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SYSTEMATIC RISK ASSESSMENT OF BANKS

Definition of "systemic risk" has been improved. Global approaches to assessment and identification of systemic risk and the basic indicator of their determination have been analyzed. Mathematical model of predicting the emergence of systemic risk in the banking system of Ukraine has been developed and its test has been conducted.

Keywords: systemic risk, systemically important banks, risk assessment, indicators of systemic stress, statistical model of nonlinear regression.

Шульга Н., Черный А., Степашова А. Оценивание системного риска банков. *Усовершенствовано определение понятия "системный риск". Проанализированы мировые подходы к оценке и выявлению системных рисков и основные индикаторы их определения. Разработана экономико-математическая модель прогнозирования возникновения системного риска в банковской системе Украины и проведено ее тестирование.*

Ключевые слова: системный риск, системно важные банки, оценка риска, индикаторы системного стресса, статистическая модель нелинейной регрессии.

Background. The phenomenon of systemic risk was at the turn of the twentieth century. But most of all it was during the last global crisis, which led to catastrophic losses. Only state financial support of banking and non-banking financial institutions during the crisis in individual countries ranged from 1–44 % of GDP. Increased globalization, concentration of banking capital and the volatility of prices in financial and commodity markets poses a threat of a new wave of systemic risk, the consequences of which can be even more devastating for the economy in general and the banking sector

in particular. This requires not only research the causes of systemic risk, but also the formation of a new paradigm of risk management in the context of their relationship, which together can generate systemic risk, diagnostic tools and risk of its occurrence the signal for different time horizons and also to develop the preventive measures actions by mega- and national regulators.

Analysis of recent research and publications. The issue of determining the nature and causes of systemic risks, their assessment methodologies, risk management system is a subject of numerous scientific papers, authored by Nobel laureates M. Spence and I. Stiglitz [1; 2], as well as famous foreign and domestic researchers: N. Roubini, C. Johnson, J. Nhuyyen, N. Kuznetsov, A. Baranowski, S. Naumenkova [3–8] and others. Paying tribute to the scientific achievements in this area still remains a debatable question of interpretation of the term "systemic risk" definition of methodological approaches to its recognition in the countries belonging to the group of developing countries, including Ukraine. After all, traditional systemic risk indicators used in foreign banking practices can not be calculated in Ukraine due to lack of appropriate information base, as well as some distortion of the data presented in the financial statements of banks. This requires further research, defines its goals and objectives.

The **aim** of the article is to open theoretical and methodological provisions on the nature of systemic risk indicator and its measurement, and develop economic and mathematical models that predict the emergence of this risk in the banking sector of Ukraine. There are the following objectives to achieve this goal: to provide interpretation of the definition of "systemic risk"; to determine the causes of systemic risk; to build a mathematical model predicting systemic risk of the domestic banking system for different time horizons.

Materials and methods. The study was conducted on the basis of scientific works of foreign and domestic scientists on the theory of systemic risk banks. The study entrusted with general scientific and special methods of cognition: abstract logic – for professional analysis of scientific literature, theoretical generalization and forming conclusions on the economic nature of systemic risk and its causes; decomposition – to disclose the purpose of the study and setting goals; analysis and synthesis – to determine the influence of the most important risk factors for the emergence of a systemic crisis in the banking sector; statistical and economic – for the prediction of systemic risk on the basis of certain indicators of macroeconomic development of Ukraine and its banking system.

Results. In English scientific literature there are two concepts: *"systemic risk"* as an event that can cause the collapse of a sector or the economy; *"systematic risk"* as general risk in the market [5]. But it is often when describing systemic risk (SR) used the first concept. The second term is used in some scientific publications as a synonym of systemic risk.

A critical review of the literature revealed debate around the definition of "systemic risk". Some researchers use the term "systemic risk" to the characteristics of particular problems, such as the payment system. But it is often seen as SR arising as a result of multiple risks. They are liquidity, credit, market and so on. In particular, the Center for Macroeconomic Analysis and long-term forecasting (RF) defines SR banking sector as a combination of credit, foreign exchange and liquidity risks, leading to a systemic banking crisis, that crisis, which covers most of the banking sector, including systemically important banks [6].

Systemic risk is aggregated inherent in the system as a whole as a combination of elements that are certain types of risks are interrelated. It should be emphasized that the total value of bank losses SR is not equal to the sum of losses on all types of risks because of the correlation between them.

Systemic risk leads to disruption of the normal functioning of some systemically important banks, the banking system and balance in the financial market. In economies where financing dominates through financial markets SR regarded as systematic market risk characteristic of all assets that can not be eliminated through diversification. In economies with handling financing through a bank loan the systemic risk is usually interpreted as the risk of the banking sector [3].

It was established that the vast majority of authors emphasize that cause of systemic risk is global financial imbalances. For example it was a high leverage ratio with a positive balance of the state budget (as in Spain), which led to an unjustified increase in lending to real estate. Extreme fiscal imbalance had a negative impact on economic growth (e.g. in Greece). Financial and economic imbalances have led to dangerous fiscal imbalances, as tax revenues declined and the cost of social insurance and "rescue" measures increased. Moreover, global financial imbalances were caused by "consumer" behavior of some countries, including the US and some European, which caused an unjustified increase in mortgage lending and, consequently, led to the so-called "financial bubbles" [1].

In the banking sector systemic risk often appears through bankruptcy of systemically important banks. For example, the bankruptcy of investment bank *Lehman Brothers* in 2008 caused a "domino effect" and many problems and defaults of related banks and corporations. SR rather turns at break (in any reason) the established relationship between financial market participants, which in turn leads to the inability to implement the overwhelming majority of their own strategic goals and objectives, the loss of added value, and perhaps bankruptcy etc.

Identification and regulation of systemic risk of the financial sector should be viewed on three levels: *individual* (at the level of a particular financial institution); *country* (at the level of national regulator); *global* (at the level of mega regulator).

At the level of mega regulator the permanent monitoring and assessment of systemic risks are carried out by the IMF, the ECB, World

Bank Group and the leading rating agencies *Fitch* and *S & P*. Methods of calculating these codes are constantly changing and the majority of them were designed by 2010–2011. Refusal to calculate a number of indicators of systemic stress associated with not enough accurate assessment of systemic risk. A striking example is the calculation of financial stress index, which was determined by IMF in 2010, and further any information on its use are not available. The purpose of this index was to determine the breadth and intensity of the crisis and the troubled financial market segments (banking, securities, and foreign exchange markets) that lead to the systemic risk. The critical level was considered excess value of 1.5 standard deviation values of this index. The index had differences in the calculations for the developed countries and developing countries.

For developed countries included subindexes 7 in the calculation, that belonged to the banking sector, stock market volatility and foreign exchange. Among the indicators of the banking sector it was taken into account the volatility of prices of bank shares, spreads on interbank rates and rates on Treasury bonds; stock market – the spreads on corporate bonds, the yield on the stock market volatility and stock returns.

For developing countries, the method of calculation of this index had the following features. First, the calculation included the compression rate of the currency market because it is the most widespread source of stress in these countries. Although many of them officially adopted flexible exchange rate regime, the regulator often allowed only minimal fluctuations (the effect of "fear of free navigation"). Second, the calculation of the index was not included on corporate bonds due to its low value.

The most reliable indicator of systemic risk today is the *Composite Indicator of Systemic Stress* (*CISS*), which is based on the application of the basic portfolio theory to five aggregated market-specific subindexes that derived from 15 individual indicators of financial stress. The calculation also takes into account the cross-correlation between the temporal change of sub-indices [9]. *CISS* has three levels *(figure 1).*

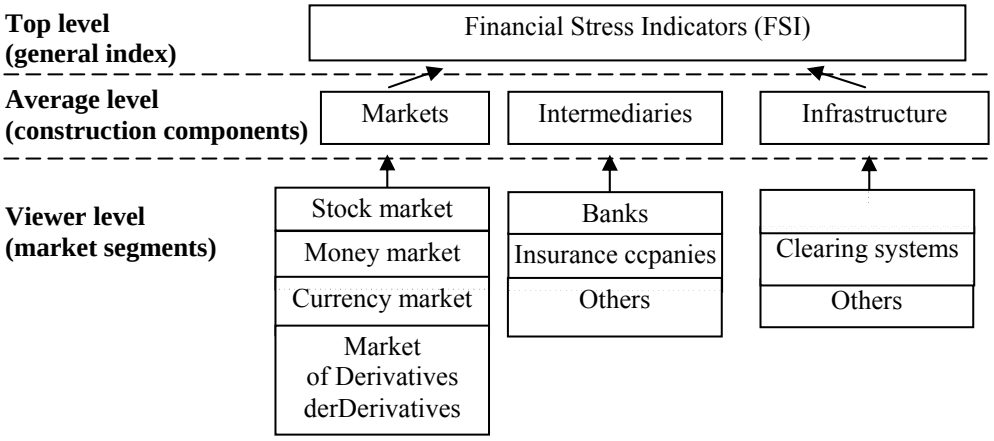

Figure 1. Indicators of Eurozone systemic stress with three levels of using [9]

This index indicates with sufficient certainty the "symptoms" of the crisis in the euro area. However, given the specificity of the functioning of the EU, it is unlikely it can be used for measuring risk in other countries. In addition, there is an objective need to identify national regulators from certain groups of indicators of systemic risk that would determine the features of each country. So, the appearance of SR source is macro level that creates the need for additional studies and national regulation of systemic risk regulator.

Most regulators of developed countries expect their own indicators of SR, for example, Federal Reserve Banks (FRB) in the United States. The most famous of them are FRB of St. Louis and FRB Kansas that define indicators of financial stress *STLFSI (St. Louise Financial Stress Indicator)* and *KCFSI (Kansas City Financial Stress Indicator)* respectively. Indices have similar methods of calculation. Both include 11 indicators, 7 of which are spread between different types of bonds, the remaining evidence of price volatility on key financial instruments (shares of banks, treasury bonds) and general stock market volatility through the index. The results of calculations are aimed at identifying increasing uncertainty about asset values and behavior of investors, asymmetry of information, reducing the desire of investors to hold risky and illiquid assets [10]. Indicators are accurate enough to identify adverse events for US markets, but absolutely unsuitable for any other countries. Index calculation example for countries with less weight the stock market can serve as a combined proactive indicator (CPI), determined by the Center for Macroeconomic Analysis and Short-term Forecasting (RF). The calculation is made for the three countries of the Customs Union: Russia, Belarus and Kazakhstan – on the basis of the actual amount of their GDP. It takes into account in calculating of this index the volume of industrial production, retail trade turnover, investment in fixed assets, the RTS index, price index for oil and nickel, as well as some indices of industrial production sector. However, this indicator has a number of significant shortcomings that does not allow it to assess the systemic risk of the banking sector. First, it virtually ignores the purely banking indicators, but focuses mainly on the real sector. Second, the indicator is inaccurate and does not reflect reality, and not adjust to changing market conditions. Thus, at the end of December 2014 CPI of currency market showed high probability of the exchange rate USD / RUB by 15 % and the inflation rate for 2014 was planned at 6.7 %. Even after the events of December 15, 2014, a day when the ruble lost nearly 30 % of its value, meaning of the forecast inflation for 2015 Russian currency remained unchanged in the updated data as at 12.26.2014 by 5.8 % [11]. This may indicate limited performance and inappropriate definition of this indicator.

Due to the limited information base, none of these indicators can be used in Ukraine, so it put forward a number of hypotheses about the reaction of some indicators of the macroeconomic situation of the country and its banking sector to the emergence of systemic risk [12; 13].

The level of systemic risk in Ukraine increased:

hypothesis 1: with a decrease in the ratio of reserves to GDP (indicator x1). Reducing reserves, which caused depreciation of the national currency to foreign, leads to an increase in money supply, which is a symptom of the instability of the economic environment;

hypothesis 2: the growth of the ratio of budget deficit to GDP (x2). This is due to the fact that the increase in the budget deficit leads to a significant breach of redistributive relations that arise due to a significant decline in business activity of economic entitie;

hypothesis 3: the growth ratio of public debt to GDP (x3). The increase in government debt due to the lack of funds and the state is a negative factor. The growth of debt increases the role of banks in the redistribution of public funds, because they buy government securities in order to obtain small but stable income as well as their use as collateral for refinancing from the central bank. Covering an acute shortage of bank liquidity at the expense of refinancing leads to wheeling of "financial flywheel" which affects the interests of not only individual banks but also gives financial equilibrium of the banking sector as a whole. You can make the hypothetical assumption that, in turn, promotes the deployment of systemic risk in the banking sector;

hypothesis 4: the growth ratio of monetary aggregate M2 to GDP (x4). The more liquid money supply in circulation, the lower the value of the currency, forcing banks to adjust interest rates adjusted for inflation, and thus leads to higher costs and a decrease in lending;

hypothesis 5: the growth of the volatility of the interbank exchange rate EUR (x5). There had been an administrative regulation of the exchange rate In Ukraine by 2014, which took into account not the real economic situation. Since February 2014, the National Bank of Ukraine began to pursue the policy of free navigation of the exchange rate of the national currency to the foreign language. This period chosen for comparison EUR exchange rate against the hryvnia on the interbank market, actively varies depending on supply and demand of foreign currency;

hypothesis 6: the growth of the average interest rates on loans (x6). Rise credits automatically means reducing the number of creditworthy borrowers, and hence the fall in lending;

hypothesis 7: the growth of the average interest rates on deposits (x7). The cost increases due to the outflow of deposits from the resource base of the banking sector, which also causes increase in the cost of active operations of banks;

hypothesis 8: with a decrease in interest rates (x8). In times of crisis, so as not to incur losses, banks reduced the number of planned revenues. Such a trend in the banking system suggests approaching crisis;

hypothesis 9: the growth of consumer price index (x9). This shows a decline in purchasing power and, therefore, the decrease in loans and deposits;

hypothesis 10: with increasing volatility in balances on correspondent accounts with the NBU (x10). Index is a reflection of liquidity in the banking system of Ukraine, and thus to a reduction in stability balances of these funds decreased ratio of deposits and loans of banks;

hypothesis 11: with a decrease in value of loans granted by banks to GDP (x11). The reduction in lending suggests slowing the movement of capital and thus economic slowdowns;

hypothesis 12: with a decrease in the ratio of trade balance to GDP (x12). Significant changes in this indicator show the imbalance in export-import operations and cash flow between Ukraine and other countries;

hypothesis 13: with a reduction in value of the ratio of deposits to loans to banks in Ukraine (x13). During the crisis of active operations are carried out largely by the borrowed funds in connection with the outflow involved;

hypothesis 14: the growth ratio of non-performing loans to the loan portfolio of banks of Ukraine (x 14). This shows a decline in credit quality and reduce borrowers' solvency;

hypothesis 15: with a decrease in loan portfolio ratio to the share capital of banks (x15). This is reflected in the reduction in lending and the degree of use of the most expensive resource which are own funds for active operations;

hypothesis 16: with a decrease in the ratio of liquid assets to current liabilities (x16). This indicator describes the liquidity of the banking system and the ability of banks to fully pay for current obligations;

hypothesis 17: with increasing volatility in overnight lending rates in the interbank market (x17). For comparison, the interest rate is taken *KievPrime*. The choice of indicator due to the fact, that the loans "overnight" are used to cover liquidity gaps. The higher the overnight rate, the greater the demands for liquid funds and, therefore, lower liquidity of the banking system;

hypothesis 18: the growth of the composite Eurozone stress indicator system (CISS) (x18). The indicator is chosen to study the relationship of national and European economies, that the impact of external factors on the banking system of Ukraine.

econometric modeling was applied to test these hypotheses, i.e. assumptions about these indicators respond to the emergence of a systemic crisis. These methods include regression model that reveals change dependent parameter influenced by other variables (factors), due to the existence of causal relationships between them.

As dependent variable was used indicator of systemic crisis, it may take two mutually exclusive (binary) values: the one in the case of crisis,

and 0 is for its absence. A value of 1 describes a period of economic downturn or recession profitability of the banking business by most researchers as a crisis. Thus, this period: the end of 2008 – beginning of 2009, the second half of 2010 – beginning of 2011 and the second half of 2014. In the case where the dependent variable takes only two values, usually 0 and 1, that is a binary variable using classical linear regression model is inappropriate. This change between the levels of the dependent variable is nonlinear, so it is appropriate to use non-linear regression model that estimates the probability of acquiring the dependent variable corresponding value [14]. Among the most popular are *Logit* and *Probit* model. This study uses logit model in which the explanatory variables are the logs (preliminary value) factor variables and the probability of crisis is modeled by logistic distribution law.

In general logit model with lagged explanatory variables can be represented as:

$$Y_t = a_0 + BX_{t-n} + \varepsilon,$$

where Yt – dependent variable that takes the value Y = 1, if the crisis;
$Y = 0$ – the absence of crisis;
B – vector of estimated coefficients;
X_{t-n} – vector of lagged explanatory variables, n – lag order;
ε – "white noise" [14].

An important prerequisite for the estimation of logistic regression models for time series data is stationary of latter. We use ADF test (appropriate criteria) to define stationarity of all time series, and if it was identified as non-stationary, we take first difference in order to brought it to a stationary state [15].

We test stationary of variables (factor) and estimate parameters of logit models with package *Gretl* 1.10 [16], which is freely available and designed for econometric modeling. It was investigated a number of models with lags of explanatory variables to identify factors that can be used as leading indicators. For the purpose of early warning the lag of 12 months is set, medium-term – 6 months and late warnings (i.e. the least to the time of the crisis) – 3 months. Models were selected by successive exclusion of variables with the highest probabilities (P-value) that included a variable effect are insignificant, i.e. coefficients equal to 0. Finally, as the best were defined the models with the lowest values of Akaike and Schwarz information criteria and all statistically significant regression coefficients [15]. Assessment criteria and adequacy of appropriate models for 3, 6 and 12 months are given in the (*tables 1–6)*. Full multicollinearity was found between x8 and other variables, making it possible to exclude this variable from further investigations. In addition in order to the reduce variation (especially distinctive presence of total value) we used logarithms of variables (and) *x10* and *x17.*

Table 1

Parameter estimation results of binary logit model with lagged variables for 12 months in the banking system Ukraine

Model: logit used observations 2009: 02-2013: 12 (T = 59)

Parameter	Coefficient	Statistical Error	*z*	*P*-value	Significance
const	−12.9431	3.7560	−3.4457	0.0005	***
d_x3	−0.0002	0.0001	−1.5413	0.1232	–
d_x6	0.8651	0.4783	1.8109	0.0701	*
x7	1.0573	0.3151	3.3538	0.0008	***
x12	−3.3922	1.2652	−2.6796	0.0073	***
d_x13	95.8342	35.4160	2.7059	0.0068	***
d_x16	0.1232	0.0900	1.3628	0.1729	–
l_x17	−0.5531	0.2313	−2.3974	0.0165	**

Indicators of model adequacy			
MacFadden *R*-squared	0.4207	Adjusted *R*-squared	0.2179
The logarithm of credibility	−22.8535	Criterion Akaike	61.7070
Schwarts Criterion	78.3273	Hannan-Quinn Criterion	68.1949

Note. The first difference between the levels of factor indicated as d.

Number of stars indicates the statistical significance of the coefficient at the appropriate level: * – 10 % ** – 5 % *** – 1 %.

Table 2

Distribution of observed and predicted events of crisis of Ukraine's banking system with 12 months lagged variables

		Estimated indicators of crisis	
		0	1
The observed indicators of crisis	0	30	6
	1	6	17

Overall adequacy of the model is confirmed by sufficiently high value of McFadden R-square (0.42), and its significance at 5 %. It is analogous to the traditional coefficient of determination for (models) logistic regression.

Based on the results it can be concluded that reveal the crisis for 12 months is possible based on the model with a (significant influence) factors *x6, x7, x12, x13* and *x17* that enabled correctly identified 47 cases of the system of 59 (79.7 %), 17 of them as crisis (73.9 %) and (to) identify the start of two crisis's (2008–2009 and 2014). In this model, there are variables whose impact is insignificant, but their exclusion leads to increase in Akaike and Schwartz criteria and reduce the adjusted coefficient of determination, so this model specification was selected.

Table 3

Parameter estimation results of binary logit model with lagged variables for 6 months in the banking system Ukraine

Model: logit used observations 2008: 08-2013: 12 (T = 65)

Parameter	Coefficient	Statistical error	*z*	*P-value*	significance
const	−3.3632	7.2031	−0.467	0.6405	
d_x1	1.0322	0.4222	2.4452	0.0144	**
x2	−0.5441	0.2231	−2.4330	0.0149	**
x4	0.0424	0.0181	2.3070	0.0210	**
d_x6	−1.8470	0.8352	−2.2102	0.0270	**
x7	0.5942	0.3524	1.6870	0.0915	*
d_x9	−3.1501	1.3642	−2.3090	0.0209	**
x11	−0.04083	0.0153	−2.6863	0.0072	***
d_x15	0.2412	0.0921	2.6161	0.0089	***
l_x17	−1.1390	0.5123	−2.2221	0.0262	**
d_x18	16.8022	7.8421	2.1421	0.0321	**

Indicators of model adequacy			
McFadden R-squared	0.6814	Adjusted R-squared	0.4300
The logarithm of credibility	−13.9371	Criterion Akaike	49.8741
Schwartz Criterion	73.7924	Hannan-Quinn Criterion	59.3114

Table 4

Distribution of observed and predicted events of crisis of Ukraine's banking system with 6 months lagged variables

		Estimated indicators of crisis	
		0	1
The observed indicators of crisis	0	37	2
	1	3	23

In six months it possible to identify crisis with a model that includes variables (del) *x1, x2, x4, x6, x7, x9, x11, x15, x17, x18*, which correctly identified 60 cases of the system of 66 (92.3 %) of including 23 crisis (88/4 %), and promptly found early 2 crises (2008–2009. and 2014).

For 3 months before the start of the crisis signals the model with factors such as *x3, x4, x5, x6, x10, x11, x12, x13, x16, x17*, which (generally) correctly identified 59 cases of the system from 68 (86.8 %), and 22 of them as crisis of 26 (84.6 %) and detects the beginning of the crisis with an average probability of 66.7 % (2 cases out of 3).

An important practical criterion of predictive power of the model is its ability to correctly identify the beginning of the crisis, i.e. high probability of correct estimation for the first month of the crisis period. Therefore, when comparing models a lot of attention is paid to the assessment of the probability of crisis for the first month of each crisis period. In the event that the probability is greater than 0.5, this assessment is defined as successful,

otherwise – no. As a result, the best model will be defined that will correctly predict the first three months of systemic crises that have occurred over the period of study. In this regard, even better (smaller) value of information as the ultimate criterion has been chosen a model which enabled correctly predict the beginning of the crisis or had higher compared with other predictive probability for the initial month crisis.

Table 5

Parameter estimation results of binary logit model with lagged variables for 3 months in the banking system Ukraine

Model: logit used observations 2008: 05-2013: 12 (T = 68)

Parameter	Coefficient	Statistical error	*z*	*P*-value	Significance
const	−2.8833	4.0694	−0.7085	0.4786	
d_x3_3	4.09494e-05	1.78586e-05	2.2930	0.0218	**
x4_3	0.04898	0.0170	2.8905	0.0038	***
d_x5_3	12.5941	6.4929	1.9397	0.0524	*
d_x6_3	1.7497	0.7904	2.2135	0.0268	**
ld_x10_3	1.2266	0.7074	1.7339	0.0829	*
x11_3	−0.0323	0.0111	−2.9100	0.0036	***
x12_3	5.3051	2.0687	2.5644	0.0103	**
d_x13_3	−250.3551	78.9197	−3.1723	0.0015	***
d_x16_3	−1.7465	0.6143	−2.8430	0.0044	***
l_x17_3	−0.8272	0.2790	−2.9647	0.0030	***

Indicators of model adequacy

McFadden *R*-squared	0.5930	Adjusted R-squared	0.3498
logarithm of credibility	−18.4104	Criterion Akaike	58.8208
Schwartz Criterion	83.2354	Hannan-Quinn Criterion	68.4946

Table 6

Distribution of observed and projected indicators of crisis in the banking system of Ukraine study period

		Estimated indicators of crisis	
		0	1
The observed indicators of crisis	0	37	5
	1	4	22

Analyzing (representation) model signals the start of the crisis *(table 7)* we can conclude that with it could be in time to determine the beginning of the crises of 2008 and 2013 with their help, but the crisis in 2010 was detected by models of late warning with a delay of one month and conditionally – early warning model. Note that the warning signal based on model with 3-month lags failed on May 2013, (that is) so, from a formal point of view the signal is wrong, (and) but practically – it has provided useful information, therefore, fulfilled its predictive function.

Table 7

Comparison of the crisis probability estimates for models with varying time lag

Time	Crisis availability	Estimates of crisis probability		
		3 months	6 months	12 months
2008:10	0.0000	0.0552	0.0011	–
2008:11	1.0000	0.8533	0.3903	–
…	…	…	…	…
2010:07	0.0000	0.0140	0.0000	0.5063
2010:08	1.0000	0.4831	0.0057	0.5321
…	…	…	…	…
2013:05	0.0000	0.9790	0.1470	0.3482
2013:06	1.0000	0.9914	0.7812	0.7872

Analyzing these models, we can conclude that as indicators of early (one year) warning can be used (serve) lagged variables *x7, x12, x13*, together with the variables (of) *x17* and *x10,* and as indicators of medium and late warning are variables *x4, x6, x11, x17* (included of the models from these periods) lagged on 3 and 6 month. Factors 8 and 14 are not significant in any model specifications, so they can not be used as indicators of systemic crisis. At the same time, factors 6 and 17 are (part) included in (of) all models, precisely because of the change should be given the focus in predicting the development of the crisis.

Thus, current study confirms all hypotheses, except 8 and 14 which were rejected. It means that the spread in interest rates and the ratio of non-performing loans to the loan portfolio does not indicate the presence of systemic risk in Ukraine, because of its incorrect calculations of domestic banks.

Due to the novelty of the problem, this work has (been studied with) certain assumptions and limitations. The first limitation is the selection of variables, due to the available information base and can be subjective, the second one is a clearly defined range forecasting crises is somewhat arbitrary, and use only static logistic models to identify crisis.

Conclusion. Systemic risk is the risk inherent in the banking system as a whole as a combination of elements that are certain types of risks, that are interrelated and interact. To assess the level of systemic risk in Ukraine put forward a number of hypotheses. It is used nonlinear regression model to test them that helped to identify changing binary indicator of the presence of systemic crisis, under the influence of other factors.

It is proved that the rate of spread of interest rates and the ratio of non-performing loans to the loan portfolio does not indicate the presence of systemic risk in Ukraine. However, in all regression models designed for different time horizons, interest rates on bank loans and rates on loans overnight interbank credit market are the key indicators of forecasting the crisis in the banking sector of Ukraine.

Using regression models described in practice of the National Bank of Ukraine will take regulatory measures in advance to avoid certain risk

factors or mitigation of action that will strengthen financial stability and reliability of the domestic banking system.

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Шульга Н., Чорний А., Степашова А. Оцінювання системного ризику банків.

***Постановка проблеми**. Посилення глобалізаційних процесів, концентрації банківського капіталу та волатильності цін на фінансових і товарних ринках створює загрозу появи нової хвилі системного ризику, наслідки якої можуть виявитись руйнівними як для економіки в цілому, так і банківського сектора, зокрема.*

***Метою** статті є розкриття теоретико-методичних положень щодо сутності системного ризику й індикаторів його виміру, а також розробка економіко-математичної моделі прогнозування виникнення цього ризику в банках України.*

***Матеріали та методи.** У процесі дослідження практики зарубіжних країн щодо оцінювання системних ризиків у банківській сфері використано такі методи: абстрактно-логічний, декомпозиції, аналізу та синтезу, статистично-економічний.*

***Результати дослідження.** Уточнено тлумачення дефініції "системний ризик". Висунуто гіпотези щодо реагування окремих індикаторів макроекономічного розвитку України та її банківського сектора на появу системного ризику за різними часовими горизонтами та проведено їх перевірку. Доведено, що процентні ставки за кредитами банків та ставки овернайт за кредитами міжбанківського кредитного ринку є ключовими індикаторами прогнозування розвитку кризових явищ у банківському секторі України.*

***Висновки.** Системний ризик – це ризик, притаманний банківській системі в цілому як сукупність елементів, що представлені окремими видами ризиків, які взаємопов'язані та взаємодіють між собою. Для оцінки рівня системного ризику в Україні висунуто ряд гіпотез, для перевірки яких використано модель нелінійної регресії, що дозволила виявити зміну бінарного індикатора наявності системної кризи під впливом інших факторів. Розрахунки проведено для часових горизонтів 3, 6 та 12 місяців.*

Доведено, що показник спреду процентних ставок і коефіцієнт співвідношення недіючих кредитів до кредитного портфеля не свідчать про наявність системного ризику в Україні. В той же час при усіх моделях регресії, розрахованих за різними часовими горизонтами, процентні ставки за кредитами банків та ставки овернайт за кредитами міжбанківського кредитного ринку виступають ключовими індикаторами прогнозування розвитку кризових явищ у банківському секторі України.

Використання описаної моделі регресії у практиці НБУ дозволить заздалегідь прийняти регулятивні заходи щодо уникнення окремих ризик-факторів або пом'якшення їх дії, що сприятиме зміцненню фінансової стійкості й надійності вітчизняної банківської системи.

Викладені концептуальні положення потребують подальшого наукового дослідження в напрямі розробки системи превентивних регулятивних заходів з боку НБУ, що підвищить результативність управління системним ризиком, а відтак забезпечить фінансову рівновагу в суспільстві.

Ключові слова: системний ризик, системно важливі банки, оцінка ризику, індикатори системного стресу, статистична модель нелінійної регресії.