BANK BUSINESS MODELING AND LEVELS OF NON-PERFORMING LOANS:
PERSPECTIVES OF INTERACTION RISK FACTORS IN UKRAINE

Olha Vovchak
University of Banking of the National Bank of Ukraine, Kyiv, Ukraine

Serhiy Reverchuk
Ivan Franko National University of Lviv, Ukraine

Viktoria Rudevska
University of Banking of the National Bank of Ukraine, Kyiv, Ukraine

Khlan Yaroslav
National Bank of Ukraine, Kyiv, Ukraine

ABSTRACT

This article identifies five different banking business models using the k-means method and demonstrates how banks carried out the migration between defined clusters during the banking crisis. The article identifies and links the banks with the business model they are most exposed to in terms of risk of insolvency. The factors that influence the rate of non-performing loans are defined. Constructed econometric models will allow banks with certain business models to improve their activity with non-performing loans. The article also analyzes how the amount of loans to related parties can be injected into the amount of non-performing loans.

Keywords: bank business model, cluster analysis, non-preforming loans, balances dollarization, credit to affiliated person

INTRODUCTION

Among the consequences of the banking crisis in Ukraine in 2014-2017 was a withdrawal of 87 banks from the market, most of which were associated with large industrial groups and their excessive lending or money laundering schemes. These financial institutions did not have a clear and adequate strategy for their development but were just an instrument for financing the owners' main activity. Indicators of the paying capacity and efficiency of the bank to a considerable degree depend on the chosen strategy. Considerable competition among banking institutions and their strengthening, as a result of the development of fintech companies, makes the management of a bank

develop new strategies for the future effective functioning in the market. Thus, the quality assessment of business models of commercial banks takes on special significance.

The banks suffered heavy losses, taking into account the significant decline of the borrowers' paying capacity and, as a result, their failure to service loans. By the end of the banking crisis the largest share of unpaid (non-performing) loans ever was recorded. As a result, solving the problem of reducing loans that are at risk for non-payment is extremely important for improving the efficiency of individual banks and the banking sector in general. Solving the issue of non-performing loans is one of the mandatory requirements of the Memorandum on Economic and Financial Policies between Ukraine and the International Monetary Fund.

LITERATURE REVIEW

The literature review regarding factors affecting the level of non-performing loans presented an opportunity to systematize an assessment of the loans. Thus, at the initial stage of the research, the scientists considered only external (exogenous) factors. Such an approach is useful and can only be used in macroeconomic analysis. In the works of recent years, scientists are increasingly using internal factors of the banking sector at an aggregated level. Such studies provide an answer to the question of the aggregate figures' impact on the individual level of non-performing loans of a particular financial institution (Table 1).

Table 1. The main factors that influence the volume of non-performing loans

Scientists	Factors that influence the amount of non-performing loans
Sinkey, J. F., Greenawalt, M. B.	High discount rate, credit interest rates, volatility of funds.
Demirguc, A., Detragiache, E.	GDP growth, terms of trade, the volatility of the exchange rate, real discount rate, inflation, government deficit to GDP.
Kauko, K. Al Hassan A.	GDP growth, level of inflation, deficit of running account, unemployment, discount rate, public debt, per capita income, quantity of money.
Badar, M. Javid, M. [	Inflation, volatility of exchange rate, interest rates, GDP growth, quantity of money.
Omoruyi, E.	Real discount rate, real exchange rate, inflation, level of unemployment, GDP growth.
Çifter, A.	Concentration level of banking system, balance of payments deficit, volatility of exchange rate, level of unemployment.
Muhammad, A. Hassan, M.	Number of the members of a supervisory board, independence of the members of a supervisory board, ownership concentration.
Kumarasinghe, P. J.	GDP growth, level of unemployment, inflation, level of the discount rate, export growth, market of capital growth.
Mazreku, I., Morina, F.	GDP growth, inflation, export growth, level of unemployment.
Koju, L., Koju, R., Wang, S.	GDP growth, foreign debt per capita, level of inflation, transfers share in GDP, share of bank credits in assets, credits and deposits ratio, average value of capital adequacy, assets profitability, assets extent.
Pop, I. D., Chicu, N., Răduțu, A.	Bank size, assets profitability, credits and deposits ratio, ownership structure, independence and transparency coefficients.

Source: compiled by the authors on the basis of the studied materials

Summarizing the research of the factors that affect the volume of non-performing loans, it is affirmed that this issue needs a comprehensive solution due to the significant impact of the external economic environment, regulatory requirements, and the banks' internal strategy. Due to the strengthening of regulatory requirements for the assessment of banking business models, there has been an increase in the number of studies devoted to this topic in

recent years. Today there are several approaches to defining business models of banks and their classification among the researchers.

The definition of a business model is being approached from different points of view, considering it as a set of actions that create value if there is a usage of favorable opportunities ; a system that reflects what actions the company performs, how and when ; a link of the value between the supply of resources and the economic results; stories that explain how an enterprise works ; description of how the organization creates economic, social, and other values. Clarifying this concept precisely for the banking sphere, it can be stated that the business model of the bank is a set of management elements of a financial institution with a clear distinguishing of priority activities, which are reflected in the structure of the bank balance. This approach is universal that allows to evaluate business models on the basis of the respective bank's key performance indicators that are available to the public.

On the basis of the literature analysis, the following types of banking business models were identified. Their classification is given in Table 2.

Table 2. Types of bank business models and objects of study

Scientists	Types	Object of study
Ayadi, R., De Groen, W. P. (2015)	Retail-oriented, diversified retail (1st subgroup); diversified retail (2nd subgroup), investment,	Sample of banks from 32 European countries
Tsatsaronis, K. (2017)	Universal, financed by private deposits, financed by debt instruments, aimed at execution of trading operations	178 banks in 34 countries over the 10-year period of operation
Ayadi, R., Arbak, E. (2011)	Retail-oriented, investment, aimed at execution of trading operations	26 of the biggest European banks and banking groups
Japparova, I. (2017)	Banks specializing in servicing international clients, banks specializing in servicing national clients	23 Latvian banks
Kornyliuk, R. (2018)	Universal, retail, corporate, banks with corporate lending due to financing individuals, frozen	180 Ukrainian banks
Rashkovan, V. Pokidin, D. (2016)	Universal, retail, corporate, frozen, investment, household corporations	180 Ukrainian banks There are 77 banks

Source: compiled by the authors on the basis of the studied materials

Taking into account the grouping of banks, researchers are actively using both the elements of mathematical modeling and the set of expert opinions. In addition to the heterogeneity of the analysis methods, another obstacle to developing a universal approach to assessing business models is the heterogeneous external impact on banking activities. The factors influencing this include the availability and effective functioning of financial markets, a favorable regulatory environment, a positive investment climate of the country, etc. As a result, there is a lack of a clear and unambiguous approach to the definition of business models of banks.

Ukrainian banking sector researchers point to dependence between business models and indicators that characterize illegal banking activities or between indicators that characterize liquidity and bank paying capacity. Therefore, it is assumed that the selected bank business model may have an influence on the level of non-performing loans (as one of the indicators of the bank's performance efficiency). So (2019) the hypothesis of our research is that the chosen business model is one of the factors influencing the level of non-performing loans. The second hypothesis is that the growth of insider lending leads to an increase in the number of non-performing assets.

METHODOLOGY AND DATA

The conducted research *de bene esse* can be divided into several parts. In the first part, the main business models of Ukrainian banks were identified. The second part of the work is an analysis of the influence of the main factors on the level of non-performing loans of the bank.

The methodology of business models' clustering.

The process of clustering banks according to their business models was carried out by the k-means method. It is the most popular practice for clustering worldwide. The method is based on minimizing the sum of squares of distances between each observation and the center of its cluster - the function. It can be described by the formula:

$$\min f(J) = \sum_{j=1}^{k} \sum_{i=1}^{n} \left\| x_i^{(j)} - c_j \right\|^2, \quad (1)$$

where $\left\| x_i^{(j)} - c_j \right\|^2$ is a distance between separate observations $(x_i^{(j)})$ and the center (c_j) of the cluster k.

During the formation of the list of indicators used for the clustering of business models, the nature and volume of active and passive operations in the context of each bank and their main counterparties was analyzed. Due to the low interest of banks in investment activity (the value of the total investment indicator [H12] in the banking system in general on January 1, 2019, was 0.15%), the clustering process was conducted on the basis of indicators of bank lending and deposit activity in terms of the activities of economic entities. The subjective approach is not new to the analysis of business models and is actively used by both foreign researchers and Ukrainian ones. The analysis conducted was based on the following indicators:

1) $Q_{l\%} = \frac{Q_{loans}}{Q_{assets}}$, where Q_{loans} is a gross loan portfolio, Q_{assets} – overall bank assets. This indicator shows how active the bank is in fulfilling the financial intermediation function. The low value of this indicator will be evidence of the limited activity of the bank in the credit market and, as a result, its insignificant influence on the financial stability of the banking system.

2) $Q_{p.l.\%} = \frac{Q_{pivate\ loans}}{Q_{loans}}$, where $Q_{private\ loans}$ is a volume of gross loans granted to individuals. The great importance of this indicator will show the active policy of the bank in the consumer lending market. In turn, the small rate of the indicator means the bank orientation for corporate lending.

3) $Q_{p.d.\%} = \frac{Q_{private\ deposits}}{Q_{deposits}}$, where $Q_{private\ deposits}$ is a number of deposits from individual persons, $Q_{deposits}$ total deposit portfolio of the bank. This indicator reveals the main sources of bank financing. Its importance indicates the orientation of the bank to deposits of individuals, while the low value shows that the bank's activities are mainly carried out at the expense of legal entities.

4) $Q_{\%} = \left| \frac{Q_{pivate\ loans}}{Q_{loans}} - \frac{Q_{private\ deposits}}{Q_{deposits}} \right|$ is a complex indicator revealing the financing nature of the main banks' activities. A small value indicates the homogeneity of the banks' business model, that is, focusing on cooperation with a subjective group (individuals or legal entities). In turn, great importance indicates a different approach to the implementation of active and passive operations

5) In addition, it should be noted that the authors in their study did not use the subjective indicators to ensure greater objectivity of the results, including affiliation with an international banking group, the management quality of the banking institution, and the existence of additional business among the shareholders of the bank. Such restrictions have been deliberately created for ensuring greater reliability of the built models.

Methodology for determining the main factors of the level of non-performing loans

The analysis of the main balance indicators of banks' functioning (in combination with preceding theoretical studies) let the researchers identify the main factors of influence on the level of non-performing loans. They include:

1. Dollarization level of the balance-sheets of commercial banks. Analysis of scientific literature indicates that there is a positive correlation of this factor, given the high risk of foreign currency loans and the high probability of termination of their services. The Ukrainian experience showed that one of the consequences of financial crises is the depreciation of the national currency. This, in turn, complicated the servicing of loans both for individuals and for businesses, and the share of non-performing loans grew. This is precisely what urged the banks to limit loaning to individuals in foreign currencies at the legislative level, while there are no restrictions for corporate lending. Therefore, the question of the impact of dollarization of balances on the level of non-performing loans needs additional analysis. It should also be noted that the activity of banks in foreign currency lending does not provide them with higher profitability. The leaders in terms of income have a much lower share of loans in foreign currencies than the average in the sector.

2. The vulnerability of the bank's financial stability. It is expressed in the adequacy of regulatory capital. It should be noted that scholars do not have a clear and unambiguous position on the causal connection between the level of insolvency and the value of capital adequacy. According to our assumptions, there is a negative correlation between these factors. That is, for a decrease in the indicator of capital adequacy, the level of unprofitable loans of the bank should increase.

3. A significant concentration of loan portfolio in the context of debtors. The impact of this factor was estimated using the maximum credit risk exposure per counterparty (norm H7) and the indicator of large credit risk (norm H8). The growth of concentration has a positive correlation with the level of non-performing loans and jeopardizes the bank in the future.

4. The level of related lending. The risk of significant insider lending was fully realized during the last banking crisis. Thus, during the 2016-2017 years, 13 banks were eliminated due to excessive lending to affiliated parties and, as a consequence, a loss of liquidity and the capital. Then, we can hypothetically assume that the growth of insider lending leads to an increase in the volume of non-performing loans.

5. Effectiveness of running of the banking business. The use of the banks' indicator of the ratio of expenditures to income indicates the viability of the business model in terms of ensuring sufficient profitability of the banking institution. As a rule, more efficient banks have less value of non-performing loans . Based on that assumption, this influence will also be traced during the study.

As a result, the overall model for each cluster will be of the form:

$$NPL_k = \beta_0 + \beta_1 * \frac{foreign\,credit}{total\,credit} + \beta_2 * CAR + \beta_3 * N7 + \beta_4 * N8 + \beta_5 * N9 + \beta_6 * \frac{cost}{income} + \varepsilon \quad (2)$$

Data

For fulfillment of clustering of business models of banks, NBU data was used from 01.01.2014 (pre-crisis period) until 01.01.2019 (post-crisis period). It should also be noted that as of 01.01.2014, the banking sector of Ukraine had 180 financial institutions, while as of 01.01.2019 there were 77 remaining (at the same time, the calculation was based on the data of 75 banks, since JSC "Vernum Bank" announced the termination of banking activity without termination of a legal entity, as well as to the general calculation, the data of JSC "CB PrivatBank" were not taken into account because of a specific business model, which was evaluated separately). The analysis of the influence of the main factors on the level of non-performing loans was made by means of the main indicators of the activity of certain financial institutions as of 01.01.2019.

RESEARCH RESULTS

The clustering of banks facilitated the

separation of five groups of banks according to their business model: retail, corporate, universal, corporate with retail financing, and a model of limited credit intermediation.

A general descriptive analysis is presented in Tab. 3.

Table 3. Descriptive analysis of defined business models at the beginning of the period

	Cluster	Retail				Corporative			
	Index	mean	std.dev.	min	max	mean	std.dev.	min	max
2014	1	63.60%	0.212	84.70%	29.90%	61.90%	0.1	79.20%	44.00%
	2	82.50%	0.147	98.20%	55.40%	18.60%	0.156	51.30%	0.00%
	3	72.70%	0.165	99.10%	47.50%	28.90%	0.165	49.10%	0.00%
	4	18.20%	0.074	26.40%	2.70%	10.70%	0.088	30.30%	0.00%
2018	1	57.80%	0.162	29.30%	57.80%	59.70%	0.115	37.20%	80.90%
	2	74.70%	0.197	50.90%	74.70%	12.00%	0.123	0.00%	40.50%
	3	68.60%	0.166	45.10%	68.60%	29.20%	0.157	0.00%	49.90%
	4	11.40%	0.061	3.30%	11.40%	17.20%	0.121	0.00%	37.80%
	Cluster	Universal				Corporative with private funding			
	Index	mean	std.dev.	min	max	mean	std.dev.	min	max
2014	1	43.60%	0.103	59.80%	25.80%	62.20%	0.147	88.50%	33.70%
	2	10.30%	0.097	38.10%	0.00%	5.20%	0.051	18.50%	0.20%
	3	39.90%	0.098	61.30%	24.70%	58.00%	0.12	87.30%	36.00%
	4	29.60%	0.067	38.70%	13.70%	52.80%	0.117	87.10%	35.40%
2018	1	29.30%	0.171	0.00%	56.60%	63.40%	0.101	42.50%	80.80%
	2	16.40%	0.224	0.00%	96.90%	3.50%	0.033	0.00%	12.30%
	3	52.20%	0.138	15.40%	84.40%	61.10%	0.105	43.90%	85.30%
	4	45.40%	0.143	24.30%	81.50%	57.60%	0.116	40.50%	84.10%
	Cluster	Limited							
	Index	mean	std.dev.	min	max				
2014	1	16.30%	0.101	30.30%	0.00%				
	2	14.40%	0.308	100%	0.00%				
	3	27.80%	0.242	67.00%	0.00%				
	4	29.80%	0.3	89.90%	0.00%				
2018	1	29.50%	0.205	0.00%	80.70%				
	2	2.80%	0.063	0.00%	20.40%				
	3	15.20%	0.117	0.00%	33.20%				
	4	12.50%	0.118	0.00%	33.20%				

Source: compiled by authors on the basis of their own calculations

- **Retail business model.** The main characteristics of this model are a significant focus on lending to individuals, including through the attraction of deposits from private clients. For this model, an extensive branch network and an active presence in households are also common. The benefits of such a business model are *low concentration on a single borrower* and in the context of lending industries. Among the negative aspects, is the high risk of operations, which is associated with the uncertainty and unpredictability of private clients. Another disadvantage for such a group of banks is the significant administrative expenditures associated with the need to maintain an extensive network of bank branches and active advertising activities.

- **Corporate business model.** Unlike retail banks, this group of financial institutions focuses its activities specifically on cooperation with corporate clients. Instead, individual lending takes a small part in the banks' portfolio or none at all. The benefits of such a model include low administrative costs, connected with the need to maintain a wide network of branches. Among the disadvantages is a significant level of competition between banks for solvent customers, whose number considerably decreased in the crisis period.

- **Universal business model.** This group of banks is characterized by the significant shares in assets and liabilities coming from transactions with legal entities, individuals, other banks, and non-bank financial institutions. Among the benefits of this model, we will note significant diversification of business, both in terms of major counterparties and economic activities.

- **A corporate business model with retail financing.** This model is the most typical for the banking market both in the pre-crisis and post-crisis period. The main share in the portfolio is comprised of loans granted to legal entities, and liabilities are borrowed from individuals. In addition to that, there is one more group, such as captive banks. They are characterized by a large proportion of active operations carried out with related parties.

- **A limited credit intermediation model.** This model includes banks that do not carry out active lending. The share of loans granted to legal entities is insignificant, and almost all active operations are funded by the expense of shareholders' equity.
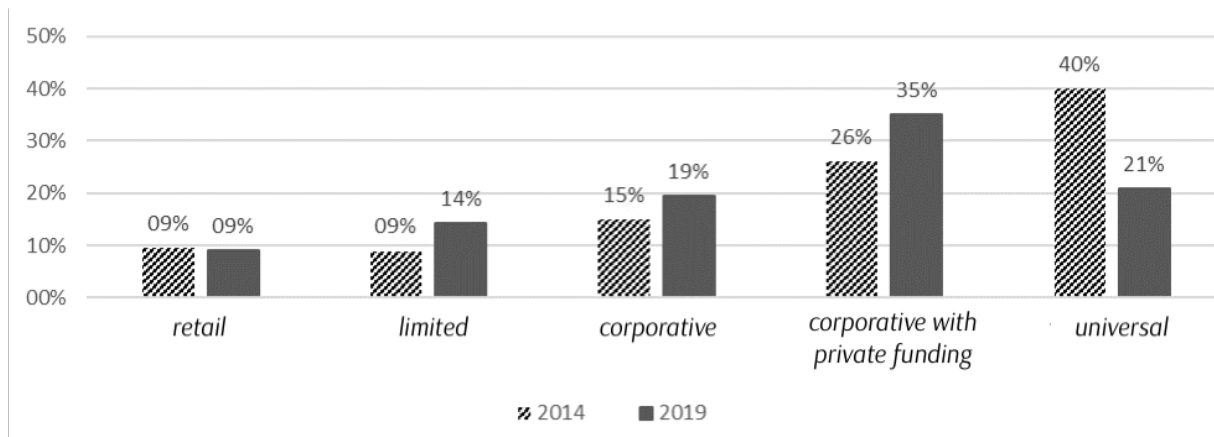

Figure 1. Structure dynamics of the banking system in the context of business models in Ukraine (% of the total number of banks at the beginning of the period)

Source: compiled by authors on the basis of their own calculations

As a result of the analysis, it became clear that in the pre-crisis period most banks used a universal model. This is largely due to the lack of diversification in the strategies of Ukrainian

banks and the targeting of all typical banking operations, including both legal entities and individuals (Figure 1). At that time, the banks with a retail business model and banks with limited credit intermediation created the smallest group, which indicates little interest, due to riskiness, low profitability, and significant administrative costs.

The negative consequences of the financial crisis have affected not only the number of banks but also the business models of those that remain in the market. Thus, at the beginning of 2019, the share of universal banks in the system has decreased almost twice. This is due to the deepening of the specialization of banks, the selection of the model of functioning in the market, and its own *niche* clients. Also, the share of banks that do not carry out active lending and deposit activity has increased. However, their amount is still less than 2% of the total assets of the system, and therefore they do not have a significant impact on financial stability (Figure 2).
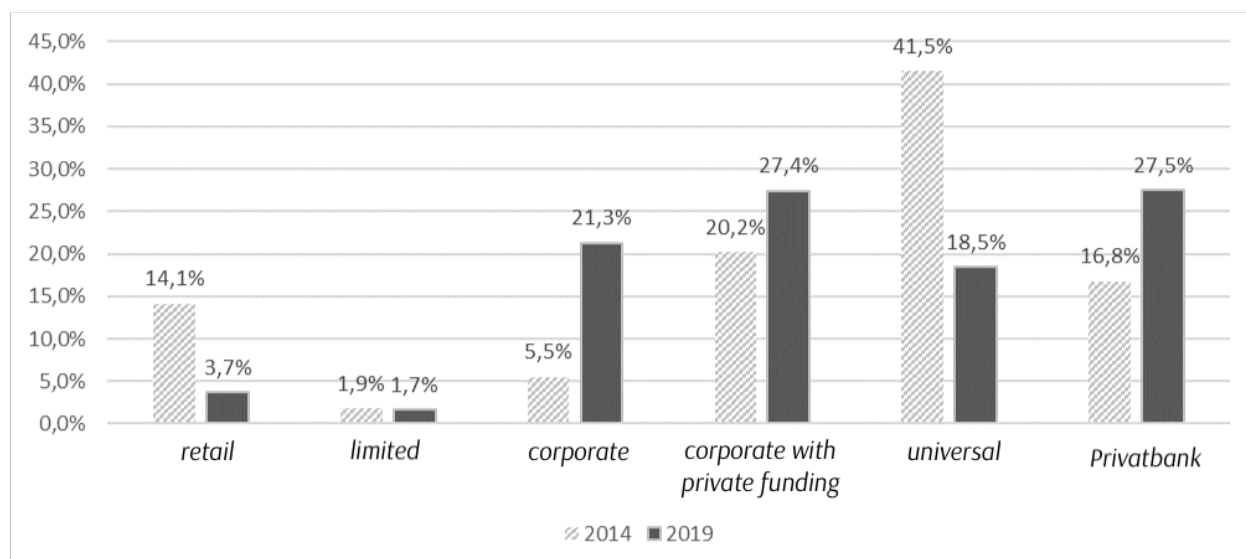

Figure 2. Structure dynamics of total assets of the banking system in terms of business models in Ukraine (% of total assets of the system as of the beginning of the period).

Source: compiled by the authors on the basis of activities.

As documented, at the beginning of 2019, the total assets of JSC CB PrivatBank accounted for 27.5% of the total assets of the system and equaled the assets of banks with a corporate business model with retail financing (the share of which in the total number of banks is 35.1%). It indicates the systemic importance of this financial institution for the financial stability of the banking system. The largest increase in assets is in the group with the corporate business model, which confirms the conclusion about the attractiveness of this development strategy for banks. Changes in the share of assets are related not only to their increase but also to the migration of banks between clusters (Table 4).

According to the matrix, the most stable group of banks were those with a retail business model: from 17 banks at the beginning of 2014, 6 keep operating with the indicated business model and in the post-crisis period. Instead, the most unstable cluster is a "universal" group: from 72 banks at the beginning of 2014, more than half were considered insolvent.

A significant proportion of insolvent banks was in the group with the corporate business model with retail financing, since historically such a model of functioning was popular among small banks and those involved in crediting the affiliated persons. It is significant that only 18% of banks with a limited credit intermediation

model at the beginning of 2014, started active banking activities (carrying out standard banking operations for lending and raising funds) by 2019, and most of these banks were considered insolvent.

Table 4. Matrix of banks migration between the clusters of defined business models in Ukraine

2019 / 2014	Retail	Limited	Corporate	Corporate with retail funding	Universal	Insolvent	Total
Retail	6	1	3	0	2	5	**17**
Limited	0	6	1	1	1	7	**16**
Corporate	0	1	4	1	2	19	**27**
Corporate with retail funding	0	1	2	11	4	29	**47**
Universal	1	2	5	13	8	43	**72**
Total	7	11	15	26	17	0	**179 / 76**

Source: compiled by authors on the basis of their own calculations

Going back to our hypothesis regarding the impact of the chosen business model on the level of non-performing loans, we can state that the largest volume (without taking into account the indicators of JSC "CB PrivatBank") of such loans is in a cluster characterized as a corporate business model with retail financing (Figure 3).

Such a distribution of non-performing loans is primarily caused by the size of the identified clusters. Thus, the cluster of the corporate business model with retail financing accounts for 27% of the total assets of the system. In addition, a significant part of the non-operating assets of the system in this cluster is due to the classification of this segment of the largest state bank (with the exception of JSC CB PrivatBank), as well as banks with Russian foreign capital, which, since 2014, have structural problems with the quality of their assets. Banks with limited credit intermediation account for only 0.11% of all non-operating system credits due to the selected business model and suspension of active lending for the analyzed period.
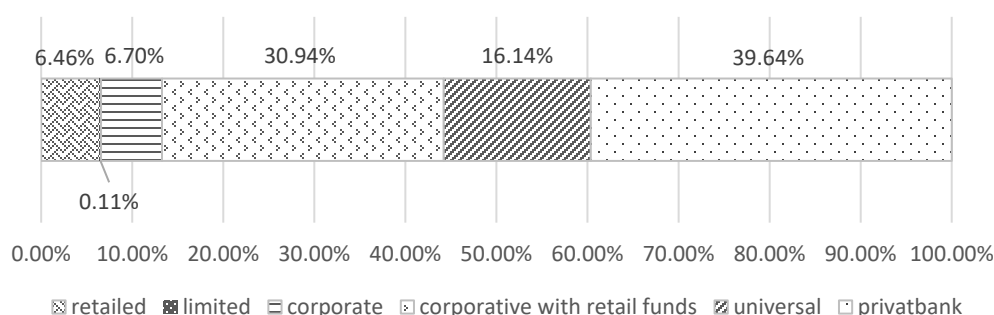

6.46% 6.70%   30.94%   16.14%   39.64%

0.11%

0.00% 10.00% 20.00% 30.00% 40.00% 50.00% 60.00% 70.00% 80.00% 90.00% 100.00%

▨ retailed ▩ limited ☰ corporate ⊡ corporative with retail funds ▧ universal ▢ privatbank

Figure 3. Distribution of non-performing loans (where 100% is the total amount of non-performing loans) in the context of business models of banks as of 01.01.2019

Source: compiled by the authors on the basis on metrics

Analysis of the amount of non-performing loans and their shares in the total loan portfolio

shows that one bank - JSC CB PrivatBank - has the largest figures. It is related to the business model of the former shareholders of the bank and a significant concentration of loans provided to affiliated individuals (Figure 4).
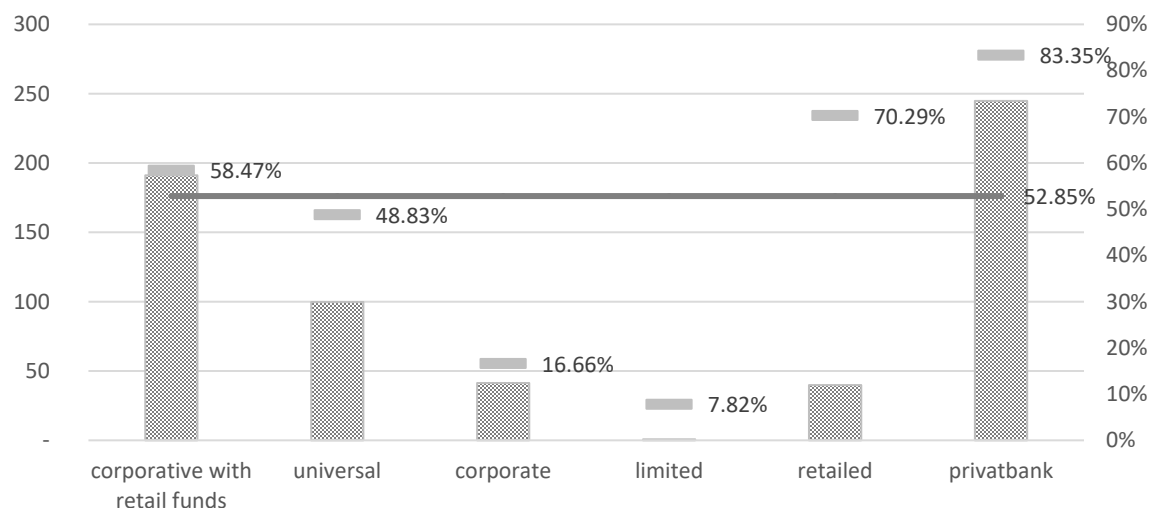

Figure 4. The volume of non-performing loans, their share in the total loan portfolio in terms of business models and the average value of the share of non-performing assets in the banking system of Ukraine, as of 01.01.2019

Source: compiled by the authors on the basis of activities.

The problem of servicing loans granted to affiliated persons (AP) is typical not only for this particular financial institution but also inherent in a group of corporate banks with retail financing, and the share of non-performing loans in this group is higher than the average system performance. In addition, the dynamics of the volume and quality of loans provided to affiliated persons shows that over the last period their size has increased significantly, which is due both to the recognition of old loans and the provision of new ones. Servicing of these loans has become worse due to the lack of real cash flows of borrowers and their weak financial position (Figure 5).

Returning to the analysis of business models, there is a significant proportion of non-performing loans among the group of retail banks (70.3%), due to their insignificant volume (6.5%). This situation may be explained by both the high risk of such operations and the legislative restrictions on the repayment of such loans at the expense of provision (in accordance with the Law of Ukraine "On the moratorium on the collection of property of the Ukrainian citizens granted as ensuring for loans in foreign currency"). Instead, corporate-oriented banks, having almost identical volumes of non-performing loans (6.7%) in the system, account for a share in total loans of the group at the level of 16.7%, which is significantly lower than the average for the system as a whole (52.9 %) Thus, these banks do not have a significant amount of deposits of natural persons in the structure of obligations, and therefore do not depend on possible panic of the population. Instead, with more reliable sources of financing, this group of banks can provide loans for a longer period, thereby ensuring higher returns. In addition, corporate clients are required to have their own business plan and financial reporting, which allows banks to minimize future risks. It is significant that the determination of the solvency and riskiness of operations with corporate clients is under constant supervision of the NBU (the biggest banks undergo an annual assessment of sustainability, one of the stages of which is stress testing of the corporate clients - major borrowers) as one of the stages

of determining the financial stability of the banking system. So, in 2019, the second annual assessment of banks' resilience will take place, consisting of asset quality assessment (AQR) and stress testing of the largest banks in terms of risk-weighted assets and deposits of natural persons. The volume of risk-weighted assets is not only a measure of the size of a financial institution, but it also helps to assess the bank in terms of risk and potential impact on the banking system as a whole. The volume of deposits of the population is also an indicator of

the social and socio-economic stability of the banking system. Bank insolvency with a large deposit portfolio of individuals can lead to a loss of confidence in the entire sector and devastating consequences for the entire economic system [23]. That is why these two are the key factors in structuring the sample of banks for stress testing. In 2019, the list of such banks included 29 financial institutions accounting for 93% of the assets of the banking system.
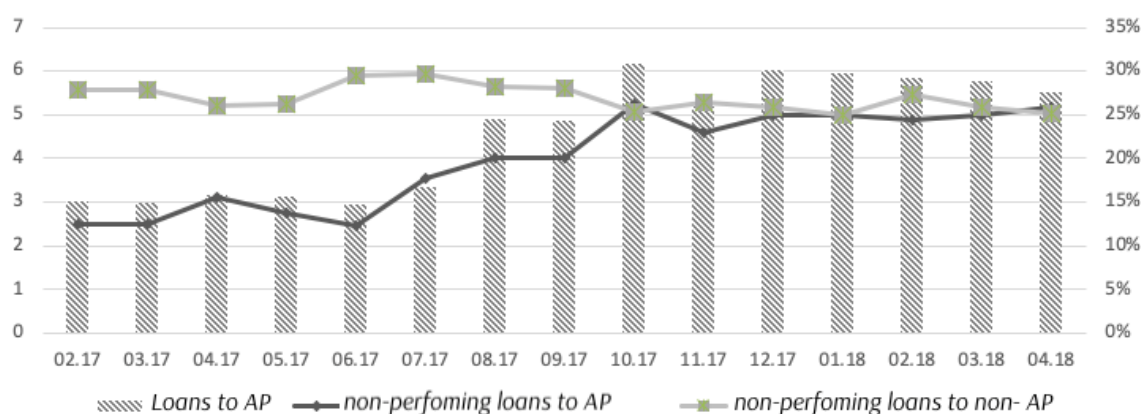

Figure 5. Non-preforming loans (UAH, billions), granted to persons, affiliated with banks, and the share of non-performing loans in domestic banks (%)

Source: compiled by the authors on the basis of activities.

Stress testing is a common tool for detecting risks of the system. Central banks use it for micro- and macro-prudential regulation. The purpose of its use is not to predict the possible development of events in the sector, but to determine what might happen to banks in the event of a crisis. To do this, the NBU models the losses of banks from the hypothetical crisis and determines the need for capital to cover such losses. For stress testing, the NBU develops two scenarios: a basic and an unfavorable. The latter contains the factors of the greatest risks, the assumptions of which are based on the statistics of previous crises and are consistent in terms of macroeconomic interconnections.

A stress-testing exercise, conducted in 2018, revealed that eight banks need capital in the baseline scenario. The sum of this need is 6 billion USD. Instead, in an unfavorable scenario,

capital requirements are much higher. For 12 financial institutions, there is a need for capital in the total amount of 1.7 billion USD. Considering that a substantial part of this amount falls on state-owned banks, it is promising to consider the causal-effect relation of low-quality assets of state-owned banks in further research.

The conducted correlation analysis of the factors, according to model (2), shows that there is a statistically significant correlation between all the regressors in our study. The highest level of correlation for the model of corporate banks with retail financing is 0.61; for the model of corporate banking only - 0,31; for the model of universal banks - 0,75 and indicates the absence of signs of multicollinearity among regressors.

Regression analysis reveals that all built

econometric models are significant since $F_{factual}$ is bigger than $F_{critical}$. It should be noted that for all models there is a positive regression relation between the level of non-performing loans and the share of foreign currency loans in the respective bank's portfolio (Table 5).

Table 5. The main indices of regression analysis of the selected models

Indices	Corporative with retail funds	Corporative	Universal
a_1	0.32343105	0.80533612	0.59053383
a_2	-0.21376401	0.01912380	-0.29874864
a_3	0.69260264	1.29954688	-0.38805507
a_4	-0.00032563	-0.00107629	-0.00018474
a_5	-0.04712015	0.15344653	0.28129824
a_6	-0.00080778	0.70811312	-0.03499269
a_0	0.08531390	-0.58703323	0.31107670
R^2	0.57018666	0.83555416	0.48045734
multiple R^2	0.75510705	0.91408651	0.69315030
F-criteria	4.20087274	4.38715466	6.77470595
Standard error	0.18512088	0.08399225	0.17796624
Number of observations	26	15	16

Source: compiled by authors on the basis of their own calculations

Consequently, in the case of an increase in the volume of foreign currency loans, the share of bank non-performing assets will also increase. This regressor is most significant for all constructed models, and, therefore, it can be argued that solving the problem of dollarization of balances will lead to a reduction in non-performing loans. In order to stimulate banks to carry out currency restructuring of granted loans (including non-performing ones), it is reasonable to establish additional risk weights for currency assets and tougher requirements for the assessment of credit risk for foreign currency loans. Considering these actions, the currency risk for banks and their clients should decrease, and, as a result, the level of unemployed loans will decrease. In addition to the impact of foreign currency loans, a positive correlation with the level of non-performing loans also has a portfolio concentration ratio (norm H7) and a level of loans granted to related parties (norm N9). Ipso facto, the

previous theoretical studies and hypotheses regarding the negative impact of concentrations and related lending on the level of non-performing loans was confirmed.

Applying the Chaddock scale to determine the qualitative level of communication between the regressors it was established that the model of corporate banks with retail financing and the model of *pure* corporate banks have a high correlation between dependent and independent variables, and the model of universal banks has a moderate one. In addition, the determination coefficients (R2) of the *pure* corporate banks model indicate that the result of the level of non-performing loans of 91.40% depends on the selected factors for all banks in this group, indicating the significance of this model. As a result, certain models will look like this:

• Model for a group of corporate banks with retail financing:

$$NPL = 0.08 + 0.32 * \frac{foreign\ credit}{total\ credit} - 0.21 * CAR + 0.69 * N7 - 0.01 * N8 - 0.05 * N9 - 0.01 * \frac{cost}{income} \qquad (3)$$

- Model for a group of "pure" corporate banks:

$$NPL = -0.58 + 0.80 * \frac{foreign\ credit}{total\ credit} + 0.02 * CAR + 1.30 * N7 - 0.01 * N8 + 0.15 * N9 + 0.71 * \frac{cost}{income} \qquad (4)$$

- Model for a group of universal banks:

$$NPL = 0.31 + 0.59 * \frac{foreign\ credit}{total\ credit} - 0.29 * CAR - 0.39 * N7 - 0.01 * N8 + 0.28 * N9 - 0.03 * \frac{cost}{income} \qquad (5)$$

However, it is important to note that the researchers have not built models for a group of retail banks nor for a group of banks with limited credit intermediation. Not building these models is because of the small sample of such banks, and, consequently, the lack of potential significance of these models. Determining the factors that affect the level of non-performing loans for these groups of banks requires further information processing and analysis.

CONCLUSION

As a result of Ukrainian banks clustering in the context of the main groups of counterparties, it is determined that:

- The biggest number of non-performing loans was at one financial institution - JSC CB PrivatBank, which is connected with its previous development strategy and a significant level of lending associated with former shareholders of the Bank;
- The largest share of non-performing loans has a group of retail-oriented banks, which indicates the imperfection of the system of assessing the solvency of borrowers and established regulatory constraints. The number and size of such banks are insignificant, which demonstrates the low interest of shareholders in this development model;
- If talking about the number and size of total assets, the largest group is one of the corporate banks with retail financing. This is due to the historical preconditions of the Ukrainian banks' creation. The lion's share of such banks has strong signs and carries out an excessive number of transactions with affiliated persons.

The evaluation of influence on the level of non-performing loans lead to the following conclusions:

- The factor of significant lending to affiliated persons is one of the main factors influencing the level of non-performing loans. Therefore, it is reasonable for banks of most identified groups to minimize related lending by imposing additional restrictions;
- Apart from the factor of a significant volume of related loans, the dollarization of the balance sheets of banks negatively influences the level of non-performing loans. It is empirically proven that this model has the most significant impact on the level of non-performing loans among all models. Therefore, the introduction of additional regulatory restrictions to assess credit risk for such loans will reduce their share in the overall portfolio of banks and bring financial institutions closer to addressing the problem of non-performing loans.

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ABOUT THE AUTHORS

Olha Vovchak, email: vovchak.olga@meta.ua

Dr. Olha Vovchak is the Professor and Head of the Department of Finance, Banking and Insurance at University of Banking of the National Bank of Ukraine. She is the author of 12 monographs, 15 books and 200 articles. Dr. Vovchak is an Academic of the Ukrainian Academy of Economic Sciences. She investigates the functioning of the banking system, state regulatory banking investment, mutual assistance in the financial and real sector of the economy.

Dr. Serhiy Reverchuk is the Professor and Chair of the Banking and Insurance Department at the Ivan Franko National University of Lviv, Ukraine. He is the author of 12 books and 185 articles. Dr. Reverchuk is an Academic of the Ukrainian Academy of Economic Sciences. His research interest includes European corporate restructuring, the regulation of banks and financial institutions, credit risk and the valuation of corporate debt, and asset pricing with a focus on the effects of liquidity risk.

Dr. Viktoria Rudevska is an Associate Professor, Associate Professor of the Department of Finance, Banking and Insurance at University of Banking of the National Bank of Ukraine. She is the author of four monographs, one books and 17 articles. Investigates the processes in the banking sector.

Mr. Khlan Yaroslav works at the National Bank of Ukraine. He is responsible for investigating the processes at Ukrainian banking sector.