__Economic Theory__

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EARLY WARNING INDICATORS OF DEFAULTS IN THE BANKING SYSTEM OF UKRAINE

Abstract

We construct and explore a new quarterly dataset of 12 traditional financial ratios for defaulted banks. The retrospective comparative analysis of bank-specific early-warning indicators' predictive power for 2 samples of problem banks over 2008–2012 and 2014 periods was conducted. The survey results reveal the most appropriate early-warning signals, which are useful for credit rating methodologies, and can improve the quality of systemic risk monitoring in the banking sector. The best predictors of defaults proved to be traditional indicators of profitability and liquidity, the share of retail deposits in the liabilities, and qualitative factor of the bank's ownership structure. Insufficiently indicative predictive ability was demonstrated by the simplified indicators of capital adequacy and assets quality.

Key words:

Banks, bank default, early-warning indicators, banking crises, systemic risk.

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JEL: G21, G01, G28.

Problem Statement. Since the beginning of 2014, the banking system of Ukraine (BSU) entered a phase of financial instability, as indicated by unprecedented high default rate and the historical record for the annual number of introductions of temporary administration at insolvent banks (Fig. 1).

Figure 1

Number of introductions made by the temporary administration
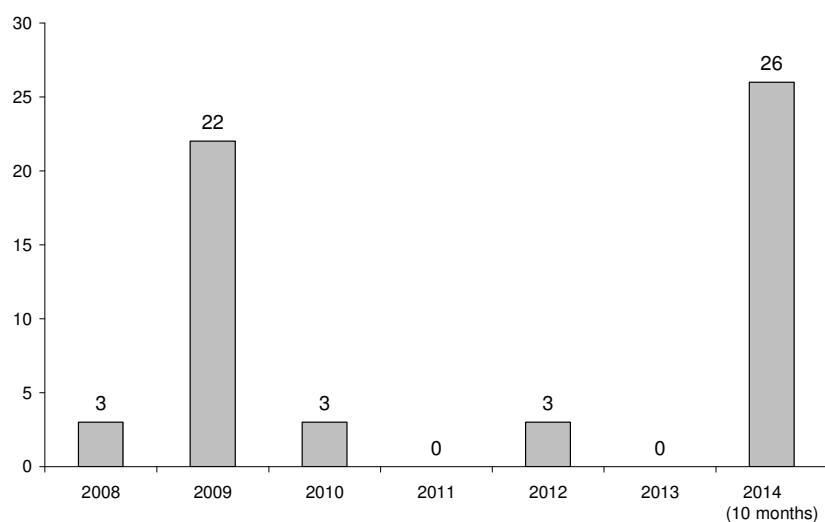
Source: Individual Deposits Guarantee Fund, NBU

The greatest interest among investors and counterparties was caused by defaults of the banks with a substantial share in the deposit market, such as Brokbiznesbank, Forum and Pivdencombank. The growth of individual bankrupt-

cies into the full blown systemic crisis in the first semester of the current year was stopped by the dynamic actions of the National Bank as the lender of last resort, which prevented the liquidation of some 'too big to fail' banks (UNIAN, 2014). On the other hand, the expansionary monetary policy and active financial support in the systemically major banks rehabilitation have caused the indirect consequences in the form of an additional contribution into the strengthening of inflationary and depreciation processes.

During the periods of banking crises deployment, the particularly acute necessity arises for the early warning system of bank defaults, potentially posing a threat of starting the scenario of systemic risks realization. Raising no objections to the importance of aggregate macroeconomic or financial indicators that are traditionally used for monitoring BSU's financial stability, it is recommended to strengthen the analysis of systemic risks by regular estimations of the bank's reliability indices at the individual bank level, tabulated into a single index or rating for regulatory purposes. Meanwhile, it is essential to improve the predictive ability of ratings and indices of reliability to perform a constant calibration of microeconomic models of defaults based on back-testing of the traditional indicators efficiency in the past bankruptcies predicting.

Research and publications analysis. The systems of bank defaults early warning have been used in the regulatory practices of leading countries for several decades. The greatest popularity among many methodologies of problem banks identifying was gained by the rating system CAMELS, which has been used in the US since 1978 and is based on a complex assessment of financial institutions stability according to 6 main groups of indicators: *Capital adequacy, Asset quality, Management administration, Earnings, Liquidity* and *Sensitivity to Market Risks* (FDIC, 1996). Methodology for calculating the bank credit ratings of international and national rating agencies (RA), numerous normative and legislative acts and internal bank documents on the risks management problems require calculation of the key financial stability indicators, which completely or partly coincide with the components of the CAMELS system.

Spreading of the Unified Financial Institutions Rating System (UFIRS, officially named CAMELS) resulted in the appearance of numerous scientific publications, which are not only using certain elements of CAMELS, but are also making attempts to verify the validity of the relevant indices in terms of predicting defaults and crises. Thus, in the articles of foreign scientists J. Babecký (Babecký et al., 2012), A. Evans (Evans et al., 2000), A. Demirguc-Kunt (Demirgüç-Kunt and Detragiache, 2005), A. Rose (Rose and Spiegel, 2009) attempts were made to choose the most significant early warning indicators of banking crises among the standard indicators of CAMELS. Methodologies and results of these studies differ, but their key difference from our research is focusing on the early warning of the system-wide instability, which allows authors to abstract from individual aspects and to aggregate the studied indices at the level of national banking systems. Among the analogous national works on financial soundness indicators,

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publications of the following scholars are worth noting: O. I. Baranovskyi (Baranovskyi, 2009), I. V. Belova (Belova and Bashlai, 2013), O. V. Dziubliuk (Dziubliuk and Mykhaylyuk, 2009), S. V. Mishchenko (Mishchenko, 2008), S. V. Naumenkova (Naumenkova and Mishchenko, 2009), V. I. Ohiyenko (Ohiyenko and Lunyakov, 2013), being characterized by theoretical and methodological orientation or based on the aggregate system-wide indices analysis. Instead, in present research we conducted a more detailed empirical analysis at the bank-specific level.

The second field of the early warning indicators research, made by such authors as R. Barro (Barro and Ursúa, 2012), G. Kaminsky (Kaminsky, Lizondo and Reinhart, 1997), P. Manasse (Manasse, Roubini and Schimmelpfennig, 2003) is also characterized by an emphasis on studying the macroeconomic disasters and financial crises signals. However, researchers do not pay attention to parameters specific to the banking system, because they are using stock and macroeconomic indicators. Meanwhile, the indicators of banking institutions' internal stress resistance, which is the main subject of the present study, remains beyond the above works.

The third group of the research works should include studies of the relationship between the individual bank indicators and the systemic risk, performed by D. Anginer (Anginer and Demirguc-Kunt, 2014), P. Diamond, R. Rajan (Diamond and Rajan, 2012), R. Engle, E. Zhondeau, M. Rockinger (Engle et al., 2014), V. Acharya, L. Pedersen (Acharya, Pedersen, Philippon and Richardson, 2010), D. Woo (Wu and Zhao, 2014) and others. These authors analyze much broader range of problems, examining, besides the bank reliability factor, the amplification mechanism of defaults cascade spreading.

The closest, as to their methodology and objectives, to our study are the research studies of such scholars as M. Arena (Arena, 2008), F. Betz (Betz et al., 2013), R. Cole (Cole and Gunther, 1998), A. Cullen (Cullen, 2010), W. Francis (Francis, 2014), who take into account the distribution of the indicative values of individual reliability indicators among problematic and stable banks. However, they relate to Latin America, Asia, the US and the EU, while with respect to Ukrainian empirical data, this problem remains understudied.

The purpose of the present paper is to determine the most accurate indicators of the banks reliability, and to compare the predictive ability of various traditional early warning indicators to improve the quality of rating methodologies and to establish a theoretical basis for monitoring systemic risks in the banking sector.

The methodology of this study is a retrospective empirical analysis of the financial data time series concerning the two insolvent banks groups: 1) banks with the introduced temporary administration during the first three quarters of 2014; 2) banks that have experienced default due to the global financial crisis in 2008–2012. The financial indicators distribution within the two samples, selected

in the troubled banks, was compared with the system-wide statistical distribution of the relevant variables at the beginning of the quarter before the default declaration. The presence of significant differences between the values of the indicator in the «problem» samples and the parameters of their distribution within the system is considered by the author as the evidence of the respective indicator's signal ability.

Main material description. In general, all 23 troubled banks, officially declared insolvent during the year as of 03.10.2014, controlled 6.5% of all assets and 6.9% of all retail deposits in the banking system of Ukraine (Fig. 2).

Figure 2

The aggregate market share of banks with temporary administration introduced in 1–3 quarters of 2014*
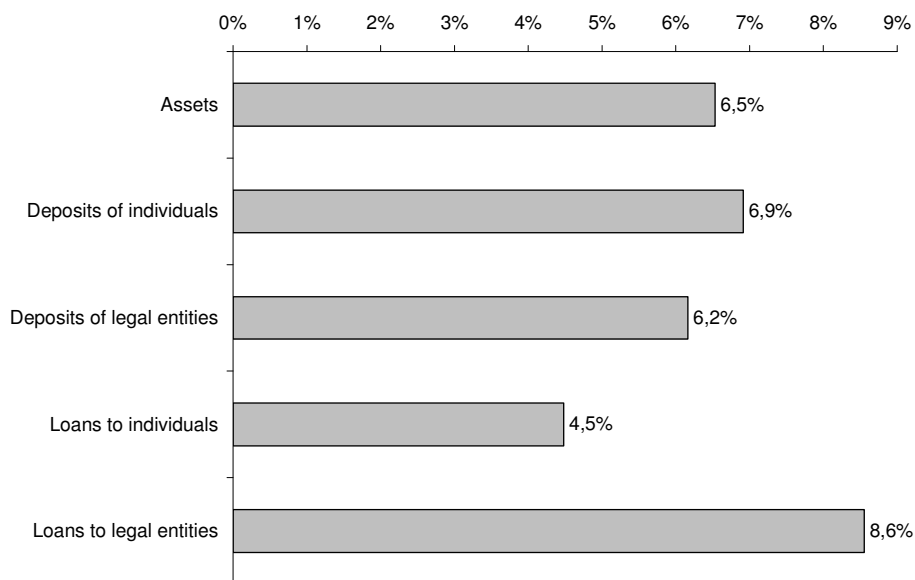
Source: National Bank of Ukraine.

* Market shares are calculated for each bank based on the latest quarterly data for the moment of the temporary administration introduction.

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Defaulted banks are causing the scientific interest in terms of the historical analysis of the liquidity indicators predictive accuracy, profitability, capital adequacy and other quantitative parameters obtained by means of CAMELS logic system. For the purpose of the signal ability back-testing, the author selected 12th simplified finance indices, this could be calculated on the basis of the banks' quarterly reports, published by the NBU (Table 1).

Table 1

Early warning indicators that were subject to testing

№ (j)	Indicator (I_j)	Indicator Group
1	Net interest margin	return
2	Interest income / Interest expenses	return
3	Return on average assets (ROAA)	return
4	Return on average equity (ROAE)	return
5	Statutory capital / Assets	capital adequacy
6	Equity / Assets	capital adequacy
7	Loans / Deposits	credit activity
8	Liquid assets / Resources, where Resources = deposits+due to other banks	liquidity
9	Liquid assets / Total assets	liquidity
10	Deposits by individuals / Liabilities	funding structure
11	Current deposits / Deposits	funding structure
12	Loan Loss Provisions / Loans	asset quality

The calculation of each indicator's predictive accuracy was made according to the single algorithm. Let's determine the indicator I_j (where $j = \overline{1, 12}$)) for each bank: $B_1, B_2, B_3, ... , B_n$ of Ukraine's banking system at the beginning of each quarter t for the studied period 1Q: 2008-3Q: 2014. Suppose, $I_{jt}(B_n)$ is the value of the j-th indicator for bank B_n as for the date t.

Let's calculated quartiles of statistical distribution I_j for each t:

$Q_{0.25\,jt}$ – the first (lower) quartile of statistical distribution I_{jt};

$Q_{0.5\,jt} = M_{jt}$ – second quartile (median) of statistical distribution I_{jt};

$Q_{0,75\,jt}$ – third (upper) quartile of statistical distribution I_{jt}.

Depending on the range, where $I_{jt}(B_n)$ fall into, let's define the value $f_t(B_n) = R$ for each bank of the system, where $R = 1$ for 25% of the banks with the studied ratio values below the lower quartile ($I_{jt} < Q_{0.25\,jt}$); $R = 2$, if $Q_{0.25\,jt} < I_{jt} < M_{jt}$; $R = 3$, if $M_{jt} < I_{jt} < Q_{0.75\,jt}$; $R = 4$ if $I_{jt} > Q_{0.75\,jt}$.

Let's explore the distribution of values for the banks that suffered a default, within the total distribution. Let $B_{n\text{-}def}$ be a bank that has been recognized as insolvent after the period t (Table 2).

Then $L_1 = \{B_n \mid B_{n\text{-}def} \sim (f(B_n) = 1)\}$ is the set, containing insolvent banks before the default, with values: $I_{jt} < Q_{0.25\,jt}$.

Thus, we can calculate:

$$w_1 = \frac{|L_1|}{N_{def}}, \tag{1}$$

where $|L_1|$ – number of elements in the set L_1,

N_{def} – the total number of insolvent banks during the analyzed period.

Thus, the predictive power of the indicator, in our understanding, depends on w_1: shares of troubled banks with the values $I_j < Q_{0,25j}$ as at the beginning of the quarter, when the temporary administration was introduced. According to the suggested method, the more troubled banks demonstrate the extreme values of the indicator below the first (or, conversely, higher than the third) quartile, the more historically accurate is this indicator to assess the reliability of the bank and to perform early warning of a default. The significance of the results obtained was additionally tested by the similar calculations for a sample of troubled banks in 2008–2012.
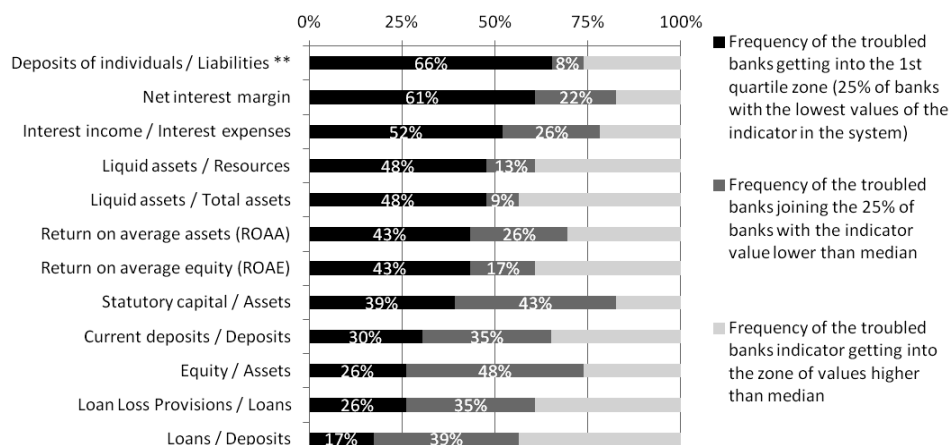
Accuracy of traditional financial indicators (w_1) in predicting defaults of 23 banks during 3 quarters of 2014, is calculated according to the results of the retrospective study, presented in Figure 3.

The result of the study is, that none of the financial indexes showed the ideal predictive accuracy ($w_1 \neq 1 \neq 100\%$), which partly confirms the popular skepticism about their use reasonability in the analysis of Ukrainian banks. It should be noted, that the low indicative ability of the parameters is partly explained by the fact, that most of the banks were officially recognized to be insolvent due to operating and non-financial risks, such as: violation of the law in the money laundering sphere, terrorism financing and performing the functions of conversion centers, formally remaining financially stable. However, even in crude sample like that, the frequency of troubled banks getting into the «red» zone below the first quartile as to certain indicators is too high to be ignored.

According to the control sample of 31 troubled bank in 2008–2012, predictive ability of the traditional financial indicators is shown in Figure 4.

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Figure 3

**Statistic distribution of the indicators for a sample of insolvent banks
for the 9 months period of 2014** *

* Compiled by the author alone on the basis of the NBU data (NBU, 2014). Predictive accuracy of the financial indicators has been calculated on the basis of the banks' latest quarterly data before implementing the temporary administration in 2014.

** The indicator demonstrated the inverse correlation: in most of the troubled banks the share of deposits by individuals in their resources was very high; therefore, frequency of the troubled banks getting into the 25% group is indicated in the diagram with the highest (not the lowest) values of the indicator in the system.


To compare the results of the indicative values statistic distribution for the both historical samples of troubled banks, we calculated an index of indicators predictive accuracy (*IPA*) according to the formula:

$$\varPi TI = \frac{w_1}{0{,}25},\qquad(2)$$

where w_1 – frequency of the indicator values getting into the group of insolvent banks in the range of the lower quartile (25% of the BSU banks with the lowest values of the indicator).

Figure 4

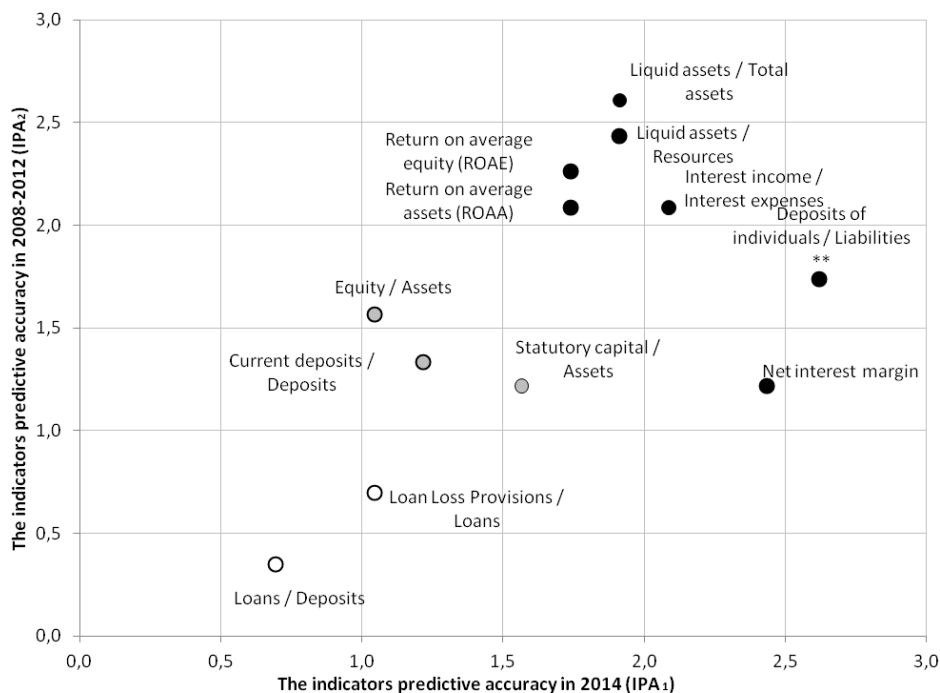**Statistic distribution of the indicators for a sample of insolvent banks for 2008–2012**
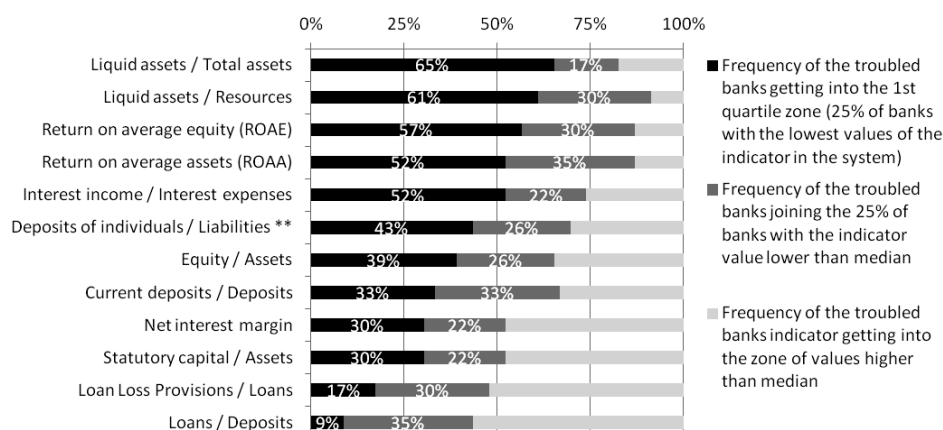
* Compiled by the author alone on the basis of the NBU data (NBU, 2014). Predictive accuracy of the financial indicators has been calculated on the basis of the banks' latest quarterly data before implementing the temporary administration in 2008–2012.

The *IPA* indices for each sample of insolvent banks are presented in Figure 5.

If most of the troubled banks, before introducing the temporary administration, demonstrated critically low values of this or that indicator compared to other banks, it may very likely testify to its use reasonability for further analysis of the banks reliability or in the rating process. *IPA* index enables to measure how many times higher the historic probability of troubled banks getting into the zone lower than the 1st quartile is, compared to the 25% system-wide probability for each indicator.

The results of the study, shown in Fig. 5, for a sample of troubled banks in 2014, demonstrate that only three indicators had *IPA* more than 2. Thus, the given indicators values were getting into the zone of extreme quartiles more than twice as frequently. The most accurate indicator of default was the *individuals' deposits / liabilities ratio* (*IPA₁ = 2.6*), because in 2014, 66% of insolvent banks were having in their funds more than half of the resources borrowed from individuals, although this was true for only one fourth of Ukrainian banks.

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Figure 5

Indices of the indicators predictive accuracy (*IPA*)*

* Compiled by the author on the basis of the NBU data (NBU, 2014).

The high predictive accuracy for the given period has been demonstrated by such indicators of return as *net interest margin* (IPA_1 = 2.4) and the *interest income / interest expense ratio* (IPA_1 = 2.1). Significant deviations from the general distribution have been observed for the both *liquidity indicators* (IPA_1 = 1.9) and for *profitability ratios* (IPA_1 = 1.7). In troubled banks, in 2014, the above indicators were significantly lower than the average for the system.

When testing a control sample of insolvent banks of 2008–2012, only one of the mentioned indicators confirmed *IPA* > 2: the *interest income / interest expense ratio* (IPA_2 = 2.1). Meanwhile, high predictive ability was demonstrated by the both liquidity indicators: the *share of liquid assets in total assets* (IPA_2 = 2.6), the *liquid assets / bank resources ratio* (IPA_2 = 2.4); and returns rate: *ROAE* (IPA_2 = 2.3), *ROAA* (IPA_2 = 2.1). The *deposits of individuals / liabilities ratio* and

the *equity / assets ratio* had *IPA₂* > 1.5. The rest of the studied indicators showed a lower signal power.

Before interpreting the results of the retrospective study, it should be noted that their accuracy is adversely affected by a number of technical reasons: a) presence in the sample systemically major, but stable banks, that are difficult to identify, because of the lacking accessibility of regulators, in terms of disclosing the reasons for the temporary administration introduction; b) simplified calculation of the liquidity, assets quality and capital adequacy indicators due to the low specification of the published financial reports data of Ukrainian banks (NBU, 2014); c) the tendency of troubled banks to manipulate reporting documentation, especially when reserving. One should not forget that the conclusions of any historical analysis always require expert reviewing and confirmation by the further series of empiric data, since it is not always that the correlation between the early warning indicators and bank defaults is an evidence of the cause-and-effect relationship.

Interpretation of the study results. A back-testing of the 12 traditional financial indicators for the two samples made among the total of 54 insolvent banks in 2014 and 2008–2012 (table 2) allowed to select those of them, which most accurately testify to the default probability, and therefore appropriate for use in the rating methods.

Significant ability of default prediction was confirmed for the indicators that reflect the **interest** and **banks returns**. In most troubled banks, in 2014, the lower indicators values were recorded compared to the average values of the returns indicators in the system, thus confirming their importance for the bank reliability assessing. This is despite the fact that the accuracy of such early warning indicators as the interest income / interest expense ratio, net interest margin (the ratio of net interest income to average annual operating assets of the bank) and ROAA (annual average return on assets) and ROAE (return on average annual equity) is often violated by the declared expenses and net income accounting manipulations of the banks. The empiric study suggests that the assessment of profitability makes sense even in the conditions of abused reporting. The hypothesis that the ability to generate interest returns and income is an indicator of the bank's financial stability is confirmed by practice (Fig. 6).

Using **indicators of liquidity** for early warning of defaults is complicated by the fact that the bank's supply of liquid assets in cash and cash equivalents has the ability to rapidly change, especially under the banking panic conditions. Nevertheless, the retrospective study of the 2008-2012 sample showed the highest predictive accuracy of liquidity indicators, which were calculated on the basis of even quarterly data. Thus, in 65% of the banks, before introducing temporary administration, share of liquid assets in total assets was below the 1st quartile. For the sample of banks that were declared insolvent during the first three quarters of 2014, this figure was 48%.

Table 2

Insolvent banks in the research samples

No	Sample 1: banks recognized insolvent in 2014	Sample 2 (control sample): banks recognized insolvent during 2008–2012
1	Daniel Bank	European Bank for Development and Savings
2	Brokbiznesbank	Prominvestbank
3	Real Bank	National Credit
4	Mercury-bank	Ukrainsky Promyslovy Bank
5	Forum	Prichernomorie Bank
6	Interbank	Kyiv Bank
7	Promeconombank	Nadra Bank
8	Pivdencombank	Zakhidinkombank
9	Zakhidinkombank	Transbank
10	Avtokrazbank	BIG Energy
11	Starokievskiy Bank	Rodovid
12	Finrostbank	Regional Development Bank
13	Eurogazbank	Dnister
14	Zoloti Vorota Bank	Arma
15	UFS Bank	National Standard
16	Terra Bank	Ukrgazbank
17	Active Bank	Volodymyrsky
18	Aktabank	Bank Stolytsya
19	Expobank	Odessa-bank
20	GreenBank	Evropeyskiy
21	Porto-Franco	Ukrainian Financial Group
22	Demark	Innovational-Industrial Bank
23	Prime-Bank	Hypobank
24	–	Eastern European Bank
25	–	Dialogbank
26	–	Zemelniy Bank
27	–	Syntez
28	–	Soccombank
29	–	Basis
30	–	Erde Bank
31	–	Tavrika

We believe that the predictive accuracy in the second case was under-stated due to the structural features of the sample. Indeed, the results of similar calculations for the 1st half of 2014, the role of the liquidity lack in the declaration of defaults was higher. However, the introduction of the temporary administration in the 3d quarter into liquidity possessing scheme and captive banks has reduced the role of the liquidity factor in the total sample of troubled banks for 2014.

The most surprising result of the study was high predictive ability of the in-dicator «**share of household deposits in liabilities**», which is much seldom than the previous ones used to assess the reliability of banks. In the both sam-ples the troubled banks tended to a sharp increase in the share of household de-posits 1–2 quarters before the default. Successful attraction of the retail financial resources by such banks can be explained both by the reluctance of the better informed entities to send money in a dubious bank and by the high interest rates, which are traditionally offered by such institutions at the stage of *ponzi finance* in the terminology of H. Minsky. During crises, such banks, dependent on retail de-posits, would feel more keenly the problem of the deposits outflow. Panic is es-pecially amplified under the conditions of low customer loyalty. Inactive in the re-tail captive banks may account for the funds of their owners in the form of house-hold deposits, which at transfer through covert insider crediting are one of the links in the gray financial schemes.

Indicators **of capital adequacy** used by regulators in most countries, turned to be less important in Ukraine for predicting defaults by means of the re-turns and liquidity indicators. However, the values of capital adequacy for insol-vent banks were more often lower than medians of the respective system-wide statistic distributions. A certain shortage of equity and share capital in troubled banks can be explained on the one hand by inefficient and risky operations of management, and the other hand – by the inability of shareholders to make addi-tional capital injections or by their unwillingness to save their non-core busi-nesses.

The share of problem loans and loan loss provisions in the loan portfolio are considered to be traditional indicators of **assets quality**. Though the actual structure of loans as the main assets item of Ukrainian banks is a key indicator of the banks' reliability, but there are serious barriers to its definition. Thus, none of the indexes, reflecting the quality of loans on the basis of public reporting, has confirmed its predictive ability: banks under temporary administration, until the very moment of its introduction, reported in a different way about their assets tox-icity level. This confirms the generally accepted view of the numerous accounting abuses aimed at distortion of the information about the real quality of bank loans. Indeed, fair estimation of the troubled assets amount binds the bank to form addi-tional reserves that is not always in the interests of the owners. Determining the actual level of loans problematicity, based on public information, is quite a difficult task, as evidenced by the world experience of stress-testing, the main precondi-tion for the accuracy of which is the procedure of the detailed assets quality re-

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view with the use of confidential data, as it is considered by the European and US financial regulators. Thus, in the Ukrainian context the loans quality assessment only makes sense if there is an access to confidential information or reliance to the bank's public reports.

Ownership structure factor. Studying the quantitative indicators of banks reliability, one should not forget about the existence of significant qualitative indicators affecting the probability of default. Since this subject requires otherwise methods of scientific research, let's analyze just one but telling example. Among the banks, where the temporary administration was introduced, most of them were owned by individuals or by limited liability companies registered in Ukraine. Among the banks that have experienced default there was none having majority foreign beneficiaries, which is explained by the significance of preserving the reputation for transnational financial holding companies present in Ukraine (Kornyliuk, 2014). The level of shareholders support is a key factor of the bank's reliability. History of Ukraine's banking sector once again confirms the advantage of banks with foreign owners over the national ones in terms of financial stability; institutional and public investors over private ones, banks participating in the financial holdings over financial industrial groups (FIG) with non-core banking business.

Conclusions. The periods of systemic bank turmoils in 2008–2009 and 2014, due to the high level of defaults, provided a rare opportunity to test the theory of financial stability in practice. Indicators, widely used in the credit ratings of banks and in the early warning systems displayed their predictive ability in different ways. The best predictors of defaults proved to be traditional indicators of profitability and liquidity, as well as the share of individuals' deposits in the liabilities. Insufficiently indicative predictive ability was demonstrated by the simplified indicators of capital adequacy and assets quality, because the statistic distribution of their values in the "problematic" samples slightly deviated from the system-wide one. Among the qualitative factors of the bank's reliability, historically significant is the real ownership structure, because most of insolvent banks were owned by private national investors and were not included into the financial holding groups.

The important scientific result of the retrospective study was substantiated reasonability of using the selected indicators within the banks credit rating of CAMELS type, and the systemic risks monitoring. The application of this methodology when testing the signaling ability of any other quantitative indicators will improve the rating methodology quality through the substantiation of reliability factors importance not only by means of the expert but also by the empirical studies.

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