризику. При інтегрованій оцінці бізнес-моделі (з одночасним урахуванням як показників фінансової результативності, так і ризиків) найбільш привабливою є корпоративна бізнес-модель банку.

Ключові слова: бізнес-модель банку, кластеризація, метод k-середніх, показники ризиків та фінансової результативності, метод ранжування, ранг показника.