# FINANCIAL AND REGULATORY REPORTS AS AN INFORMATIONAL BASIS FOR ASSESSING BANK SOLVENCY

Jelena Galijaš

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**Abstract:** After the global financial crisis of 2008, i.e. the collapse of Lehman Brothers, bankruptcy prevention has gained importance. Also, since the costs of preventing a crisis are almost always lower than the costs of resolving its consequences, this paper aims to look at models for assessing bank solvency. A precondition for applying the model is good quality input data, taken from financial and regulatory reports by banks. The models that are discussed more closely in the paper have come a long way, beginning with financial soundness indicators and continuing with the development of the S-score model and later stress testing, while over the past decades there has been an increasing focus on the use of artificial neuron networks. The practical part of the paper includes an analysis of the results obtained by applying the S-score model on data of systemically important banks in the Republic of Serbia. The analysis confirmed the strong financial position of these banks, even against the backdrop of uncertainty caused by the coronavirus pandemic.

[In a modified form, the paper is based on a Master thesis defended in March 2022 at the Faculty of Economics in Belgrade.]

## Non-Technical Summary

In addition to achieving and maintaining price stability, the National Bank of Serbia is also tasked with contributing to the preservation and strengthening of the Republic of Serbia's financial system, as well as defining and implementing activities and measures in relation to that objective. Financial system stability enables the smooth performance of banks' core functions, thus supporting economic growth. On the other hand, financial crises have a negative effect on the financial sector and can consequently have a significant impact on declining production and employment.

Since the costs of preventing a crisis are, as a rule, lower than the costs of resolving it, it is very important to monitor the situation in the financial system in order to act pre-emptively rather than correctively. Therefore, this paper aims to present methods for assessing the financial position of banks, as well as of the banking sector as a whole, based on financial and regulatory reports. The methods presented include (1) the ratio analysis, i.e. financial soundness indicators, (2) S-score model for the banking sector, and (3) macroprudential stress testing.

The practical part of the paper aims to point out the strong and stable financial position of systemically important banks in the Republic of Serbia. By applying the S-score model for the banking sector to financial and regulatory reports of systemically important banks, the banks' financial position over the past five years was tested. The results obtained suggest that systemically important banks remained solvent even during the coronavirus pandemic.

To achieve the above objectives, the National Bank of Serbia conducts periodic and comprehensive analyses. Among other, the NBS drafts a set of macroprudential indicators used for supervision and management of systemic risk within the financial system. Additionally, the National Bank of Serbia conducts quarterly macroprudential stress testing of the banking sector which is discussed at regular meetings of the NBS Executive Board. Starting from 2012, the results of stress testing are also published annually within the *Annual Financial Stability Report*.

# Contents

## 2 Introduction

The global financial crisis unambiguously revealed shortcomings in financial reporting, as well as in financial sector supervision. Several important lessons were learned. Firstly, the development of the financial sector has a strong bearing on economic activity. Secondly, the costs of the crisis are very high, therefore special attention should be paid to crisis prevention. Finally, price stability is a necessary but an insufficient condition for achieving financial stability. Financial stability implies that financial system enables an efficient allocation of financial resources and achievement of key macroeconomic functions both in normal conditions and in conditions of a financial crisis. In an environment of financial stability, economic players have confidence in the banking system and access to financial services, such as payment execution, lending, deposit investment and risk hedging.

The first part of the paper concerns financial and regulatory reports. Namely, good quality accounting information is input that is important for both external and internal users of banks' financial reports, as it can be used for assessing the financial position, primarily solvency. Considering how important banks are for the financial system, as well as for the national economy, in addition to general purpose reports, banks are also obligated to publish special purpose reports, as well as regulatory reports prescribed by the central bank. It is based on these reports that analyses can be conducted for the purpose of assessing the financial position. Also, based on the historical movements of some indicators, as well as the mutual interconnectedness of macroeconomic variables and, for instance, non-performing loans, it is possible to project this indicator's movements in future.

The second part of the paper aims to present basic models for assessing banks' financial position. As it has become increasingly important to prevent potential crises, we must look at models that can indicate problems in business operations, as well as insolvency, with some degree of certainty. The oldest insolvency prediction model is the ratio analysis which has not lost importance even today, primarily because of its simplicity, though it has become more sophisticated over time. Moreover, financial crises have necessitated the introduction of special regulations and indicators used in assessing business operations and stability of financial institutions. Namely, in the wake of the crisis in Eastern Asia, the International Monetary Fund conducted research that resulted in the publication of a guide for calculating financial soundness indicators. Their main purpose is the assessment of capital adequacy, liquidity and profitability of financial institutions. The ratio analysis was the basis for developing the Z-score model which integrates a certain number of indicators with various weights. The result of the model is a unique number for each company, based on which it is possible to determine whether a company is facing bankruptcy. The crisis we mentioned inspired researchers to come up with a measure, fashioned after the Z-score model, that would be applied in the banking sector. The research resulted in the S-score model, and in this paper, it will be applied to data of systemically important banks in the Republic of Serbia. The main goal of this analysis is to test the solvency and profitability of those banks whose bankruptcy would jeopardise the normal functioning of the entire financial system, as well as the real sector.

After the global financial crisis, i.e. following the collapse of the Lehman Brothers investment bank, the importance of stability of financial institutions increased, as did the importance of the central bank's supervisory role. Accordingly, central banks were allocated the task of using macroprudential stress testing to assess the banking sector's resilience to potential shocks from the environment. The National Bank of Serbia was no exception to this, therefore in the final part of the paper we will explain the manner of solvency stress testing of the Serbian banking sector.

## 3   Growth and development of the green bond market

Supranational Banks are financial institutions primarily engaged in credit-deposit operations with the aim of making profit. The importance of banks is reflected in the performance of financial mediation and preservation of confidence in the monetary system, all of which contributes to financial system stability and is a precondition for economic growth. In the Republic of Serbia, banks account for the dominant share of institutions in the financial system, making up around 91% (Q3 2022) in terms of the share of their assets in total financial sector assets.

Pursuant to Article 50 of the Law on Banks (RS Official Gazette, Nos 107/2005, 91/2010 and 14/2015), a "bank shall maintain business books and accounting records, and compile annual financial statements, which truthfully and objectively present its operations and financial condition, with contents and in the form laid down in the law governing accounting, this Law and regulations of the National Bank of Serbia." Financial reporting by banks can be divided into general and special. General financial statements include (1) end-of-period statement of financial position (balance sheet), (2) statement of overall result in a period (income statement), (3) statement of cash flows, (4) statement of changes in equity, and (5) notes to financial statements (Knezevic et al., 2012).

Considering the importance of banks primarily for the financial system, the users of banks' financial reports are many, and they include internal users, such as bank managers, owners, employees, as well as external ones – clients, the central bank and other authorities. All of these users are interested in data from financial reports which must be relevant and truthfully disclosed. Users of financial reports need information about liquidity, solvency, risks related to assets and liabilities and off-balance sheet items, as well as a bank's revenues, expenditures and profit.

When Basel standards were adopted in response to the global financial crisis, more attention was directed to regulatory reports which banks are obligated to disclose publicly and submit to their regulators. Namely, the third pillar of the Basel II standard pertained to the strengthening of the banking sector's market discipline. By transposing Basel II, and later Basel III requirements into domestic legislation through six decisions – two of which are the most relevant for this paper, i.e. the Decision on Disclosure of Data and Information by Banks and the Decision on Reporting Requirements for Banks – a framework was established for disclosing good quality information about bank operations. The key importance of disclosure of such information lies in the fact that market participants were enabled to make good decisions that will have a positive impact on banks that operate well and adhere to the prescribed standards. More importantly, market discipline is a necessary condition for supervisors to adequately assess systemic risk and act pro-actively in order to safeguard financial system stability.

Reporting by banks is closely defined in the Decision on Reporting Requirements by Banks, which stipulates that banks must prepare and submit to the NBS the following reports:

1. Major bank shareholders,

2. Investment in non-financial sector persons and fixed assets of the bank,

3. Investment in financial sector persons,

4. Report on large exposures of the bank,

5. Large exposure to a group of related persons,

6. Report on forborne exposures,

7. Report on the structure of forborne exposures,

8. Report on the classification of balance sheet assets and off-balance sheet items,

9. Report on the structure of non-performing loans,

10. Report on non-performing exposures,

11. Cash-flow report,

12. Balance sheet statement,

13. Income statement,

14. Statement of other comprehensive income of the bank,

15. General bank data

16. Report on loan applications received and approved, and early and extended loan repayments,

17. Report on changes in expected credit losses on financial assets,

18. Report on transfers between impairment stages,

19. Major bank depositors,

20. Daily report on bank liquidity ratio,

21. Report for the purpose of calculating the liquidity coverage ratio,

22. Daily report on bank FX risk ratio,

23. Daily report on planned transactions and projections of liquid funds,

24. Report on new share issues,

25. Report on share capital increase/decrease,

26. Consolidated balance sheet statement of the banking group,

27. Consolidated income statement of the banking group,

28. Consolidated statement of other comprehensive income of the banking group,

29. Reports on the ratio of the bank's Tier 1 capital and the exposure amount – leverage ratio,

30. Report on debt-to-income ratio,

31. Report on daily balance of receivables and liabilities,

32. Report on the share of FX-indexed dinar loans and FX loans in total new loans approved to debtors in the non-financial and non-government sector,

33. Report on changes in FX-indexed dinar loans and FX loans approved to debtors from the non-financial and non-government sector,

34. Report on changes in FX-indexed dinar loans and FX loans approved to debtors from the non-financial and non-government sector – cumulatively (Decision on Reporting Requirements for Banks, 2022).

Also relevant for analyses in this paper are reports stipulated by the Decision on Reporting on Capital Adequacy of Banks (RS Official Gazette, Nos 103/2016, 8/2019 and 27/2020), which sets out that banks are obligated to submit: (1) Report on bank capital, (2) Report on data for calculation of individual capital elements and deductions, and capital buffers, and (3) Report on elements of risk-weighted assets and capital adequacy ratios.

Some of the previously mentioned reports have significant disclosive power as they contain data that are used as input for the purpose of assessing the financial position of institutions. The paper used data from reports such as the balance sheet, income statement, report on the leverage ratio, report on the structure of a bank's non-performing loans, etc.

## 4 Financial soundness indicators

For a more efficient supervision of financial institutions, the IMF created the core set Financial Soundness Indicators (FSI),with a cross-country relevance, together with an additional set accounting for specific market conditions of each individual country (National Bank of Serbia, 2020, p. 144). These indicators can be applied both to an individual institution and sector-wide. The basis for their calculation are banks' financial reports, primarily balance sheet and income statement, as well as regulatory reports. Further, in our country, based on the Decision on Disclosure of Data and Information by Banks (RS Official Gazette, No 103/2016), banks are obliged to calculate and disclose information on certain indicators, such as for example the capital adequacy ratio. Table 1 gives an overview of the core set financial soundness indicators, and the key indicators from the table are defined in the text below.

Table 1 – **Core set financial soundness indicators**

| | |
|---|---|
| **Capital Adequacy** | Regulatory capital to risk-weighted assets |
| | Tier 1 capital to risk-weighted assets |
| | Common Equity Tier 1 capital to risk-weighted assets |
| | Tier 1 capital to assets |
| **Asset Quality** | Non-performing loans to total gross loans |
| | Provisions to non-performing loans |
| | Non-performing loans net of provisions to capital |
| **Profitability** | Return on assets |
| | Return on equity |
| | Interest margin to gross income |
| | Non-interest expenses to gross income |
| **Liquidity** | Liquid assets to total assets |
| | Liquid assets to short term liabilities |
| | Liquidity coverage ratio |
| | Net stable funding ratio |
| **Sensitivity to Market Risks** | Net open position in foreign exchange to capital |

Source: International Monetary Fund, 2019, p. 2.

The negative consequences of the global economic crisis of 2008 revealed the weaknesses in regulations and financial institutions leading to the tightening of standards and criteria, primarily with regard to capital items. The capital adequacy ratio (CAR), obtained through formula (1) is an additional amount of capital the bank is required to maintain so as to be able to buffer potential losses in crisis periods.

$$CAR = \frac{\text{Regulatory capital}}{\text{Risk−weighted assets}} \, x \, 100 \qquad (1)$$

Regulatory capital, i.e. the nominator in the formula, is comprised of the highest quality Common Equity Tier 1 capital, Additional Tier 1 Capital and Tier 2 capital. In accordance with Basel standard regulations, banks are required to maintain this ratio above 8%. In practical terms, if the bank approves

a EUR 100,000 loan, with a 40% weight, the risk-weighted assets will amount to EUR 40,000. In that case, regulatory capital would amount to EUR 3,200 ($40.000 x 0.08$), meaning that this is the minimum amount of the regulatory capital the bank is required to maintain based on the approved EUR 100,000 loan. The next two indicators in the capital adequacy category can be calculated by applying the above formula, with the different numerator. Namely, the definition narrows so that the next indicator does not include Tier 2 capital, but only Common Equity Tier 1 capital, and Additional Tier 1 Capital. The minimum threshold above which the Tier 1 capital to risk-weighted assets must be maintained is 6%. Tier 1 capital to risk-weighted assets ratio contains in its nominator, obviously, only Common Equity Tier 1 capital, and banks are required to maintain this ratio at a minimum of 4.5%.

The next category comprises indicators related to asset quality, and within this category it is particularly important to emphasize the non-performing loan ratio (NPLs). This ratio, calculated according to formula (2), if trending low, attests to the credit portfolio quality. However, while this is a reliable determinant of credit risk, the level of NPLs can be determined only after they have originated. Namely, NPLs are an *ex-post* measure, revealing mistakes in prior credit activity (Lukić et al., 2019).

$$\text{NPL ratio} - a = \frac{\text{Non-performing loans}}{\text{Total loans}} x \ 100 \tag{2}$$

The numerator in this ratio includes all payments of principal or interest past due 90 days or more. By way of exception, if there is evidence such as debtor's bankruptcy, past-due payments of less than 90 days may also be included (International Monetary Fund, 2019).

The share of non-performing loans net of provisions to capital is defined as non-performing loans less the value of specific loan loss provisions (net non-performing loans) and regulatory capital. It is calculated by formula (3). There is no regulatory threshold, but the ratio should be as low as possible, because low ratio levels indicate a bank's ability to buffer the losses associated with non-performing loans that are not covered by loan loss provisions.

$$\text{Non-performing loans net of provisions to capital} = \frac{\text{Net NPLs}}{\text{Regulatory capital}} \tag{3}$$

The next indicator category refers to the profitability segment, with two key indicators standing out – return on assets and return on equity. Return on bank's assets is a measure of profitability allowing us to determine how efficiently the bank manages its assets to generate earnings. This indicator is calculated by formula (4).

$$\text{Return on assets (ROA)} = \frac{\text{Net pre-tax profit}}{\text{Average assets}} x \ 100 \tag{4}$$

As for return on equity, its value measures a bank's efficiency in using capital. It is calculated by formula (5), however, its interpretation requires caution. Namely, banks with a higher leverage will record higher values of this indicator. In such cases, the analysis considering this indicator in isolation would not capture the real situation and would fail to account for all operating risks with the high leveraged funding sources (National Bank of Serbia, 2020). It is advised that this indicator should be interpreted together with the abovementioned return on assets.

$$\text{Return on equity (ROE)} = \frac{\text{Net pre-tax profit}}{\text{Average capital}} x \ 100 \tag{5}$$

One of the main liquidity ratios is liquid assets to total assets. It provides an indication of the size of liquidity which can be used to meet the expected and unexpected cash flows. It is calculated by formula (6).

$$\text{Liquid assets to total assets} = \frac{Liquid assets}{Total assets} x\ 100 \tag{6}$$

Liquidity ratios of special importance are the liquidity coverage ratio and net stable funding ratio. The reason lies in the fact that they are of a more recent date, i.e. they were introduced in 2013 by Basel III standard which was a regulatory response to the global financial crisis. In our country, the liquidity coverage ratio was officially introduced by the Decision on Liquidity Risk Management by Banks. The purpose of its introduction was to ensure that a bank is able to meet its liabilities under the assumption of a 30-day liquidity stress. Namely, possession of highly liquid assets that can be converted to cash on a short notice facilitates the bank's response in meeting liquidity needs (*Macroprudential Framework*, 2015). This indicator is calculated by formula (7) and the bank is required to maintain it at a level of above 100%, according to the mentioned Decision.

$$\text{Liquidity coverage ratio} = \frac{\text{High quality liquid assets}}{\text{Total liabilities over 30 days}} x\ 100 \tag{7}$$

The net stable funding ratio (NSFR) serves as a complement to the previous indicator, its main purpose being to encourage the reliance on more stable sources of funding (*Macroprudential Framework*, 2015), which could reduce the probability of threats to the bank's liquidity position and consequent bankruptcy. It is calculated by formula (8).

$$\text{Net stable funding ratio} = \frac{\text{Available stable funding}}{\text{Required stable funding}} x\ 100 \tag{8}$$

The net open position in foreign exchange to capital as a financial soundness indicator measures sensitivity to market risks, i.e. aims to identify exposure to exchange rate risk. By calculating the mismatch of foreign currency asset and liability positions relative to capital it is possible to assess the potential vulnerability of the banking sector to exchange rate movements. The regulatory threshold is set in such a way so that at the end of each business day this indicator must not exceed 20%. It is calculated by formula (9).

$$\text{Net open position in foreign exchange to capital} = \frac{\text{Net open position}}{\text{Regulatory capital}} x\ 100 \tag{9}$$

The table below shows the movement of selected financial soundness indicators for the Republic of Serbia from Q2 2017 until Q2 2022, giving grounds for certain conclusions about the financial position of the domestic banking sector. Speaking of capital adequacy, the ratios were trending above the regulatory minimum throughout the whole period. A mild decrease in the capital adequacy ratio since 2020 can be partially put down to the negative effects of the coronavirus pandemic, but it is important to note that even in such circumstances the ratios remained above the prescribed values. Further, the major part of banks' capital is comprised of the highest quality Common Equity Tier 1 capital, enabling the coverage of requirements for the combined capital buffer.

Asset quality, measured by the share of non-performing loans, rose over the time horizon, signalling an improvement in banks' credit portfolio. The historically low values of the NPL ratio were mainly achieved owing to the positive effects of the NPL Resolution Strategy from 2015 and also the accompanying Programme adopted in 2018. This is corroborated by the fact that when the Strategy was adopted, NPLs measured 22.25% (August 2015), only to drop to 5.70% by the end of the period covered by the Strategy (December 2018), which is 16.55 pp lower compared to the period preceding Strategy implementation. At end-2020 the share of non-preforming in total loans equalled 3.71%, due to the negative effects of the pandemic and an increased amount of loans falling due after the second moratorium on loan repayment, only to resume its fall to 3.03% at end-November 2022. Generally, the

moratoria had a favourable effect on limiting NPL growth, as they were enabled at times of debtors' most dire need.

Banking sector profitability measured by the return on assets was relatively high, i.e. from Q2 2017 until Q4 2018 this indicator consistently recorded values above 2%. In the period thereafter, it turned downward, which was particularly pronounced in the first year of the pandemic, when RoA measured 1.06% in December 2020. RoA value stabilized in 2021 at 1.17%, while 2022 saw a gradual increase, to 1.49% at end-June 2022.

Liquidity ratios of the banking sector indicate that the sector would have sufficient liquidity in case of increased or unforeseen outflows. Liquid assets to total assets ratio posted relatively stable values in the period observed, averaging around 36%. The values of this ratio did not drop significantly even during the pandemic, which, *inter alia*, can be attributed to adequate support measures of the National Bank of Serbia. Additionally, the liquidity coverage ratio trended above the reference value of 100 from Q2 2017 until Q2 2022, suggesting that the banking sector could easily meet the liquidity needs.

Table 2. **Selected financial soundness indicators for the Republic of Serbia for the period Q2 2017 – Q2 2022**

| Indicator | Q2 2017 | Q4 2017 | Q2 2018 | Q4 2018 | Q2 2019 | Q4 2019 | Q2 2020 | Q4 2020 | Q2 2021 | Q4 2021 | Q2 2022 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Regulatory capital to risk-weighted assets | 22.44 | 22.61 | 22.93 | 22.26 | 23.23 | 23.39 | 22.66 | 22.42 | 22.20 | 20.77 | 19.43 |
| Tier 1 capital to risk-weighted assets | 21.27 | 21.62 | 22.07 | 21.13 | 22.13 | 22.37 | 21.83 | 21.58 | 21.11 | 19.70 | 18.23 |
| Net NPLs to regulatory capital | 22.77 | 17.73 | 12.74 | 9.68 | 8.10 | 6.34 | 6.03 | 6.72 | 6.87 | 7.60 | 7.48 |
| NPLs to total loans | 15.58 | 9.85 | 7.81 | 5.70 | 5.21 | 4.09 | 3.74 | 3.71 | 3.63 | 3.57 | 3.26 |
| Return on assets | 2.12 | 2.14 | 2.07 | 2.19 | 1.80 | 1.77 | 1.41 | 1.06 | 1.17 | 1.17 | 1.49 |
| Return on equity | 10.62 | 10.47 | 10.59 | 11.27 | 9.70 | 9.81 | 8.38 | 6.48 | 7.51 | 7.76 | 10.46 |
| Liquid assets to total assets | 36.46 | 35.12 | 34.17 | 35.72 | 34.23 | 35.99 | 36.94 | 37.34 | 37.87 | 37.67 | 33.01 |
| Liquid assets coverage ratio | 265.39 | 239.51 | 218.31 | 213.32 | 213.28 | 199.30 | 208.63 | 211.79 | 231.81 | 199.82 | 163.24 |
| Net open FX position to regulatory capital | 1.80 | 2.39 | 2.29 | 4.29 | 2.54 | 0.57 | 0.23 | 0.17 | 0.92 | 0.37 | 1.70 |

Source: NBS.

Based on the above, it can be concluded that it is necessary to have a separate set of indicators for the financial sector which will allow us to assess institutions' vulnerability in the best possible way, accounting for all specificities. All the listed indicators may also serve as early warning signals, thanks to which it is possible to predict that an institution's stability might deteriorate or that it may go bankrupt.

However, to view this method more comprehensively, it is also necessary to specify the reach of financial soundness indicators in assessing the bank's financial standing. Despite their solid predictive power, individual ratios have numerous weaknesses, and we will mention a few of the most relevant. First, the inputs for calculating ratios are derived from financial and regulatory reports and are based on historical data. Second, it is necessary to decide which weight to assign to each individual indicator, since it is possible, for example, that profitability is rising, with the leverage also going above the target limit. Excessive leverage can be one of the reasons for bankruptcy, but if the entity is generating sufficient income to timely service all its liabilities as they fall due, it is hard to determine which indicator should be assigned greater weight. Third, some indicators do not have the tentative normal value based on which we could determine if there is a threat of negative business tendencies and potential going into bankruptcy. Finally, the abuse of accounting policies for the purpose of creative financial reporting can significantly reduce the quality of reports used for the analysis of ratios. In order

to prevent an erroneous interpretation caused by the change in accounting policies, it is necessary to thoroughly examine the quality of financial information, i.e. determine if they are relevant and truthfully disclosed.

## 5  S-score model

Altman's Z-score model is relevant for institutions from the real sector. As financial sector institutions, banks call for an approach which reflects all specificities of their operations. A good example is the S-score model developed in the wake of the 2007–2008 crisis to assess banks' solvency. The model described below was designed after the Z-score model, based on the IMF's recommendations. For the purposes of the practical part of this chapter, this model will be slightly modified and actualised, which will not greatly affect the results:

$$S = 1.5*X1 + 1.2*X2 + 3.5*X3 + 0.6*X4 + 0.3*X5 + 0.4*X6$$

Where (Shar et al., 2010):

$X_1$ – loan to assets ratio;

$X_2$ – capital to assets ratio;

$X_3$ – capital adequacy ratio;

$X_4$ – leverage ratio (in the original version of the model, equity to assets ratio);

$X_5$ – NPL ratio;

$X_6$ – cost to income ratio.

The above model comprises several ratios which are only used in assessing banks' operations. They include: capital adequacy ratio, leverage ratio, NPL ratio and cost to income ratio. As some of these ratios have already been analysed in detail in the previous chapter, only the newly introduced indicators will be defined below.

The leverage ratio is an indicator first introduced by the Basel III regulatory standard in order to restrict the build-up of leverage as a source of financing. If leverage is above the optimum level, deleveraging by banks in case of crisis and pressure could threaten financial system stability *(Basel Committee on Banking Supervision*, 2014). The above ratio is calculated according to the following formula (1) and may not be lower than 3%, in line with regulatory requirements.

$$\text{Leverage ratio} = \frac{\text{Capital measure}}{\text{Exposure measure}} x\ 100 \tag{1}$$

The cost-to-income ratio is used a measure of banks' profitability. It is calculated according to the formula below (2), with operating costs in the numerator and operating income in the denominator. The lower its value, the higher the profitability of a bank.

$$\text{Cost} - \text{to} - \text{income ratio} = \frac{\text{Operating costs}}{\text{Operating income}} x\ 100 \tag{2}$$

The S-score is obtained as a result of calculating all ratios and applying weights. All banks with a score greater than 70 are classified as banks with a stable financial position and no financial difficulties. A score between 50 and 70 is defined as the grey area because these banks may have some financial problems and an equal probability of going bankrupt and continuing to operate, which greatly depends

on their management's decision. Finally, banks with a score below 50 face substantial problems in doing business, have a weak financial position and, as a result, face a high risk of bankruptcy (Shar et al., 2010).

Some ratios comprising the S-score model also have tentative normal values, that is, a desirable value range. Table 3 shows the above ratios and their pertaining benchmark values.

Table 3. **Financial soundness indicators and their tentative normal values**

| Indicator | Tentative normal value |
|-----------|------------------------|
| Loan to assets ratio | ≤65% |
| Capital to assets ratio | ≥4% |
| Capital adequacy ratio | ≥8% |
| Leverage ratio | ≥3% |
| NPL ratio | ≤5% |
| Cost to income ratio | ≤40% |

Source: Budimanetal., 2017.

The key advantage of using this model is that it is simple to calculate. Also, the inputs required for the S-score model can be obtained from the financial and regulatory reports banks are required to disclose. However, like the ratio analysis, this method too has its limitations in practice. The results of the model depend exclusively on the quality of inputs, i.e. the information obtained from financial and regulatory reports. If such information is not relevant or truthfully disclosed, the result will not be of high quality either. Accounting policies, such as NPLs write-off etc., may affect the results of some ratios included in the model.

## 4.1 Analysis of systemically important banks in the Republic of Serbia using the S-score model

The purpose of this paper is to apply the above model in order to confirm the solvency of systemically important banks in the Republic of Serbia. According to the definition, a systemically important bank "is a bank whose deterioration of financial condition or failure would have serious negative effects on financial system stability" (National Bank of Serbia, 2022a). Once a year, the National Bank of Serbia establishes the list of systemically important banks and capital buffer rates for these banks. The criteria for determining systemically important banks include: size of a bank, importance for the economy, importance for the financial system, complexity of a bank's operations, etc. According to the latest data,[6] there are nine systemically important banks operating in the Republic of Serbia. Of this, five banks are required to maintain their capital buffer at 2% and four banks – at 1% of risk-weighted assets.

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[6] Pursuant to the Decision on Establishing a List of Systemically Important Banks in the Republic of Serbia and Capital Buffer Rates for Those Banks of 16 June 2022

Based on publicly available financial statements and data and information published by the above banks, we took over indicators to be used in the model in order to assess the banks' solvency position. By applying the formula described in the previous chapter, S-score values of systemically important banks were calculated for the period between Q2 2017 and Q1 2022 (Table 4). Chart 1 was generated on the basis of these values, where it can clearly be seen that all these banks are in the solvency zone, confirming our initial assumption.

Chart 1. **S-score values of systemically important banks in the RS from Q2 2017 to Q2 2022**
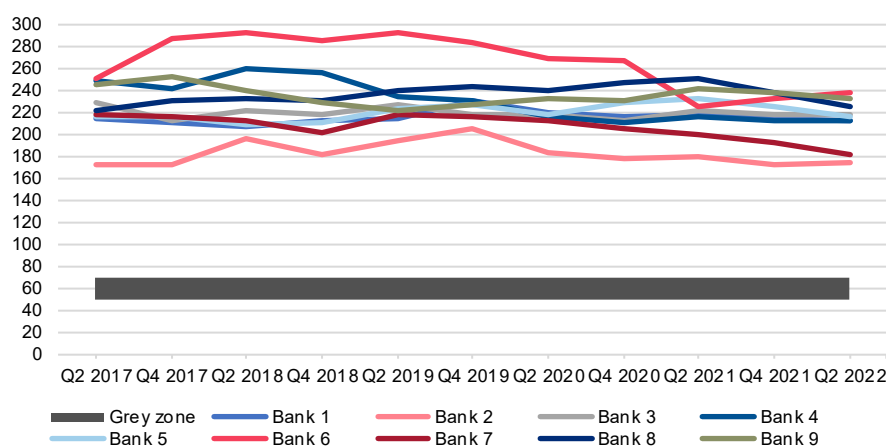


* Banks' ranking in the table does not correspond to the ranking by systemic importance available on the NBS website.
Source: NBS, author's calculation.

In the period between Q2 2017 and Q2 2022, all banks had scores above the minimum (70). In practical terms, this means that they are both solvent and stable. Starting from 2020, seven out of nine banks recorded a mild decline compared to 2019, but their S-score values remained well above the solvency threshold. This slight decrease can in part be ascribed to the repercussions of the coronavirus pandemic. Two banks posted the largest decline in their S-score values, while one bank recorded an increase. The reduction in the capital adequacy ratio at the end of 2021 compared to 2019 contributed to the aforementioned decrease in the value of two banks. In both banks, the cost to income ratio went up, which is not a favourable trend and signals a mild decrease in the S-score value. Though S-score values of some banks went down, it is important to note that all individual ratios of both banks remained within regulatory bounds. According to data for Q2 2022, no major oscillations in S-score values were recorded relative to end-2021.

Analytically speaking, the capital adequacy ratio (X3) and the cost to income ratio (X6) of individual banks changed the most. The NPL ratio displayed the least volatility. The reason for this can be twofold. Firstly, since the implementation of the NPL Resolution Strategy, NPLs have been placed under control and the ratio has been declining, both for individual institutions and for the banking sector as a whole. Secondly, given the consequences of the coronavirus pandemic and measures introduced to mitigate them, including primarily the moratorium on debt repayment, this ratio did not change significantly relative to the previous year.

Table 4. **S-score values of systemically important banks from Q2 2017 to Q2 2022**

| Banks/period | Q2 2017 | Q4 2017 | Q2 2018 | Q4 2018 | Q2 2019 | Q4 2019 | Q2 2020 | Q4 2020 | Q2 2021 | Q4 2021 | Q2 2022 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bank 1 | 214 | 211 | 207 | 212 | 213 | 231 | 219 | 216 | 218 | 214 | 212 |
| Bank 2 | 173 | 172 | 197 | 182 | 195 | 206 | 182 | 178 | 179 | 171 | 174 |
| Bank 3 | 228 | 213 | 222 | 217 | 226 | 218 | 218 | 213 | 221 | 218 | 218 |
| Bank 4 | 248 | 240 | 260 | 255 | 234 | 231 | 217 | 210 | 216 | 213 | 212 |
| Bank 5 | 215 | 215 | 209 | 211 | 222 | 227 | 218 | 229 | 232 | 225 | 216 |
| Bank 6 | 250 | 287 | 293 | 285 | 293 | 284 | 269 | 267 | 225 | 233 | 237 |
| Bank 7 | 218 | 216 | 212 | 202 | 218 | 215 | 212 | 205 | 199 | 192 | 182 |
| Bank 8 | 222 | 230 | 233 | 230 | 240 | 243 | 239 | 246 | 251 | 238 | 225 |
| Bank 9 | 245 | 251 | 240 | 229 | 222 | 226 | 232 | 230 | 241 | 237 | 232 |
| maximum | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 |
| minimum | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| Grey zone | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |

\* Banks' ranking in the table does not correspond to the ranking by systemic importance available on the NBS website.
Source: NBS, author's calculation.

## 6 Macroprudential stress-tests of the Serbian banking sector

Whenever an economy is affected by a crisis, lessons are learnt and guidelines to improve the system are formulated, which is significant for the professional public, economic policy makers and experts. For instance, the East Asian crisis of 1997, caused by an unsustainable inflow of investments due to market liberalisation, first triggered a currency crisis and then a financial crisis which spread throughout the region. Many financial institutions became insolvent and went bankrupt, plunging the economy into recession. For this reason, the IMF and the World Bank jointly established the Financial Sector Assessment Program. The key purpose of the programme is to minimize the occurrence and severity of potential shocks in the financial sector. Thanks to this programme, stress-tests have become one of the tools used for assessing financial sector stability and vulnerability (*Financial Sector Assessment Program (FSAP)*, 2022).

Stress-tests can be defined as a tool to help assess the stability and vulnerability of the financial system to exceptional but plausible events. According to Čihák (Cihak, 2004), stress testing is a complex process which consists of the following steps:

- identifying the major risks;
- defining the coverage and identifying the data for analysis;
- calibrating the scenarios;
- selecting the methodology;
- interpreting and implementing the results.

In the Republic of Serbia, the National Bank of Serbia conducts banking sector stress testing on a quarterly basis, including solvency stress-tests. The results are published in the *Annual Financial Stability Report*. The top-down approach is applied, based on the use of information from financial and regulatory reports which individual banks submit to the central bank. The advantages of this approach include the application of a single methodology and identical assumptions for all institutions, whereas

its greatest shortcoming is the possibility that the assessment of a financial institution may not be entirely accurate, reflecting the availability of data and reliability of the assumptions.

As business models of Serbian banks are mostly traditional and based on loan and deposit operations, credit risk can be identified as the most significant. This is confirmed by the fact that credit risk accounted for the largest share (86.7%) of risk-weighted assets (National Bank of Serbia, 2020). Hence, the key purpose of the solvency stress-test is to assess the impact of credit risk on banks' solvency in a one-year period. The abovementioned NPL ratio is used in order to quantify credit risk. Since these are macroprudential stress tests, it is important to determine the factors with the greatest impact on change in the level of the above indicator. "An econometric model which includes three relevant macroeconomic variables is used in projecting the level of NPLs. The variables which displayed reliable predictive power are: nominal exchange rate, seasonally-adjusted net wages and the key policy rate." (National Bank of Serbia, 2020, p. 63). The solvency stress-test is conducted on the basis of three macroeconomic scenarios: baseline, moderate and worst-case scenario. The baseline scenario shows the most probable movement in the NPL ratio, while worst-case and moderate scenarios are based on historical data and reflect a spectrum of shocks of different probability.

The resilience of the banking sector and of individual banks can also be tested through change in the capital adequacy ratio assuming changes in the macroeconomic environment. The key channels through which macroeconomic variables affect the capital adequacy ratio are shown in Diagram 1. This complex model enables us to perceive both direct and indirect impacts on the capital adequacy ratio, and on capital and risk-weighted assets (Diagram 1). For instance, a higher RSD/EUR exchange rate results in diminished capacity of households and corporates to service their FX-indexed obligations to banks. This may lead to an increase in NPLs and in banks' allocations to cover NPLs through required reserves or allowances for impairment. Changes in the exchange rate also lead to a revaluation of risk-weighted assets.

Diagram 1. **Impact of the macroeconomic environment on the capital adequacy ratio**
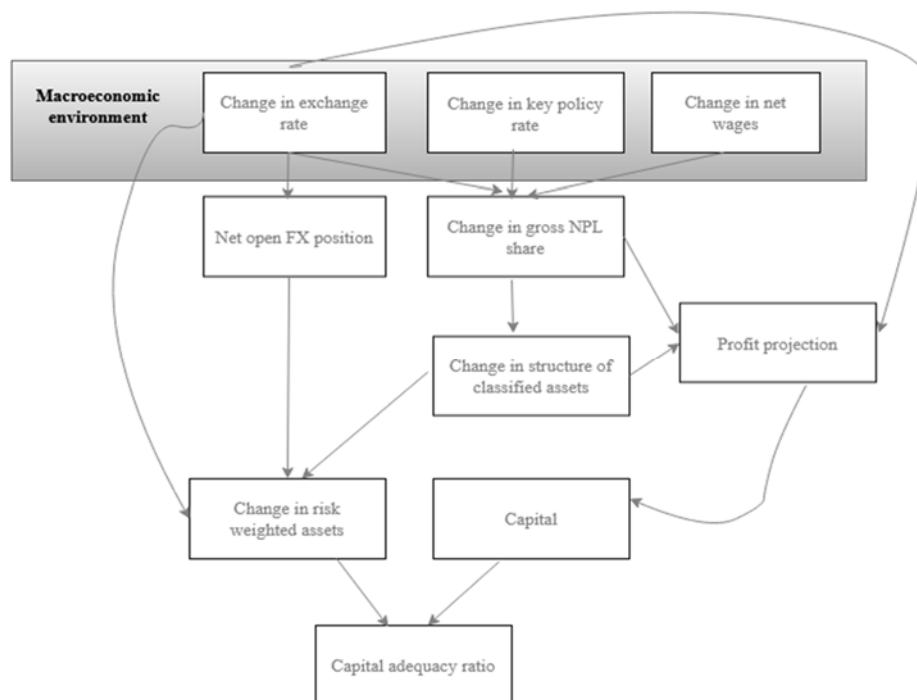


Source: National Bank of Serbia, 2020, p. 66.

The results of different scenarios are interpreted with reference to minimum requirements for these indicators set to a bank and the capital buffers applied by the bank. The obtained results should be interpreted with enhanced caution. The reason for this is that the "publishing of results of individual institutions is a sensitive matter, as they could be misinterpreted, causing the bankruptcy of institutions which fail the test. Moreover, the conclusion regarding a bank's resilience and solvency can only be reached on the basis of all available information." (National Bank of Serbia, 2022b).

Finally, it is important to understand the limitations of stress testing as a tool for assessing banks' solvency. Firstly, solvency stress-tests are a tool to assess whether the capital adequacy ratio is aligned with regulatory requirements, but they are by no means a substitute for an adequate regulatory and supervisory framework. Moreover, they cannot replace adequate supervision or risk management by individual institutions. Further, the results of stress tests are only as robust as the methodology used and the assumed scenarios. For this reason, they are not used as the only tool, but as just one input into the macroprudential policy implementation process (Dent, 2016).

## 7 Conclusion

After the global financial crisis which destabilised financial systems worldwide, numerous professions faced the shortcomings highlighted by the crisis. The accounting profession realised it was imperative to better regulate fair value accounting, primarily with regard to financial assets measurement. Supervisors were set the task to regulate capital adequacy, as a measurement of a bank's available capital, and to enhance the transparency of financial system participants. The adoption of Basel II and Basel III regulatory packages and their transposition into domestic legislation enabled the disclosing of bank data and information, enhancing transparency in reporting and regulating the calculation of the capital adequacy ratio.

Given banks' significance in the financial system and their role in sustaining the real sector and households, particularly in times of crises, it is important to reflect on the methods used for assessing the financial position of these institutions. The global financial crisis encouraged regulatory authorities to formulate a special set of financial soundness indicators, in order to evaluate the stability and solvency of banking institutions. The most important indicators from the above group are certainly the capital adequacy ratio, NPL ratio, ROA and ROE. This is supported by numerous regulatory standards which aim to maintain these ratios at prescribed levels. The above ratios were a solid basis for developing the S-score model for the financial sector. The result of this model are the scores according to which entities may be classified as either solvent or insolvent. Certainly, given the subject matter of this paper, it is important to note the results that are obtained by applying the statistical methods and the S-score model to data of systemically important banks in the Republic of Serbia. Despite the coronavirus pandemic, all banks recorded values that are well above the solvency threshold, which confirms that the bulk of the banking sector is stable, adequately capitalised and profitable. A far more comprehensive tool for assessing the stability of Serbia's banking sector are the stress-tests, whose key characteristics and limitations have been presented in this paper.

All of the above methods, from financial soundness indicators to stress-tests, indicate that the domestic banking sector has a robust financial position. The latest, Covid-19 crisis did not have major negative consequences for banks' solvency, as all relevant indicators range within the prescribed benchmark values. Moreover, the S-score values of systemically important banks in the domestic sector are higher than 70, signalling their robust financial position.

This matter could be expanded by improving the existing insolvency prediction models, through the adjustment of parameters in order to accommodate the specificities of the domestic economy. We should, however, also bear in mind the criticism often levelled at traditional methods, suggesting that analysts are subjective when selecting indicators and models. We should, therefore, keep an eye on the development of new methods, such as artificial neuron networks which, thanks to the use of modern computers and mathematical-statistical methods, are able to process numerous inputs and classify output values in a non-linear fashion. Going forward, these advanced methods could gain predominance.

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