DOI: 10.55643/fcaptp.6.59.2024.4531

THE RELATIONSHIP BETWEEN BANKING RISKS UNDER THE CRISIS: EMPIRICAL ASSESSMENT POST-SOVIET COUNTRIES DATA

Ľuboš Cibák
PhD in Economics, Associate Professor, Rector, Bratislava University of Economics and Management, Bratislava, Slovakia;
ORCID: 0000-0003-3881-7924

Volodymyr Yermachenko
PhD in Economics, Professor of the Department of Tourism, Simon Kuznets Kharkiv National University of Economics, Kharkiv, Ukraine;
ORCID: 0000-0002-5779-3967

Anatolii Kovalov
D.Sc. in Economics, Professor, Rector, Odesa National Economic University, Odesa, Ukraine;
ORCID: 0000-0002-6128-7012

Liliia Zherdetska
D.Sc. in Economics, Professor of the Department of Banking, Odesa National Economic University, Odesa, Ukraine;
e-mail: lzherdetska@gmail.com
ORCID: 0000-0001-5398-868X
(Corresponding author)

Dmitry Kretov
PhD in Economics, Associate Professor of the Department of Banking, Odesa National Economic University, Odesa, Ukraine;
ORCID: 0000-0001-7129-4040

Received: 20/08/2024
Accepted: 23/10/2024
Published: 31/12/2024

ABSTRACT

The study aims to substantiate the mutual influence of banking risks during the financial crisis by the empirical assessment of data from post-Soviet countries.

Empirical substantiation of the mechanism of mutual banking risks within the crisis periods was based on a consecutive verification of the statistical significance of regression models. Firstly, the influence of foreign exchange risk on credit risk and liquidity risk is determined. Secondly, the causality between liquidity risk and credit risk is checked. Next, the impact of foreign exchange, credit and liquidity risks on interest rate risk is evaluated. As a result, the influence of the specified banking risks on solvency is determined, which is evaluated in this study by the indicator of equity capital adequacy.

The results of the analysis have proved that in the post-Soviet economies (except the Baltic countries), foreign ex-change risk caused an increase in credit risk and did not have a statistically significant effect on liquidity risk. An in-crease in credit risk caused an increase in banking liquidity, which revealed the effect of replacing income assets with liquid ones during the crisis. The level of liquidity affects the interest rate risk (spread level); in Ukraine, the level of the spread is also negatively affected by credit risk. The level of solvency of banks is determined by their liquidity. In post-Soviet developing countries, the level of solvency is negatively affected by credit risk.

The economic literature pays the main attention to the formalization of relationships between credit and interest risks, between credit risk and liquidity risk. In this aspect, we expanded the object of scientific research on banking risks, as we considered the empirical relationships between the main types of banking risks.

The obtained empirical results can be useful for regulatory authorities when strategizing micro- and macro-prudential policy instruments.

Keywords: credit risk, liquidity risk, foreign exchange risk, interest rate risk, systemic risk, solvency of banks, financial crisis

JEL Classification: G01, G 21, G32

INTRODUCTION

The current state of economic development is characterised by uncertainty and a long period of stagnation in global economic growth. The most recent financial crisis, which began in 2007-2008, has been compared to the Great Depression in terms of its consequences, and its source is seen in the liberalization and excessive growth of financial markets. The 2020 crisis had a non-economic cause, but the spread of the COVID-19 pandemic caused a number of consequences for the economy and for the banking sector in particular. Moreover, although the consequences of the "coronavirus crisis" were quite uneven for different countries, they are considered less destructive compared to the financial crisis. To date, the main determinant that shapes the current conditions of the economy in general and the banking sector in particular is the full-scale invasion of Russia into Ukraine and global geopolitical uncertainty. The uncertainty and unpredictability of the economic environment require banks to form an additional reserve of financial strength, which is primarily embodied in the adequacy of their own capital to cover risks and maintain solvency. In addition, in modern economic studies, scientists

and practitioners emphasize the need for preventive macro-regulation and strengthening the role of state institutions in ensuring financial stability. The creation of prerequisites for the stable functioning of the banking market requires the formation of an effective toolkit of macroprudential policy capable of ensuring timely identification of the sources of emergence, accumulation and implementation of systemic risk in order to prevent the occurrence of financial crises. It is worth noting that cyclical systemic risk, among others, combines (interacts) with various risks: the complexity of the systemic risk phenomenon is inextricably linked with financial crises and in practice is embodied in the implementation of several types of banking risks. In this connection, there is a need to substantiate the sequence of implementation and mutual influence of banking risks during the financial crisis, which will allow choosing the most effective macroprudential policy instruments in the future.

LITERATURE REVIEW

Modern economic literature represents a number of scientific developments in the interrelationships between banking risks. However, only certain types of risks are investigated. Thus, Imbierowicz B. and Rauch (2014) investigated the relationship between credit risk and liquidity risk of US banks. Scientists did not find a significant correspondence between risks, but they established their determining influence on the probability of bank defaults [1]. Similar studies were conducted by M. Hertrich (2015), who found that in the case of Switzerland and Germany, rather liquidity affects credit risk than vice versa [2]. Scientists Ruoyu Cai and Mao Zhang (2017) prove the impact of credit risk on liquidity risk for the banking system of Ukraine for the period from the 1st quarter of 2009 to the IV quarter of 2015 [3].

González-Aguado and Suarez J. (2014) evaluate the relationships between interest and credit risks based on monetary policy and the impact of interest rates on the probability of borrower default [4]. Similar studies relate to the relationship between default risk and interest rate based on the valuation of credit default swaps and their time structure. In the study, Ren-Raw Chen, Ren-Raw Chen & Liuren Wu (2013) concluded that "credit risk demonstrates complex dynamic interactions with interest rate factors" [5].

There are also a number of regional studies. Agrawal, T. J., & Sehgal, S. conducted a study on the Indian banking system for the period 2004-2014 (2018) [6]. They expanded the number of variables and considered market risk, interest rate risk exchange rate risk, credit risk and equity risk. Their main findings are: that credit risk and exchange rate risk have a reciprocal relationship; equity risk impacts credit risk positively; interest rate risk is affected by its lagged values and does not appear to be affected by other risks.

Hakimi Abdelaziz, Boussaada Rim, and Hamdi Helmi (2020) determined the impact of credit risk and liquidity risk on the profitability of banks in the Middle East and North Africa [7]. They proved the impact of risks on profitability (the influence of credit is stronger) and the relationship between them (increasing credit risk causes an increase in liquidity risk).

Bandyopadhyay & Saxena (2023) proved, that credit risk has a statistically significant impact on a bank's liquidity position: "higher credit risk has led to a rise in the liquidity risk for Indian banks" [8]. Also, they showed, how credit risk and liquidity position affect soundness measured in terms of Z-score).

Nguyen & Le (2022) based on empirical research on the Afghanistan banking system consider that credit and liquidity risks don't have a mutual relationship with each other. However, it is worth noting that scientists use it as a variable to measure liquidity Natural logarithm of total Assets – Total Liabilities. Also, they proved that both types of risks jointly impact on bank stability measured as capital adequacy ratio [9].

Cheng L. and Nsiah T. (2020) examine the impact of credit risk, liquidity risk and operational risk on the profitability of South African banks [10]. The negative impact of credit risk and liquidity risk on banks' profitability was established; the bank's specific risk relates to all investigated risks but does not have a direct impact on profitability indicators.

In addition to profitability, the subject of study is the impact of credit risk and liquidity risk on financial stability. The results of a study by Tijani Amara and Mohamed Mabrouki (2019) for Tunisian banks show that credit risk and liquidity risk do not have an economically significant mutual relationship. However, both risks separately affect the bank's stability, and their interaction contributes to the bank's instability [11].

Consequently, most studies are devoted to credit risk and liquidity risk and their impact on the profitability or financial stability of banks. It is also worth noting that even in the case of interest rate risk, its impact on credit risk is revealed. However, currently, there is a lack of research that would study the relationships between a wider range of banking risks to understand the mechanism of the unfolding of crisis phenomena and ensure adequate regulation.

DOI: 10.55643/fcaptp.6.59.2024.4531

AIMS AND OBJECTIVES

Concerning the work of foreign and Ukrainian economists, it should be noted that the issues of assessing the relationship and sequence of banking risks during periods of financial crises remain insufficiently developed. Therefore, the quantitative assessment of the banking risks interaction during the financial crisis based on the empirical data of the post-Soviet countries will contribute to the problem resolution.

The aim of the article is to substantiate the interaction and interrelationship of banking risks during the financial crisis based on an empirical assessment of data from post-Soviet countries. The period between the "corona crisis" and the beginning of a full-scale invasion will also be analyzed separately using the example of Ukraine.

METHODS

To achieve the goal of the research, we used data from the International Monetary Fund on the dynamics of financial stability indicators [12]. In the late 1990s, the International Monetary Fund launched a data collection project to monitor the soundness of the system-wide financial sector, from a macroprudential point. The project involved the formation of the Financial Soundness Indicators (FSIs) database. The FSIs include indicators of capital adequacy, asset quality, profitability, liquidity, and market risk sensitivity [13]. It should be noted that until 2019, the list of indicators and the procedure of their calculation was slightly different: in 2004 – 2018, all indicators were calculated in accordance with the Compilation Guide on FSI of 2004 [14], and from 2019 on - in accordance with to the improved FSI compilation guide [13].

To assess the dependence between risks during the financial crisis, as well as the change in approaches to the calculation of indicators, the study singled out the period of 2007-2018: data immediately before the crisis, the period of the financial crisis and the so-called post-crisis period. Data from all post-Soviet countries were planned to be included in the sample, but data for this period are not available for Azerbaijan (only from 2022) and Turkmenistan (data are not available in IMF statistics for FSI). Thus, the sample includes data from 13 countries (Armenia, Belarus, Estonia, Georgia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, the Russian Federation, Tajikistan, Uzbekistan, and Ukraine) on five indicators, the list and description of which is provided below. As individual data are unavailable, the total sample contains 469 observations. Among the sample, three countries - Estonia, Lithuania and Latvia - are regarded as developed, and the others are characterized as developing. Therefore, the calculations will be carried out both on the sample as a whole and with the exclusion of developed economies (Baltic countries). The specificity of the interrelationships between risks in the banking system of Ukraine will also be evaluated.

To illustrate how the indicators behave during crisis episodes (shocks) other than the financial crisis of 2007-2008, it is necessary to estimate the dependencies in 2019-2022. In addition, this period ensures the comparability of the indicators, since monthly data are available for the banking system of Ukraine only since 2019. This period for the Ukrainian banking sector includes the crisis associated with pandemic restrictions due to the spread of COVID-19 (the so-called "coronavirus crisis") and the crisis caused by the full-scale invasion of the Russian Federation and the introduction of martial law.

The types of risks to be evaluated are based on the recommendations of the Basel Capital Agreement [15-18], according to which credit, market (foreign exchange, interest, and commodity), operational risks and liquidity risks are distinguished. To enable formalization and use of the available information base, credit, foreign exchange risk, interest rate risks and liquidity risks will be evaluated. Furthermore, it will be evaluated how all these risks will affect the risk of solvency loss. Table 1 describes the indicators used for the analysis.

Table 1. Indicators for quantitative assessment of risks.

№	Types of risks	Indicators
1	Liquidity	Liquid assets by short-term liabilities
2	Credit	Non-performing loans by Total amount of loans
3	Market	
3.1.	*Foreign exchange*	*Net open position in foreign exchange to capital*
3.2.	*Interest rate*	*Spread between credit and deposit rates*
4	Solvency	Regulatory capital by Risk-weighted assets

To assess liquidity, we suggest using the ratio of liquid assets to short-term liabilities (core) (FSI-11) [19]. This indicator characterizes the liquidity of the bank in the short term and means the availability of liquid assets of the bank to cover short-term liabilities. The required value of the indicator depends on the current economic state and development of financial markets: in stable conditions with a developed financial market, the value of the indicator may be lower than in crisis periods, given the presence of highly liquid securities in the portfolio.

Credit risk assessment is based on the ratio of non-performing loans to their total amount (core) (FSI-11) [19]. In stable conditions, the value of the indicator should not exceed 5%.

The indicator of the net open position in foreign exchange to the capital (FSI-07) was used to assess the foreign exchange risk. For developed countries, this indicator is lower compared to developing economies.

The interest rate risk is estimated using the spread between reference lending and deposit rates (SLDR) [20]. We believe that this indicator best reflects the level of interest rate risk since credit risk does not directly affect the spread level.

To assess solvency, it is advisable to use the ratio FSI-1 – regulatory capital to risk-weighted assets (core) [19].

It should be noted that according to the updated financial soundness indicators compilation guide of 2019, the list of FSI remained unchanged, but liquidity assessment indicators - Liquidity Coverage Ratio and Net Stable Funding Ratio - were added. However, statistical data are currently not available for all countries starting from 2018-2022. Therefore, the FSI-11 (liquid assets to short-term liabilities) will be used in the work to compare the obtained results for the level of productivity.

Periods of financial crises are characterized by systemic risk, observed when several banking risks and the strengthening of their negative effect. Figure 1 shows the author's assumption regarding the sequence of arising and interaction of banking risks during the financial crisis.

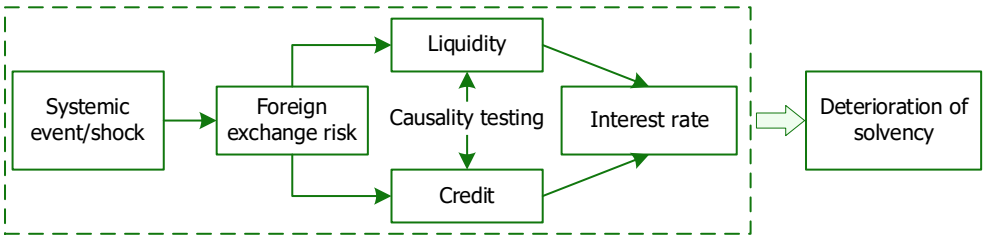

Figure 1. Theoretical scheme of the sequence of arising and interaction of banking risks during the crisis.

We believe that for developing economies, a systemic event primarily creates currency shocks and the origin of foreign exchange risk. Liquidity risk can appear at the same time as foreign exchange risk in the case of so-called "depositor raids", but liquidity can also deteriorate due to credit risk, which causes insufficient cash flows to cover the bank's obligations. That is why the consistency and cause-and-effect relationships between credit risk and liquidity risk require additional proof.

Liquidity risk, the need for additional resources and the lack of solvent borrowers during the financial crisis can lead to a reduction in the interest rate spread, i.e., to an increase in interest rate risk.

All the mentioned events in aggregate lead to the deterioration of the banks' solvency, since the negative effect of the risks origin will lead to a reduction of the financial result and equity capital.

Empirical substantiation of the mechanism of the banking risks interaction during the financial crisis is based on a consequent verification of the statistical significance of regression models. In the first stage, the presence and closeness of the influence of foreign exchange risk and credit and liquidity risk are determined:

$$Liquidity_{i,t} = C + aCurrency_{i,t-1} + \varepsilon_{i,t} \quad (1)$$

$$Credit_{i,t} = C + a_1 Currency_{i,t-1} + \varepsilon_{i,t} \quad (2)$$

At the next stage, the cause-and-effect relationship between liquidity risk and credit risk will be checked:

$$Credit_{i,t} = C + b_1 Liquidity_{i,t-1} + \varepsilon_{i,t} \quad (3)$$

DOI: 10.55643/fcaptp.6.59.2024.4531

$$Liquidity_{i,t} = C + b_2 Credit_{i,t-1} + \varepsilon_{i,t} \quad (4)$$

Next, the impact of foreign exchange risk, credit and liquidity risks on the interest rate will be evaluated:

$$Interest_{i,t} = C + c_1 Currency_{i,t-1} + + c_2 Liquidity_{i,t-1} + c_3 Credit_{i,t-1} + \varepsilon_{i,t} \quad (5)$$

Finally, the influence of the mentioned banking risks on solvency, which in this study is represented by the indicator of equity capital adequacy, will be evaluated:

$$Solvency_{i,t} = C + Interest_{i,t-1} + d_1 Currency_{i,t-1} + d_2 Liquidity_{i,t-1} + d_3 Credit_{i,t-1} + \varepsilon_{i,t} \quad (6)$$

Note. Liquidity – liquid assets by short-term liabilities; Foreign exchange – Net open position in foreign exchange to capital and the share of assets in foreign currency to total assets; Credit – share of non-performing loans in their total amount; Interest – spread between credit and deposit rates; i – country, t – time period; C – a constant; ε(i, t) – standard error

RESULTS

Firstly, the impact of foreign exchange risk on liquidity risk and credit risk with a lag of one quarter was estimated (Table 2).

Table 2. Results of modelling the relationships between risks (the impact of foreign exchange on credit risk and liquidity risk). Note: variables are ratios.

Independent variables, specifications and statistical parameters of models	Dependent variables			
	Credit (t)(2)		Liquidity (t)(1)	
	Coefficient	P-value	Coefficient	P-value
I. Full sample (1st quarter 2007- 1st quarter 2018)				
Constant	9.34	<0.001	65.83	<0,001
Net open position in foreign exchange to capital (t-1)	0.14	<0.001	0.04	0,63
R2 of a model	0.25		<0.001	
F-test significance	<0.001		0.63	
II. Full sample (excluding the Baltic countries) (1st quarter 2007- 1st quarter 2018)				
Constant	10.31	<0.001	75.20	<0,001
Net open position in foreign exchange to capital (t-1)	0.23	<0.001	0.02	0,78
R2 of a model	0.4		0.0002	
F-test significance	<0.001		0.78	
III. Baltic countries (1st quarter 2007- 1st quarter 2018)				
Constant	7.6	<0.001	35.01	<0,001
Net open position in foreign exchange to capital (t-1)	-0.009	0.85	-0.03	0,71
R2 of a model	<0.001		<0.001	
F-test significance	0.85		0.71	
IV. Ukraine (1st quarter 2007- 1st quarter 2018)				
Constant	8.08	<0.001	70.28	<0,001
Net open position in foreign exchange to capital (t-1)	0.27	<0.001	0.16	0,08
R2 of a model	0.65		0.05	
F-test significance	<0.001		0.08	
V. Ukraine (2019-2020, monthly data)				
Constant	18.78	<0.001	80.44	<0,001
Net open position in foreign exchange to capital (t-1)	0.56	<0.001	0.25	<0,001
R2 of a model	0.28		0.65	
F-test significance	<0.001		<0.001	

The results of modelling the interrelationships between risks given in Table 2 ground the following conclusions.

First, a statistically significant effect of foreign exchange risk on liquidity risk was not found both for the sample as a whole and for selected groups of countries. The best level of significance was obtained for Ukraine, but other parameters of the model call into question the presence of the influence of foreign exchange risk on banks' liquidity risk.

We believe that almost simultaneous changes in foreign exchange risk and liquidity risk in response to a shock event explain the lack of such an impact.

In Ukraine, moreover, the lack of influence is due to the heterogeneous dynamics of indicators. The beginning of the 2008 crisis led to an increase in the currency position and a short-term decrease in the liquidity indicator. In addition, banks continued to prioritize liquidity (rather than lending) and kept most of their resources in liquid assets, while the currency position continued to fluctuate in response to adverse events starting in 2015.

Secondly, a statistically significant influence of foreign exchange risk on credit risk was found for developing countries: in other words, the relationship was confirmed for the Full sample excluding the Baltic countries, and for Estonia, Latvia, and Lithuania, there was no relationship.

Therefore, in developing countries during the crisis, the growth of foreign exchange risk leads to an increase in the share of problem debt. This is explained as follows: the exchange rate to some extent reflects the market stability. In weaker economies, the national currency exchange rate is too sensitive to the influence of negative factors; in this case, the devaluation of the national currency causes additional risk for banks, both foreign exchange (open positions) and credit (deterioration of the economic situation and borrowers' solvency). However, the deterioration of borrowers' solvency occurs with a slight lag.

It is worth noting certain changes in the results for the banking sector of the Ukrainian economy in 2019-2022. The influence of foreign exchange risk on credit is present, but the model is less accurate compared to the period of the financial crisis. At the same time, the foreign exchange risk factor (currency position) is significant for credit risk and causes its growth. Therefore, regardless of monetary policy reforms and the monetary policy of the National Bank of Ukraine, foreign exchange risk in Ukraine arises as a reaction to any shock, regardless of whether it is related to the financial crisis.

Compared with the period of 2007 – 1st quarter of 2018, currency loan also has a statistically significant effect on the liquidity indicator. At the same time, this influence is not negative, when a larger currency position is associated with a decrease in the liquidity indicator, but positive - an increase in the currency position causes an increase in the liquidity indicator. This can be explained by the fact that during periods of instability foreign exchange risk increases, and banking systems respond to such instability with policies that are more cautious and strengthening of their balance sheets. Moreover, this accordingly means an increase in the liquidity indicator.

The next stage of the research is to check the causal relationship between credit risk and liquidity risk.

On the one hand, the deterioration of the quality of the loan portfolio negatively affects the incoming cash flow of the bank - the lack of flow from the repayment of loans will lead to a lack of highly liquid assets to cover liabilities.

On the other hand, the emergency of the financial crisis, as a rule, begins with problems with liquidity, and the indicators of the loan portfolio quality in statistical reporting will deteriorate later. In this case, the cause-and-effect relationship between the risks is not so obvious, but the sequence of their appearance enables us to make an assumption that a statistically significant relationship will be obtained in the direction of credit risk → liquidity risk.

The above requires Granger testing: the statistical significance of coefficients b_1 and b_2 in equations (3) and (4), respectively, will be checked (Table 3).

DOI: 10.55643/fcaptp.6.59.2024.4531

Table 3. Results of modelling the causal relationships between credit risk and liquidity risk. Note: variables are values of dynamics of ratios.

Independent variables, specifications and statistical parameters of models	Dependent variables			
	Liquidity→ Credit (3)		Credit → Liquidity (4)	
	Coefficient	P-value	Coefficient	P-value
I. Full sample (1st quarter 2007- 1st quarter 2018)				
Constant	1.14	<0.001	0.98	<0.001
Net open position in foreign exchange to capital (t-1)	0.0007	0.995	0.05	0.001
R2 of a model	0.002		0.026	
F-test significance	0.995		0.001	
II. Full sample (excluding the Baltic countries) (1st quarter 2007- 1st quarter 2018)				
Constant	1.32	<0.001	0.998	<0.001
Net open position in foreign exchange to capital (t-1)	-0.1	0.571	0.04	0.002
R2 of a model	0.001		0.02	
F-test significance	0.571		0.002	
III. Baltic countries (1st quarter 2007- 1st quarter 2018)				
Constant	0.38	<0.001	0.97	<0.001
Net open position in foreign exchange to capital (t-1)	0.45	0.02	0.03	0.36
R2 of a model	0.07		0.009	
F-test significance	0.02		0.36	
IV. Ukraine (1st quarter 2007- 1st quarter 2018)				
Constant	1.57	<0.001	0.55	0.02
Net open position in foreign exchange to capital (t-1)	-0.08	0.65	0.44	0.003
R2 of a model	0.006		0.22	
F-test significance	0.65		0.003	
V. Ukraine (2019-2022, monthly data)				
Constant	1.64	0.002	1.09/1.11	<0.001/ <0.001
Net open position in foreign exchange to capital (t-1)	-0.84	0.25	-0.14/-1.16	0.002/ <0.001
R2 of a model	0.04		0.27/0.35	
F-test significance	0.25		0.002/ <0.001	

Table 3 data conclude the following. Liquidity risk does not affect the level of credit risk, as in response to a shock event, there is a short-term decrease in the liquidity ratio, but in the future, fluctuations in bank liquidity and credit risk are not related.

The P-value level of ratios for variables in the model described by equation (4) indicates their statistical significance, but other indicators do not confirm the accuracy of the constructed models.

It should be noted that the highest level of accuracy has the specification built according to the data of the banking system of Ukraine. Therefore, in Ukraine, the growth of credit risk during the crisis caused an increase in the liquidity ratio of banks (the ratio of liquid assets to short-term liabilities). However, this means that the growth of credit risk did not have a negative impact on liquidity indicators, at least in the short term. The increase in the indicator characterizing short-term liquidity in response to the growth of problem debt highlights the effect of replacing income assets with liquid ones in Ukraine. In times of crisis, this is a consequence of banks' more cautious policies; however, if the situation continues for too long, it will reduce the ability of banks to make a positive contribution to economic growth.

For 2019-2022, the obtained results indicate the negative impact of credit risk on banks' liquidity indicators. An increase in credit risk can worsen the dynamics of liquidity ratios. We have the most accurate data in the case of a lag of six months. It is also worth noting that in modern conditions, there is also the effect of replacing income assets with liquid ones; and the banking sector of Ukraine, despite certain negative dynamics of liquidity indicators in 2022, maintains liquidity at a high level.

The preliminary analysis provides slightly different results for the data of the 1st quarter of 2007 – 2018 and 2019-2022. In the episode of the financial crisis (2007-Q1 2018), foreign exchange risk had a negative impact on credit risk but did not affect liquidity risk. There was no clear causality between credit risk and liquidity risk.

Simultaneously, for Ukraine in 2019-2022, a positive influence of the currency position on liquidity indicators was established, which can be explained by a more cautious policy of banks during this period. The negative impact of credit risk on liquidity indicators was also revealed.

At the next stages of the research, it is necessary to find how the above banking risks affect the interest rate and what effect they all have on the solvency of banks (Table 4).

Table 4. Results of modelling the relationships between risks and their impact on solvency (the impact of foreign exchange, credit and liquidity risk on interest rate risk). Note: variables are values of dynamics of ratios.

Independent variables, specifications and statistical parameters of models	Dependent variables			
	Dependent variable – spread (5)		Dependent variable – solvency (6)	
	Coefficient	P-value	Coefficient	P-value
I. Full sample (1st quarter 2007- 1st quarter 2018)				
Constant	0.91	<0.001	0.79	<0.001
Foreign exchange risk	0.0008	0.71	-0.001	0.36
Credit	-0.007	0.65	0.02	0.06
Liquidity	0.098	0.07	0.13	0.001
Interest rate	x	x	0.07	0.13
R^2 of a model		0.01		0.06
F-test significance		0.33		0.002
II. Full sample (excluding the Baltic countries) (1st quarter 2007- 1st quarter 2018)				
Constant	0.87	<0.001	0,74	<0,001
Foreign exchange risk	0.001	0.66	-0,001	0,37
Credit	-0.004	0.83	*0,03*	0,01
Liquidity	0.11	0.05	*0,13*	0,004
Interest rate	x	x	0,08	0,18
R^2 of a model		0.02		0.09
F-test significance		0.26		0.001
III. Baltic countries (1st quarter 2007- 1st quarter 2018)				
Constant	0.99	<0.001	0,73	<0,001
Foreign exchange risk	-0.06	0.19	0,03	0,34
Credit	0.05	0.38	-0,04	0,29
Liquidity	0.03	0.85	0,37	0,002
Interest rate	x	x	-0,006	0,93
R^2 of a model		0.02		0.2
F-test significance		0.55		0.09
IV. Ukraine (1st quarter 2007- 1st quarter 2018)				
Constant	1.10	<0.001	0,81	0,0005
Foreign exchange risk	0.003	0.83	-0,02	0,10
Credit	-0.122	0.09	0,11	0,10
Liquidity	0.10	0.21	0,09	0,18
Interest rate	x	x	0,02	0,91
R^2 of a model		0.10		0.30
F-test significance		0.26		0.09
V. Ukraine (2019-2022, monthly data)				
Constant	-0.26	0.45	1,13	0,03
Foreign exchange risk	0.42	0.02	-0,31	<0,001
Credit	1.33	<0.001	1,19	<0,001
Liquidity	н/з	н/з	-0,61	0,17
Interest rate	x	x	-0,17	0,04
R^2 of a model		0.42		0.85
F-test significance		<0.001		<0.001

DOI: 10.55643/fcaptp.6.59.2024.4531

Table 4 shows that indicators of foreign exchange, credit and liquidity risks explain very poorly the fluctuations of banks' interest spread and the solvency index during the financial crisis of 2007-2008 and the post-crisis period, however, without taking into account the "corona crisis" and martial law (in the case of Ukraine). This means that factors that are not included in the presented study (for example, macro-environmental factors, regulations, etc.) have a decisive influence on the spread and solvency indicators. Despite the low accuracy of the built models, some indicators turned out to be significant. Thus, for post-Soviet developing countries (i.e., excluding the Baltic countries), the level of short-term liquidity (the ratio of liquid assets to short-term liabilities) has a statistically significant effect on the interest rate spread. Consequently, with an increase in the level of liquidity, the value of the interest spread will increase slightly. Given the study period, which covers mainly the post-crisis period, we believe that such an impact will be determined mainly by deposit rates, since the loan portfolio is currently growing very slowly, and the average rate level is determined by existing loans granted in past periods. That is, in the presence of excessive resources (high liquidity indicator), banks will reduce deposit rates, continuing to receive a slightly higher rate on loans, which will mean an increase in the interest rate spread. However, as noted above, such influence is not confirmed for the Baltic countries and for Ukraine. Comparing data on liquidity and spread indicators for individual countries, it is worth noting the following. The level of liquidity for the Baltic countries is lower than for other post-Soviet countries. In response to the 2008 crisis, the level of liquidity in post-Soviet developing countries increased significantly and exceeded the level of 100%, and now remains at a relatively high level. However, more developed economies and banking systems do not need such a level of short-term liquidity: first, even in a crisis period, the risks of sudden withdrawal of deposits are lower; second, developed financial markets allow banks to hold more resources in secondary liquidity reserves (for example, in securities), while for less developed economies liquidity reserves are mostly concentrated at the primary level (cash and correspondent accounts). In Ukraine, the lack of such an impact can be explained by the negative influence of external shocks and significant fluctuations in the quality of the credit portfolio, the impact of which on the spread indicator is more statistically significant than that of liquidity (an increase in credit risk leads to a decrease in the spread).

For solvency (the ratio of equity capital to risk-weighted assets), the studied factors are also not dominant, as evidenced by the low value of the R2 factor of the models. However, the level of P-significance allows us to conclude that credit risk and liquidity risk have a slight, but statistically significant influence on the solvency indicator (this applies to the analysis of the indicators of the post-Soviet countries excluding the Baltic States, for the last – only the liquidity risk is statistically significant).

Therefore, in most post-Soviet countries, the level of solvency is affected by the level of liquidity and, to a lesser extent, by the level of credit risk. The increase in liquidity causes an increase in the solvency ratio of banks, which confirms the theoretical assumption that liquidity is a necessary (but not sufficient) condition for bank solvency. In addition, an increase in the level of highly liquid assets reduces the amount of risk-weighted assets, which directly affects the increase in the solvency ratio. However, in Ukraine, the statistical significance of the effect of liquidity on solvency is significantly lower.

Credit risk does not have a statistically significant effect on the solvency level in the Baltic countries. However, such an influence is typical for other post-Soviet countries, although the ratio for the credit risk variable is much lower compared to the liquidity risk. The increase in credit risk with a one-quarter lag causes a slight increase in solvency. The reverse effect can be more grounded: risk increase → decrease in solvency. The positive effect of credit risk on solvency with a lag one- quarter lag is explained as follows: the growth of loan reserves will mean a reduction in profit and capital, and therefore solvency, almost simultaneously (period t-1); however, in response to a decrease in solvency, banks will carry out recapitalization, which will cause the indicator to increase (period t). In Ukraine, the influence of credit risk on solvency is greater (the ratio value for a variable is higher), but somewhat less statistically significant (p-value at the level of 10%). The above, as has been repeatedly noted, is explained by the Ukrainian specificity - the destructive impact of external political shocks and, accordingly, a significant deterioration in the quality of banks' loan portfolios in 2015-2016.

More than that, in Ukraine, unlike in other countries, the level of solvency is also affected by foreign exchange risk: the growth of the currency position leads to a decrease in the solvency index. This is further confirmation of the importance of foreign exchange risk for transition and developing economies. It should be added that this influence is insignificant considering the ratio level.

In 2019-2022, which covers the "corona crisis" and the introduction of martial law in Ukraine, the growth of the open currency position (foreign exchange risk) causes a widening of the spread: an increase in foreign exchange risk allows to manage the cost of resources, which can further increase the difference between interest rates. In addition, if the growth of open currency positions is accompanied by the growth of the exchange rate, this can be an additional factor of inflation and spread growth.

The modern period is also characterized by a "positive" effect of credit risk on the interest rate spread: an increase in the share of non-performing loans widens the spread. This effect can be explained by the growth of the risk premium in the structure of the credit rate at the beginning of a negative episode, then a possible reduction of the spread due to the failure to receive income from problematic loans. In Ukraine, the consequences of the "coronavirus crisis" did not have a significant negative impact on credit risk. Assessing the consequences of a full-scale invasion on the relationship between credit risk and spread requires a longer period of observation, but now the credit risk determines the growth of credit rates and spreads.

For the capital adequacy indicator, which reflects the overall level of stability and solvency of the sector, the best effect was the impact of factors with a lag of 1 month. This can be explained by the importance of this indicator in the implementation of macro- and micro-prudential regulation - banks always pay attention to this indicator in order to ensure the necessary regulatory requirements. The level of the currency position has a negative impact, as it directly affects capital requirements to cover market risk. An increase in credit risk causes an increase in the capital adequacy ratio. This means that in the event of an increase in this type of risk, banks are able to form additional capital to cover risks; on the other hand, the risk is not so great as to lead to a decrease in capital and the adequacy ratio. Unlike the period including the financial crisis, the effect of liquidity on capital adequacy turned out to be statistically insignificant. The interest rate spread has a negative impact on capital adequacy. Currently, Ukrainian banks operate in a period of increased risks - inflation and credit risk lead to high credit rates because of the risk premium. Therefore, the mechanism of such influence of the spread relates to the growth of the spread in 2019-2022, associated with the growth of risks and, accordingly, the decrease of the capital adequacy indicator.

DISCUSSION

In economic literature, the main attention is paid to the formalization of relationships between credit and interest risks, between credit risk and liquidity risk. In this aspect, we expanded the object of scientific research on banking risks, considering the empirical relationships between the main types of banking risks.

Similar to the results of Jain, Tarunika & Sehgal, Sanjay (2018), the study proved the impact of currency risk on credit risk. In other words, this relationship is confirmed for developing countries, unlike the Baltic countries.

The data of our research demonstrate the growth of liquidity indicators in response to the growth of the level of credit risk (non-performing loans) for observations before 2018. It is explained by the immutability of liquid assets and the reduction of net assets as a result of the realization of credit risk. However, for Ukraine data in the period 2019-2022, the negative impact of credit risk on liquidity indicators was confirmed. It relates to the results obtained by Bandyopadhyay, A., & Saxena, M. (2023) for Indian banks and by Hakimi Abdelaziz, Boussaada Rim, and Hamdi Helmi (2020) for banks in the Middle East and North Africa. In these cases, non-performing loans lead to a reduction in liquid assets through the borrower defaults channel.

Similar to the research Nguyen, D. T., & Le, T. (2022) the impact of credit risk on bank stability capital adequacy ratio has been proved.

However, unlike other studies, we examined risk behaviour in different crisis periods. In connection with this, the im-pact of currency risk on other risks and, accordingly, the mechanism of the unfolding of the crisis was identified.

CONCLUSIONS

The research, the results of which the article is presenting, have proved empirical relationships between the main banking risks during the crisis. In particular, credit, foreign exchange, interest rate risks, as well as liquidity risks and loss of solvency were considered. These are the main banking risks defined in the Basel Capital Agreement that have a decisive influence on the solvency and financial stability of banks.

Significant differences have been found between the manifestation of the main banking risks during the financial crisis in developed and developing post-Soviet economies. In developing economies, the shock event, which is associated with the unfolding of crisis phenomena, primarily leads to foreign exchange risk. Foreign exchange risk causes an in-crease in the level of non-performing loans (credit risk) in post-Soviet developing countries and does not have a statistically significant effect on the level of short-term liquidity of banks. Foreign exchange risk and liquidity risk occur simultaneously during the financial crisis, but in the post-crisis period, banks accumulate reserves of excess liquidity, while the loan portfolio continues to deteriorate. The deterioration of the credit portfolio in Ukraine causes an increase in the short-term liquidity indicator.

DOI: 10.55643/fcaptp.6.59.2024.4531

Excess volumes of liquid assets, on the one hand, are the result of a more cautious policy, however, on the other hand, this situation limits the banks' ability to promote economic growth.

In most post-Soviet countries (except the Baltic States), the liquidity risk affects the spread level: as the liquidity indicator increases, the spread level will decrease and vice versa. Credit risk has a significant and statistically significant im-pact on the interest rate spread only in Ukraine.

The results of the study showed certain differences in the banking sector of the economy of Ukraine in 2019-2022. Foreign exchange risk remains the main threat to the banking sector and the economy as a whole and arises as a reaction to any shock, regardless of whether it relates to the financial crisis. The foreign exchange risk factor (foreign ex-change position) is significant for credit risk and causes its growth; however, the growth of the foreign exchange position causes an increase in liquidity due to a more cautious policy of banks. The negative impact of credit risk on banks' liquidity indicators is confirmed for both of the investigated periods for the banking system of Ukraine.

Liquidity influences the level of banking solvency in all studied countries, which proves the theoretical connection be-tween these economic concepts. For developing countries, the impact of credit risk also turned out to be significant, but for Ukraine, the statistical significance of such an impact is lower, and during 2019-2022, this impact was negative and with a low level of statistical significance. Moreover, the expansion of the interest spread occurs during periods of rising inflation and credit risk, its impact on capital adequacy in Ukraine in 2019-2022 turned out to be negative.

The obtained empirical results can be useful for regulatory bodies, in particular for the National Bank of Ukraine, when choosing the instruments of micro- and macro-prudential policy, as they will contribute to the improvement of the methodology of assessment and regulation of banking risks, and therefore will make a positive contribution to ensuring financial stability.

In the presented study, the ratio of liquid assets to short-term liabilities was used to measure liquidity risk. This made it possible to compare data for a long period, which included the financial crisis, the "coronavirus crisis" and the current crisis in the Ukrainian economy. However, given the current practice of assessing liquidity based on indicators of liquid coverage and stable funding, further research should be supplemented with these indicators. It is also worth expanding the research for different types of economies, which will make it possible to explain the differences in the obtained results and become a basis for evaluating the influence of the institutional environment on banking risks.

ADDITIONAL INFORMATION

AUTHOR CONTRIBUTIONS

All authors have contributed equally.

FUNDING

Bratislava University of Economics and Management, Bratislava, Slovak Republic.

CONFLICT OF INTEREST

The Authors declare that there is no conflict of interest.

REFERENCES

1. Imbierowicz B., & Rauch, C. (2014). The relationship between liquidity risk and credit risk in bank. *Journal of Banking & Finance, 40*, 242-256. https://doi.org/10.1016/j.jbankfin.2013.11.030
2. Hertrich, M. (2015). Does Credit Risk Impact Liquidity Risk? Evidence from Credit Default Swap Markets. *International Journal of Applied Economics*, *12*(2), 1-46. https://mpra.ub.uni-muenchen.de/67837/
3. Ruoyu, Cai, & Mao, Zhang (2017). How does credit risk influence liquidity risk? Evidence from Ukrainian banks. *Visnyk of the National Bank of Ukraine*, *241,* 21-33. https://doi.org/10.26531/vnbu2017.241.021
4. González-Aguado, C. & Suarez, J. (2014). Interest Rates and Credit Risk. http://www.cemfi.es/~suarez/gaguado-suarez2014.pdf
5. Chen, Ren-Raw, & Wu, L. (2013). Dynamic Interactions Between Interest-Rate and Credit Risk: Theory and Evidence on the Credit Default Swap Term Structure. *Review of Finance*, *17*(1), 403–441.https://doi.org/10.1093/rof/rfr032

6. Agrawal, T. J., & Sehgal, S. (2018). Dynamic interaction of bank risk exposures: An empirical study for the Indian banking industry. *IIM Kozhikode Society & Management Review*, *7*(2), 132–153. https://doi.org/10.1177/2277975218767543

7. Abdelaziz, H., Rim, B., & Helmi, H. (2022). The Interactional Relationships Between Credit Risk, Liquidity Risk and Bank Profitability in MENA Region. *Global Business Review*, *23*(3), 561-583. https://doi.org/10.1177/0972150919879304

8. Bandyopadhyay, A., & Saxena, M. (2023). Interaction between credit risk, liquidity risk, and bank solvency performance: a panel study of Indian banks. *Indian Economic Review*, *58*(2), 311–328. https://doi.org/10.1007/s41775-023-00202-y

9. Nguyen, D. T., & Le, T. (2022). The interrelationships between bank risk and market discipline in Southeast Asia. *Studies in Economics and Finance*, *40*(2), 354–372. https://doi.org/10.1108/sef-02-2022-0122

10. Cheng, L. M., Nsiah, T. K., Charles, O., & Ayisi, A. L. (2020). Credit risk, operational risk, liquidity risk on profitability. A study on South Africa commercial banks. A PLSSEM Analysis. *Revista Argentina de Clínica Psicológica, XXIX(5),* 5-18. https://doi.org/10.24205/03276716.2020.1002

11. Amara, T., & Mabrouki, M. (2019). The impact of liquidity and credit risks on the bank stability. *Journal of smart economic growth, 4*(2), 97-116. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjehabA2KSJAxVsh_0HHcw_FK0QFnoECBIQAw&url=https%3A%2F%2Fjseg.ro%2Findex.php%2Fjseg%2Farticle%2Fdownload%2F67%2F69%2F%23%3A~%3Atext%3DOur%2520results%2520show%2520that%2520credit%2Cinteraction%2520contributes%2520to%2520bank%2520instability.&usg=AOvVaw0wwLHnoxjn4gY0muETKxIk&opi=89978449

12. Financial Soundness Indicators Database. (n.d.). http://data.imf.org/regular.aspx?key=61404590

13. IMF. (2019). Financial soundness indicators compilation guide. https://www.imf.org/en/Data/Statistics/FSI-guide

14. IMF. (2004, July 30). Compilation Guide on Financial Soundness Indicators. https://www.imf.org/external/np/sta/fsi/eng/2004/guide/index.htm

15. Basel Committee on Banking Supervision. (2005). International Convergence of Capital Measurement and Capital Standards. A Revised Framework. https://www.bis.org/publ/bcbs118.pdf

16. Basel Committee on Banking Supervision, BCBS (2000). Principles for the Management of Credit Risk. http://www.bis.org/publ/bcbs75.pdf

17. Basel Committee on Banking Supervision, BCBS (2008). Principles for sound liquidity risk management and supervision. http://www.bis.org/publ/bcbs144.pdf

18. Basel III: Finalising post-crisis reforms. (2017). https://www.bis.org/bcbs/publ/d424.pdf

19. Compilation Guide on Financial Soundness Indicators, Chapter Six. Specification of Financial Soundness Indicators for Deposit-Takers, 112-133. https://www.imf.org/external/np/sta/fsi/eng/2004/guide/chap6.pdf

20. Chapter Eight. Financial Markets. (n.d.). https://www.imf.org/external/np/sta/fsi/eng/2004/guide/chap8.pdf

Сібак Л., Єрмаченко В., Ковальов А., Жердецька Л., Кретов А.

ВЗАЄМОЗВ'ЯЗОК МІЖ БАНКІВСЬКИМИ РИЗИКАМИ В УМОВАХ КРИЗИ: ЕМПІРИЧНА ОЦІНКА ДАНИХ ПОСТРАДЯНСЬКИХ КРАЇН

Метою дослідження є обґрунтування взаємодії банківських ризиків у кризові періоди на засадах емпіричної оцінки даних пострадянських країн.

Емпіричне обґрунтування механізму взаємодії банківських ризиків у період фінансової кризи проведено на засадах поетапної перевірки статистичної значущості регресійних моделей. На першому етапі визначається наявність впливу валютного ризику на кредитний ризик і ризик ліквідності. На наступному етапі перевіряється причинно-наслідковий зв'язок між ризиком ліквідності та кредитним ризиком. Далі оцінюється вплив валютного, кредитного ризиків і ризику ліквідності на процентний ризик. Та в підсумку визначається вплив зазначених банківських ризиків на платоспроможність, яка в даному дослідженні оцінюється показником адекватності власного капіталу.

За результатами аналізу встановлено, що в пострадянських економіках (окрім країн Балтії) валютний ризик спричиняє збільшення кредитного та не чинить статистично значущого впливу на ризик ліквідності. Зростання кредитного ризику спричиняє зростання показника ліквідності банків, що свідчить про наявність ефекту заміщення дохідних активів ліквідними в умовах кризи. Рівень ліквідності впливає на процентний ризик (рівень спреду); в Україні на рівень спреду негативно впливає й кредитний ризик. Рівень платоспроможності банків визначається їхньою ліквідністю. У пострадянських країнах, що розвиваються, на рівень платоспроможності негативно впливає кредит-ний ризик.

DOI: 10.55643/fcaptp.6.59.2024.4531

В економічній літературі основу увагу приділено формалізації взаємозв'язків між кредитним і процентним ризиками, між кредитним ризиком і ризиком ліквідності. У цьому аспекті ми розширили об'єкт наукового дослідження банківських ризиків, оскільки розглянули емпіричні взаємозв'язки між основними видами банківських ризиків.

Отримані емпіричні результати можуть бути корисними для регуляторних органів при обґрунтуванні інструментів мікро- та макропруденційної політики.

Ключові слова: кредитний ризик, ризик ліквідності, валютний ризик, процентний ризик, системний ризик, платоспроможність банків, фінансова криза

JEL Класифікація: G01, G 21, G32