Routledge
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Economic Research-Ekonomska Istraživanja

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rero20

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To cite this article: Stella Suljić Nikolaj, Bojana Olgić Draženović & Vesna Buterin (2022) Deposit insurance, banking stability and banking indicators, Economic Research-Ekonomska Istraživanja, 35:1, 5632-5649, DOI: 10.1080/1331677X.2022.2033130

To link to this article: https://doi.org/10.1080/1331677X.2022.2033130

Published online: 03 Feb 2022.

ECONOMIC RESEARCH-EKONOMSKA ISTRAŽIVANJA
2022, VOL. 35, NO. 1, 5632–5649
https://doi.org/10.1080/1331677X.2022.2033130

Deposit insurance, banking stability and banking indicators

Stella Suljić Nikolaj, Bojana Olgić Draženović and Vesna Buterin

Faculty of Economics and Business, University of Rijeka, Rijeka, Croatia

ABSTRACT

The deposit insurance system is a form of banking regulation that protects depositors and provides stability in the banking system. It is an important part of the financial safety net, especially in times of economic turmoil, as it provides explicit depositor protection and prevents a 'bank run'. However, there are some negative effects on banking stability associated with the increase in bank risk, i.e., moral hazard, adverse selection and the principal-agent problem. The functioning of the deposit insurance system depends on its determinants, but also on the characteristics of the national banking system, supervision, legal and cultural framework and the general development of the country. Considering that the banking systems in EU and especially in comparison to Southeast European countries are very different, the aim of this paper is to study the impact of the deposit insurance system on bank stability depending on the characteristics of banks. Bank stability is analysed using bank risk variables: z-score and ratio of non-performing loans to total loans. By applying a dynamic panel analysis using the GMM Arellano–Bond (AB) estimator to a sample of EU countries and selected Southeast European countries, we provide further evidence on the deposit insurance system over the period from 2005 to 2014. The results provide evidence that large and systemically important banks behave in a riskier way, distorting the purpose of the deposit insurance scheme and jeopardising the safety of banking systems.

ARTICLE HISTORY
Received 17 June 2021
Accepted 12 January 2022

KEYWORDS
Banking system; deposit insurance; bank risk; European Union; Southeast European countries; dynamic panel analysis

SUBJECT CLASSIFICATION CODES
C33; GO1; G21

1. Introduction

In addition to the basic purpose of the deposit insurance system to protect the banking system from deposit withdrawal ('bank run') and to provide protection to small depositors, Barth et al. (2006) and Faulend and Kraft (2004) point out that it is necessary because most depositors do not have sufficient knowledge to assess bank risk. Carisano (1992) states that preventing a bank run is the main reason for the existence of a deposit insurance scheme because it creates safety in the banking system.

CONTACT Stella Suljić Nikolaj stella.suljic.nikolaj@efri.hr

This is by Kundid Novokmet and Bojić (2016) who suggest that the withdrawal of deposits from banks threatens the main source of funding in traditional banking, as the level of deposits indicates potential credit growth. The fear of a bank run stems from the view that depositor panic increases the possibility of systemic crises ('domino effect') and banking instability. Therefore, the role of the deposit insurance system in the crisis is crucial when depositor panic occurs, as well as the fear of withdrawal of deposits from banks, which has a direct impact on bank failure and can lead to the materialisation of systemic risk.

Accordingly, deposit insurance is considered one element of the safety net, along with the lender of last resort and regulation and supervision. The impact of the deposit insurance system depends on the design of the system in terms of its features,[1] which should be determined depending on the government capabilities, infrastructure, banking system development, supervision, and legal and cultural framework in order to create the most appropriate deposit insurance model (Anginer & Demirgüç-Kunt, 2018). Despite the aforementioned advantages, empirical research points out the negative impact of deposit insurance system on banking stability due to moral hazard problem, adverse selection and principal-agent problems.

The aim of this paper is to investigate the effect of deposit insurance scheme on banking stability as a function of bank characteristics. Accordingly, the hypothesis of the paper is that the effect of deposit insurance system on banking stability, measured by the level of banking risk, depends on banks' indicators. The deposit insurance schemes of EU countries that became 'generous'[2] during the 2008 financial crisis by increasing the level of protection and additional functions to prevent depositors' panic are analysed (characteristics of the deposit insurance system in the observed period and the sample of countries, see in Demirgüç-Kunt et al., 2014; Suljić Nikolaj et al., 2019).

Our contribution to the existing literature is not only in our choice of topic and set of variables, but also in our choice of time period and spatial setting for the study. Empirical studies on the impact of the deposit insurance system on banking stability are scarcely represented, especially for Southeast Europe countries. Moreover, the temporal coverage of the study provides a comparison of three observed periods: before, during and after the global financial crisis. Compared to previous scientific research, this study also includes other credit institutions (besides commercial banks) in the deposit insurance system, depending on the legal framework of each country.

The article is organised as follows: Section 2 briefly introduces the related literature, while Section 3 stipulates econometric methodology and the dataset used in the study. Section 4 reveals the empirical results and concluding remarks are outlined in the last section.

2. Literature review

Previous papers indicate that the operation of a deposit insurance system is associated with a higher share of bank assets (Camara et al., 2020; Wheelock, 1992), while capitalisation and liquidity are weaker (Fauzie & Sitepu, 2020; Lambert et al., 2017; Lé, 2013). Using data on 150 banks in the US (1970–1986), Kelley reveals that due to the

operation of the deposit insurance system, banks with greater market power and a market at book value have higher capital/asset ratios and lower default risk. In a sample of deposit insurance systems in the United States and Kansas during the period 1934–1939 and 1910–1926, Grossman (1992), Wheelock and Wilson (1994) showed that banks participating in newly established deposit insurance systems had less capital and operated at a higher risk.

Gueyie and Lai (2003) analysed the period before, during and after the introduction of deposit insurance scheme in Canada (1956–1983) on the sample of 5 large banks. Their study suggests that the banks with the largest capital increase due to the deposit insurance system are also the riskier banks. González (2005) studied the relationship between bank regulation, deposit insurance schemes, charter values and bank risk in 36 countries and 251 banks during 1995–1999 and found that banks with higher leverage ratios are riskier. Using a sample of 1337 banks in 70 countries during 1995–2002, Fonseca and González (2010) confirmed that a generous deposit insurance system reduces bank capital and increases risk.

Analysing 117 countries in the period 1986–2011, Lé (2013) confirmed that the introduction of a deposit insurance system increases bank risk by significantly reducing capital buffers (the ratio of capital to assets of banks decreases by 15%). This decrease in capital buffers is defined by an increased risk of insolvency (reduced by 15%). According to Lambert et al. (2017), the introduced changes in the US deposit insurance system (2000–2012) regarding the amount of deposit insurance led to increased risk taking by banks, especially for banks with lower capitalisation.

Studying the impact of the deposit insurance system in Bolivia (1993–2003, 2003–2012), Ioannidou and Penas (2010) found that the introduction of the deposit insurance system, reduced market discipline and the gap between large and small banks. Before the introduction of the scheme, large banks were more vulnerable to risks. The introduction of the deposit insurance system led to riskier loans and higher lending rates. In a recent study, Ioannidou and Dreu (2019), confirm the link between the deposit insurance system and disrupted market discipline. At the same time, a higher level of protection of the deposit insurance system leads to a higher risk of banks, and co-insurance reduces the negative effects of the deposit insurance system. Previously highlighted research Lé (2013) shows that large banks are stable and do not react to the introduction of the system.

Lakštutienė et al. (2011) find that smaller banks are riskier because they attract depositors with higher deposit rates, thus reducing the efficiency of the deposit insurance system. In contrast, O'Hara and Shaw (1990) point out the negative consequences of the 'too big to fail' doctrine, which protects the largest banks regardless of the existence of a deposit insurance system. This form of government protection of the largest banks encourages these banks to take risks.

Researching a large number of developed and developing countries (in the period from 1970 to 2010), Calomiris and Chen (2020) concluded that generous deposit insurance is associated with riskier assets of banks. Empirical evidence point out that depositors respond to changes in deposit insurance limits (Iyer et al., 2017) and to changes in deposit insurance credibility (Bonfim & Santos, 2020). This is confirmed by recent evidence from Gattia and Oliviero (2021), who suggest that an increase in

deposit insurance has a negative effect on the funding cost per unit of customer deposits and that this effect is stronger for riskier banks.

3. Methodology

In this scientific research, data analysis was carried out using the statistical program STATA and due to the dynamic nature of economic relations, dynamic panel analysis was used. The time dimension of the research is focussed on annual observations in the period from 2005 to 2014. A total of 34 countries were selected for the research sample, of which 28 EU member states and 6 Southeast European countries (Albania, Bosnia and Herzegovina, Montenegro, Kosovo, Macedonia and Serbia). Data on banks and other credit institutions were used from the commercial database Bankscope, Bureau van Dijk. The total number of active institutions in the analysis is 1453, of which 809 are commercial banks and 644 are other credit institutions participating in a deposit insurance scheme of selected countries.

A two-step Arellano–Bond (AB) estimator is used for the model requirements (Arellano & Bond, 1991). Testing the model with the Sargan test revealed the presence of heteroskedasticity of variance, and a version of the robust standard errors based on the methodology of Windmeijer (2005) and Newey and Windmeijer (2009) is used in the analysis. They were tested with the Wald test and the test for autocorrelation, which showed the correctness of the results of all models set.

3.1. Data

Banking stability is approximated by banking risk (z-score, non-performing loans as a share of total loans). The Z-score represents the sum of the return on assets E (ROA) and the ratio of capital to total assets in relation to the standard deviation of the return on assets (σROA). It is calculated using rolling window analysis over the 3-year period. Since the z-score is highly skewed, we use the natural logarithm of the z-score, which is normally distributed.

Non-performing loans represent an undesirable cost to the bank by reducing bank performance and need to be controlled because of their negative impact on the banking system.

The independent variables used in the econometric analysis refer to the specific characteristics of the deposit insurance system and macroeconomic developments. The impact of the deposit insurance scheme on banking (in)stability depends on the characteristics of the particular deposit insurance scheme. Therefore, to describe the specific characteristics of the deposit insurance scheme for the defined sample, variables (mostly dummy variables, i.e., dichotomous variables) are constructed in terms of: amount of insured deposit (protection), type of premium (differentiated premium or non-differentiated premium), type of administration and foreign currency deposit insurance.

The group of independent variables that describe the banking system and the characteristics of banks includes the index Herfindahl–Hirschman (HHI, banking concentration index), the absolute size of banks, capitalisation ratios (ratio of capital to

assets), liquidity ratios (ratio of liquid assets to total deposits received and short-term funding) and profitability (return on assets and return on capital).

The system size of banks, i.e., the HHI index and the natural logarithm of the absolute size of banks, attempts to determine the relationship between this characteristic of the banking system and individual banks and banking (in)stability. Both the size of an individual bank and the size of the banking system are expected to reduce the banking risk.

Larger banks are expected to be more inclined to build better quality loan portfolios because of advanced credit risk assessment systems. In analysing the impact of the deposit insurance system on bank risk as a function of bank characteristics, indicators of capitalisation (ratio of capital to assets), liquidity (ratio of liquid assets to total deposits received and short-term funding) and profitability (return on assets and return on capital) are used.

These variables are expected to be negatively associated with bank risk variables. Dummy variables that are indicators of economic conditions as well as (non)membership in the EU are also included in the study to examine the risk-taking capacity of banking systems.

Scientific research suggests that some EU countries experienced depositor panics and systemic crises at the onset of the financial crisis, while the banking systems of non-EU countries (i.e., countries of SE Europe) were more stable.

3.2. Model

Banking stability cannot be expressed with only one indicator, so we use two panel models with dependent variables expressing banks' riskiness: z-score and NPL. The scientific study consists of two samples: EU members and the countries of SE Europe, therefore, in addition to the presented models, an analysis with a dummy variable for the countries of SE Europe (NOEUSTATE) is performed. This leads to conclusions about the differences in the characteristics of banking activities between the countries of the EU and SE Europe.

The specification of the panel analysis model to prove the established hypothesis follows.

$$y_{it} = \mu + \gamma y_{i,t-1} + \beta_1 x_{it1} + \beta_2 x_{it2} + \ldots + \beta_K x_{itK} + \alpha_i + \varepsilon_{it};\ i = 1, \ldots N,\ t = 1, \ldots T. \tag{1}$$

$$\begin{aligned} z\text{-}score_{i,t} = {} & \alpha + \gamma z\text{-}score_{i,t-1} + \beta_1 lnlimit_{i,t} + \beta_2 ADMINISTRATION_{i,t} \\ & + \beta_3 PREMIA_{i,t} + \beta_4 FOREIGNCUR_{i,t} + \beta_5 lnassets_{i,t} + \beta_6 EQTA_{i,t} \\ & + \beta_7 LIQADEP_{i,t} + \beta_8 ROA_{i,t} + \beta_9 ROE_{i,t} + \beta_{10} HHI \\ & + \beta_{11} lnGDPPCAPITA_{i,t} + \beta_{12} CPIINDEX_{i,t} + \beta_{13} EUSTATE_{i,t} + \varepsilon_{i,t}; i \\ & = 1, \ldots, 14530,\ t = 1, \ldots, 10. \end{aligned} \tag{2}$$

$$NPL_{i,t} = \alpha + \gamma NPL_{i,t-1} + \beta_1 lnlimit_{i,t} + \beta_2 ADMINISTRATION_{i,t} + \beta_3 PREMIA_{i,t} + \beta_4 FOREIGNCUR_{i,t} + \beta_5 lnassets_{i,t} + \beta_6 EQTA_{i,t} + \beta_7 LIQADEP_{i,t} + \beta_8 ROA_{i,t} + \beta_9 ROE_{i,t} + \beta_{10} HHI + \beta_{11} lnGDPPCAPITA_{i,t} + \beta_{12} CPIINDEX_{i,t} + \beta_{13} EUSTATE_{i,t} + \varepsilon_{i,t}; \; i = 1, \ldots, 14530, \; t = 1, \ldots, 10. \quad (3)$$

4. Results

The results presented in the following tables show the justification of the empirical analysis performed by the dynamic panel analysis, because the effects of the dependent variables from the previous period are positive with the movement of these variables in the current period.

This is in line with expectations, since the characteristics of banking activities: banking risk, measured by the z-score, and the proportion of non-performing loans (NPLs), depend on the movements of these variables in the previous period. Below we present the results of a panel analysis of the impact of the deposit insurance system on bank risk as a function of bank characteristics (Tables 1 and 2).

According to the results of the models, the relationship between the level of protection (limit) of the deposit insurance system and the z-score is positive and significant, which means that an increase in the level of protection increases the value of the z-score, i.e., reduces the risk of banks. This is in line with expectations, as the

Table 1. Results of the panel analysis of the impact of the deposit insurance system on banks' risk as a function of banks' characteristics (with the variable EU membership).

Dependent variables	z-score	NPL
Independent variables		
Lagged dependent variable	0,123** (0,054)	0,300** (0,128)
lnimit	0,018* (0,014)	0,707** (0,353)
ADMINISTRATION	0,069* (0,039)	0,024 (0,376)
PREMIA	0,079*** (0,029)	0,542** (0,308)
FOREIGNCUR	0,012 (0,055)	0,460 (0,794)
lnassets	−0,298*** (0,070)	−0,492 (0,442)
EQTA	0,008*** (0,002)	0,0007 (0,001)
LIQADEP	−0,00001 (0,0001)	0,003 (0,004)
ROA	−0,016 (0.014)	−0,540*** (0.129)
ROE	0,016*** (0,003)	0,002 (0,003)
HHI	0,0001 (0,00006)	0,004** (0,002)
lnGDPPCAPITA	0,052 (0,037)	−4,940*** (0,947)
CPIINDEX	0,019*** (0,002)	0,283*** (0,062)
EUSTATE	−0,107*** (0,021)	0,168 (1,021)
constant	5, 923*** (1,267)	24,921 (12,630)
Z (1)	−3,581***	−1,778
Z (2)	0,138	0,808
Wald test	279,87***	240,84***
No. of instruments	50	50
No. of observations	5365	2260
No. of banks	1117	630
Stage	2	2

*,**,*** – level of significance on 10%, 5% and 1%.
Source: Authors' calculation according to STATA/SE 13.0.

Table 2. Results of the panel analysis of the impact of the deposit insurance system on banks' risk as a function of banks' characteristics (with the variable non-EU membership).

Dependent variables	z-score	NPL
Independent variables		
Lagged dependent	0,123** (0,054)	0,300** (0,128)
lnimit	0,018* (0,014)	0,707** (0,353)
ADMINISTRATION	0,069* (0,039)	0,024 (0,376)
PREMIA	0,079*** (0,029)	0,542** (0,308)
FOREIGNCUR	0,012 (0,055)	0,460 (0,794)
lnassets	−0,298*** (0,070)	−0,492 (0,442)
EQTA	0,008*** (0,002)	0,0007 (0,001)
LIQADEP	−0,00001 (0,0001)	0,003 (0,004)
ROA	−0,016 (0.014)	−0,540*** (0.129)
ROE	0,016*** (0,003)	0,002 (0,003)
HHI	0,0001 (0,00006)	0,004** (0,002)
lnGDPPCAPITA	0,052 (0,037)	−4,940*** (0,947)
CPIINDEX	0,019*** (0,002)	0,283*** (0,062)
NOEUSTATE	0,107*** (0,021)	−0,168 (1,021)
constant	5,817*** (1,268)	25,089 (12,553)
Z(1)	−3,581***	−1,778
Z(2)	0,138	0,808
Wald test	279,87***	240,84***
No. of instruments	50	50
No. of observations	5365	2260
No. of banks	1117	630
Stage	2	2

*,**,*** – level of significance on 10%, 5% and 1%.
Source: Authors' calculation according to STATA/SE 13.0.

level of protection usually increases during the crisis, when this measure is justified by preventing depositors' panic and attacks on banks.

The positive and significant relationship between the level of protection and the ratio of non-performing loans to total loans (NPL) proves that the increase in the level of protection (realized during the crisis) increases the NPL. This result is expected as the ratio of non-performing loans to total loans (NPL) increases during periods of financial instability.

The premium (PREMIA) of the deposit insurance system or the differential premium is positive and significant with both banking risk variables. This proves that the fair premium reduces banking risk as measured by the z-score and increases banking risk as measured by the ratio of non-performing loans to total loans (NPLs).

Since the fair premium also depends on the quality of lending, if the quality of lending is expected to be poor, the ratio of nonperforming loans to total loans is expected to increase. The fair premium is a more expensive form of deposit insurance for credit institutions with higher business risk, which induces credit institutions to reduce riskiness, i.e., increase the z-score.

The natural logarithm of banks' total assets (lnassets), has a negative and significant relationship with the measure of banking risk, the z-score. This result proves that bank size increases bank risk, which is consistent with the findings of Dell'Ariccia et al. (2013) study.

For depositors and borrowers, bank size is usually synonymous with bank stability, but the very symbol of power it represents is the reason for the positive relationship between the absolute size of a bank and banking risk. Banks' reliance on high rates of asset growth encourages them to take risks based on the way they do business; a

greater number of approved loans (loan growth) and a willingness to increase competition in obtaining deposit funding sources.

Banking stability, which becomes imperative with the current doctrine that large banks are 'too big to fail', contributes to the riskier behaviour of large banks because they are aware of the protection that governments provide in addition to the deposit insurance system (insuring risk assets, issuing loan guarantees, providing liquidity for an extended period of time, and 'injecting' public capital into an insolvent bank).

This assistance to individual large and insolvent banks is associated with high government costs and other negative effects to prevent the emergence of a systemic banking crisis, which has social costs (more in Moosa, 2010). On the other hand, small banks that are encouraged by aggressive policies to attract customers are less likely to invest in riskier businesses characterised by higher returns on the placement of collected funds (Kundid, 2012, p. 105). Despite the above result and the preceding argument, it is important to note that the selected sample of the study differs in terms of the characteristics of the banking system of each country. In some EU Member States where banking crises were recorded, large and systemically important banks were 'problematic' (Laeven & Valencia, 2013; Lee et al. (2015). This is because banks' growth was mainly in trading secondary securities and derivatives, which are often cited as the cause of the financial crisis (Greenberger, 2010; Grgić & Kordić, 2011; Sornette & Woodard, 2010). In contrast, banks in the selected countries of SE Europe and in Croatia based their business mainly on classical and traditional products (for an overview of the representation of derivatives in banks, see Appendix, Table A1). Therefore, there were no banking crises in these countries at the time of the 2008 financial crisis. The stability of the Croatian banking system is enabled by large banks, while small banks are less efficient and profitable and tend to take risks in their operations. According to Šverko et al. (2013, p. 42), small banks in Croatia have lower assets per employee, higher costs and a relatively higher share of non-performing loans, which is not accompanied by a higher capital adequacy ratio. It can be concluded that the relationship between bank asset size and bank risk also depends on other characteristics of the banking system in a given country. For this reason, it would be desirable in some subsequent studies to observe the above relationships on a sample of similar banking systems so that the result can be generally accepted for the entire observed sample.

The ratio of capital to assets (EQTA) is positively and significantly related to the z-score, implying that a higher ratio of EQTA leads to lower risk as measured by the z-score. A higher ratio of capital to assets provides banks with protection in the event of instability and sudden situations due to an increase in non-performing loans, inadequate management, fraud or regulatory sanctions. This result is consistent with research Fungáčová et al. (2017) and Lambert et al. (2017).

Return on assets (ROA) is negative and significant with the ratio of non-performing loans to total loans (NPLs). Considering that ROA is a function of net income and average total assets of banks in a given period, the opposite result could be expected due to the positive relationship between banking assets and risk presented. Nevertheless, the result is considered logical considering that ROA is able to control operating costs, and it is expected that banks with higher ROA can withstand financial shocks more easily and have fewer 'bad' loans.

The relationship between return on equity (ROE) and banking risk is positive and significant with z-score. Return on equity (ROE) is the profit earned per one monetary unit of the bank's invested capital. A higher value of the indicator means that bank owners receive a return in a shorter period of time, that is, it indicates the image and reputation of the bank. Higher ROEs are mostly achieved by smaller banks (bank size showed a negative and significant relationship with z-score).

Achieving high and stable ROEs implies a lower probability of failure of the institution. However, just as a low score of ROE indicates higher risk, high scores may indicate higher risk of banking operations. An indication that the bank is highly leveraged in the financial market (European Banking Authority, 2015).

The variable related to concentration of banks in a particular country expressed by HHI index is significant and positive with NPL. Since the above concentration index gives more weight to the largest banks in its calculation because the market shares are squared, this result can be explained by the fact that the higher concentration of banks is associated with an increase in the share of non-performing loans in total loans.

According to the 'too big to fail' doctrine, large banks are systemically important banks. Due to the fact that they are provided with government assistance in case of insolvency, they are more prone to engage in risk operations and thus make unsustainable loans that become uncollectible over time.

The variable representing GDP growth (lnGDPPCAPITA) is significantly and negatively associated with the share of non-performing loans in total loans (NPLs). This result is consistent with the theoretical assumption that during a period of GDP growth per capita, i.e., economic prosperity, the share of non-performing loans in total loans may increase less. The CPIINDEX is positive and significant with the bank risk variables, implying that consumer price growth increases the share of non-performing loans (NPLs) and reduces bank risk as measured by the z-score.

As for the previously analysed model results, it is clear that the average increase in the index CPI is not due to the economic growth of the countries representing the study sample, but the increase in consumer prices increased significantly during the financial crisis, from 2009 to 2012, the purchasing power of citizens was weakened and the unemployment rate increased. Therefore, under the above economic conditions, the consequence of irregular loan repayments is expected. Although the positive relationship of the CPIINDEX with the z-score is contrary to expectations, looking at the movement of the CPIINDEX, which showed growth in the period from 2009 to 2012, it can be concluded that it is in line with the average movement, i.e., the growth of the z-score.

The dummy variable EU membership (EUSTATE) is significant and negative with the z-score. This result supports the fact that banks in EU member states were more vulnerable to risk, which led to the failure of some banks. The results of the model with the dummy variable referring to the countries of SE Europe (NOEUSTATE) have the opposite sign (compared to the results with the EUSTATE dummy). This variable is significant with the z-score, which proves that the risk of banks in non-EU countries is lower.

The interpreted results of the dynamic panel analysis indicate that the deposit insurance system has a differential impact on the level of assumed risks in banking depending on the specificities of banks, which confirms the hypothesis of this paper.

5. Conclusion

The importance of the deposit insurance system is particularly evident in times of crisis to maintain confidence in the banking system and prevent depositor panic and a bank run. In situations where the consequences of risk banking occur, such as a decline in lending and the support of risk (troubled) banks, the deposit insurance system is seen as justified to achieve social welfare.

Together with the central bank's function as a lender of last resort and the regulation and supervision of banks, deposit insurance plays a role in achieving financial stability. In addition to the positive effects, there are also negative effects of the deposit insurance system on banking stability in the form of moral hazard, adverse selection, and the principal-agent problem. The effect of the deposit insurance system on banking stability depends mainly on the characteristics of the banking system, in addition to other determinants (characteristics of the deposit insurance system, country development, supervision, legal and cultural framework).

In line with the changes in the deposit insurance systems of European countries and the conditions of banking systems, especially during the 2008 financial crisis, this paper analysed the impact of the deposit insurance system on banking stability as a function of banking ratios. Banking stability is represented by variables of banking risk (z-score and non-performing loans) on a sample of European Union countries and selected Southeast European countries from 2005 to 2014. This research was conducted by dynamic panel analysis using GMM Arellano–Bond (AB) estimator in two steps.

In this paper, it is possible to point out several conclusions about the analysis of the impact of the deposit insurance system on the banks' risk depending on the banks' characteristics. First, the analysis that banks' assets increase banks' total risk, measured by the z-score, which demonstrates the riskiness of large banks. Accordingly, higher concentration of the banking system indicates higher credit risk as measured by the proportion of non-performing loans. Moreover, the results of comparing two samples (banks in the EU and in Southeast Europe) show that large banks in the EU were riskier and therefore the financial crisis was associated with banking crises. Because of risk in banking operations, during the crisis of 2008, large and systemically important banks in the EU were saved from collapse with safety net and the doctrine 'too big to fail'. The reason for banking instability lies in taking risk in the years before the crisis, which was based on secondary securities and derivatives.

In contrast, banks in Croatia and selected countries of SE Europe were more stable because they tended to use classic and traditional banking products. Of the other bank-specific variables, the results confirm that banks should have a higher proportion of capital in assets and higher returns on capital and assets because they reduce banks' overall and credit risk. Although these results are consistent with some

previous studies it should be noted that this study differs from all previous research in terms of empirical analysis of the selected spatial and temporal sample, and especially with regard to SEE countries.

Finally, this paper represents an empirical basis for emphasising the importance of the deposit insurance system in ensuring banking stability as well as the stability of the entire financial system. These findings have important implications for the policy makers, regulators and depositors, as banking stability is perceived to have a crucial role in promoting economic growth and enabling macroeconomic stability. Therefore, it is of crucial importance to continue with the policy of further development of financial safety net, especially in the pillar of deposit insurance system.

Limitations of scientific research include the lack of data for key variables within the Bankscope commercial database. Therefore, at this stage of the research, the results could not be supplemented with other variables that were planned but had a smaller number of recorded observations. Furthermore, the database in question can no longer be accessed, but Dana can be assessed through another source. An important guideline for further research on the effectiveness of the deposit insurance system refers to the systemic analysis after the full implementation of the EU Banking Union. That is, due to the emergence of a new regulatory model, it would be important to investigate whether the Banking Union, i.e., the third pillar through which the European deposit insurance system is regulated, realises the previously mentioned benefits compared to existing national deposit insurance systems. In addition, the analysis should also be carried out for EU members that are not part of the euro area and will therefore not be part of the banking union (until the introduction of the euro), which would allow the impact of the European deposit insurance scheme on banking stability to be compared with the national schemes.

Notes

1. The features of the deposit insurance system are divided into basic and additional. Basic features of deposit insurance relate to the manner of: establishing the system (explicit/implicit), participate within the system (compulsory/voluntary), managing the system (privat/state/mix) and collecting the funds (ex-ante/ex-post). Also, the basic features include the type of the deposit insurance premium (equal for all institutions/ aligned with the institution's risk – »fair premium«) and the existence of co-insurance amount or limit of insured deposits (protection). Additional features are: paybox plus form of protection, coverage of deposits in foreign currency, coverage of interbank deposits and backstop protection. Paybox plus presents a payout function guarantees payment to depositors in the event of a bank failure. The state can decide whether to attach to this basic protection model (paybox) the function of a bank supervisor or macroprudential regulator, which is a paybox plus form of protection that includes a higher level of protection for depositors (Suljić Nikolaj et al., 2019). Backstop is a government protection in case of a shortfall in funds, mostly in the form of credit lines or guarantees on debt issuances from the Treasury (Demirgüç-Kunt et al., 2014).
2. In response to the financial crisis, in 2009 the amount of protection has been increased from EUR 20 000 to EUR 50 000. By the end of 2010, protection amounts became universal and the differences in the specifics of individual EU deposit insurance systems were in the process of being harmonized with the Directive (2014/49/EU) aiming to preserve EU banking stability. Austria, Denmark, Ireland, Germany, Hungary, Slovenia and Slovakia had unlimited amount of protection in the period from 2008 to 2013. Except

for the increase of protection amounts, in time of crisis, deposit insurance systems in EU become 'generous' because of leaving co-insurance and introduction of additional forms of protection (paybox plus, foreign currency and interbank deposits, backstop) (Suljić Nikolaj et al., 2019).

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This work was supported by the University of Rijeka; under Grant uniri-drustv-18-61; Grant ZIP-UNlRl-130-5-20 and Grant uniri-mladi-drustv-20-13.

ORCID

Stella Suljić Nikolaj http://orcid.org/0000-0002-0435-4047
Bojana Olgić Draženović http://orcid.org/0000-0002-5175-7439
Vesna Buterin http://orcid.org/0000-0002-1090-6549

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Appendix

Table A1. The share of derivative securities in balance sheets in selected EU and Croatian banks in the period from 2006 to 2010.

Percentage of derivatives in bank's balance sheet	2006	2007	2008	2009	2010
The sample of banks in EU	35.8	38.0	43.2	42.5	42.5
Croatian banks	0.1	0.1	0	0.1	0

Source: Otero González et al. (2016); Slijepčević and Živko (2008); Bilten o bankama 23 (2011).

Table A2. List of dependent and independent variables.

Name of variable	Label	Explenation	Source
Dependent variables			
Banking risk indcators			
z-score	z-score	Measure of bank stability z-score = [E(ROA) + CAP]/σROA the natural logarithm of the z-score	Own calculation by rolling window analysis for 3 years according to data on return on assets and the ratio of capital to total assets, Bankscope, Bureau van Dijk
Non-performing loans/ total loans	NPL	Share of non-performing loans in total loans (%) Deposit volatility indicators	Bankscope, Bureau van Dijk
Independent variable			
Characteristics of the deposit insurance system			
Amount of protection	lnlimit	Natural logarithm of the amount of protection in euros for the period from 2005 to 2014	European Commission (2007), Schich (2009) CESifo DICE Report 4/2008, 4/2011, Demirgüç-Kunt et al. (2014) Data from deposit insurance institutions and central banks
Management of the deposit insurance system	ADMINISTRATION	Dummy variable: 0 – state 1 – private way of managing the deposit insurance system	Schich (2009) CESifo DICE Report 4/2008, 4/2011, Demirgüç-Kunt et al. (2014) Data from deposit insurance institutions and central banks
Premia	PREMIA	Dummy variable: 0 – undifferentiated premium according to the credit institution's risk 1 – differentiated (fair premium) according to risk	Schich (2009) CESifo DICE Report 4/2008, 4/2011, Demirgüç-Kunt et al. (2014) Data from deposit insurance institutions and central banks
Coverage of foreign currency deposits	FOREIGNCUR	Dummy variable: 0 – non-coverage of foreign currency deposits 1 – coverage of foreign currency deposits	Schich (2009) CESifo DICE Report 4/2008, 4/2011, Demirgüç-Kunt et al. (2014) Data from deposit insurance institutions and central banks
Bank indicators			
Banking system indicators			
Banking concentration index	HHI	The Herfindahl–Hirschman index – is based on total bank assets	Official websites of the central banks and the ECB

(*continued*)

Table A2. Continued.

Name of variable	Label	Explenation	Source
		For EU members, the ECB publishes concentration data for all credit institutions	
Banking performance indicators			
The size of the bank	lnassets	natural logarithm of the total assets of the bank in thousands of EUR	Bankscope, Bureau van Dijk
Bank capitalisation indicators			
The ratio of capital and assets	EQTA	Share of capital in assets (%)	Bankscope, Bureau van Dijk
Bank liquidity indicators			
Relationship between liquid assets and total deposits received and short-term financing	LIQDEP	Share of liquid assets in total deposits received (%)	Bankscope, Bureau van Dijk
Profitability indicators of banks			
Return on assets	ROA	Net profit/total assets (%)	Bankscope, Bureau van Dijk
Return on equity	ROE	Net profit/capital (%)	Bankscope, Bureau van Dijk
Indicators of economic conditions			
EU membership	EUSTATE	Dummy variable: 1 – EU members 0 – SEE countries	
Non-EU membership	NOEUSTATE	Dummy variable: 1 – SEE countries 0 – EU members	
Macroeconomic indicators			WDI database
GDP per capita	GDPPCAPITA	The natural logarithm of the annual amount in thousands of dollars, converted into thousands of euros	WDI database
Consumer price index	CPIINDEX	Consumer price index in %	WDI database

Source: Authors.

Table A3. Descriptive statistics of model variables with dependent variable z-score and NPL.

Variable		Arithmetic mean	Standard deviation	Minimum value	Maximum value	Number of observations
z-score	Overall	2,876875	1,557244	−4,66531	8,902474	N = 11433
	Between		1,503968	−2,808699	6,818049	n = 1368
	Within		0,38116303	−2,801569	6,825821	T = 8,35746
NPL	Overall	8,128249	10,76065	−4,35	108,71	N = 5369
	Between		10,0161	0,0257143	104,885	n = 1126
	Within		5,988975	−32,49318	88,777	T = 4,76821
lnlimit	Overall	10,94649	0,7570291	7,846199	11,56637	N = 13576
	Between		0,3990982	8,006368	11,52912	n = 1453
	Within		0,650518	8,977107	12,07456	T = 9,34343
ADMINISTRATION	Overall	0,1783202	0,3827953	0	1	N = 14502
	Between		0,3367885	0	1	n = 1453
	Within		0,1817097	−0,5216798	0,8783202	T = 9,98073
PREMIA	Overall	0,376224	0,484454	0	1	N = 14502
	Between		0,2910743	0	1	n = 1453
	Within		0,3880854	−0,323776	1,076224	T = 9,98073
COINS	Overall	0,1688733	0,3746529	0	1	N = 14502
	Between		0,1543953	0	0,5	n = 1453
	Within		0,3413951	−0,3311267	0,8688773	T = 9,98073
INTERBANK	Overall	0,058061	0,2338667	0	1	N = 14502
	Between		0,2261802	0	1	n = 1453
	Within		0,0589544	−0,241939	0,758061	T = 9,98073
FOREIGNCUR	Overall	0,9628327	0,1891781	0	1	N = 14502
	Between		0,1568688	0,3	1	n = 1453
	Within		0,1055981	0,6628327	1,662833	T = 9,98073
lnGDPPCAPITA	Overall	10,07438	0,6893274	7,49599	11,99526	N = 14530
	Between		0,6776451	7,777148	11,27312	n = 1453
	Within		0,1274905	9,637592	12,07964	T = 10
CPIINDEX	Overall	2,758824	2,559203	−4,5	16,1	N = 14530
	Between		1,473569	1,19	8,9	n = 1453
	Within		2,103415	−4,0429	13,3271	T = 10
GDS	Overall	22,87887	8,469526	−13,8	52,8	N = 14526
	Between		8,294994	−5,56	50,62	n = 1453
	Within		1,775576	13,37887	31,24887	T = 9,99725
EUSTATE	Overall	0,9227805	0,2669487	0	1	N = 14530
	Between		0,2530475	0	1	n = 1453
	Within		0,0852539	0,1227805	1,72278	T = 10
NOEUSTATE	Overall	0, 0772195	0,2669487	0	1	N = 14530
	Between		0,2530475	0	1	n = 1453
	Within		0,852539	−0,7227805	1, 8772195	T = 10

Source: Authors.

Table A4. Descriptive statistics of independent variables related to the characteristics of banking operations.

lnassets	Overall	21,03305	2,226008	6,907755	28,42058	N = 12065
	Between		2,195441	6,907755	28,23507	n = 1441
	Within		0,6006291	4,099867	31,9809	T = 8,37266
EQTA	Overall	10,71977	15,77646	−45,82	761,93	N = 11961
	Between		11,42347	−9,133333	129,96	n = 1449
	Within		11,50926	−75,99624	642,6898	T = 8,25466
LIQADEP	Overall	45,45104	42,074	−6,58	940	N = 10876
	Between		42,55967	0,01	890,2	n = 1302
	Within		23,1243	−287,465	672,4551	T = 8,3533
ROA	Overall	0,3304469	3,825025	−116,58	185,57	N = 11613
	Between		2,733503	−30,60833	66,061	n = 1376
	Within		2,812306	−85,64122	166,6975	T = 8,43968
ROE	Overall	2,944255	28,97089	−992,29	900	N = 11920
	Between		17,01554	−213,585	274,145	n = 1428
	Within		24,82541	−906,1827	628,7993	T = 8,34734
HHI	Overall	681,5129	574,89	174	4039	N = 14466
	Between		567,0369	242,1	3076	n = 1453
	Within		116,8497	106,0129	1700,013	T = 9,95595

Source: Authors.

Table A5. Correlation matrix of dependent and independent model variables.

	z-score	NPL	lnlimit	ADMINISTRATION	PREMIA	FOREIGNCUR	lnassets	EQTA	LIQDEP	ROA	ROE	HHI	lnGDPPCAPITA	CPIINDEX	EUSTATE	NOEUSTATE
z-score	1															
NPL		1														
lnlimit	0,0261*	−0,0568*	1													
ADMINISTRATION	−0,2205*		0,0825*	1												
PREMIA	−0,0837*		−0,3874*	−0,1212*	1											
FOREIGNCUR	0,1603*	−0,2224*		0,0915*	0,1526*	1										
lnassets	−0,0891*	−0,1742*	0,0983*	0,0398*	0,0343*	0,0881*	1									
EQTA		0,1465*		0,0425*	−0,0350*	−0,0639*	−0,2818*	1								
LIQDEP	−0,0533*		−0,036*	0,1079*	0,0804*		0,0485*		1							
ROA		−0,1712*	−0,0527*		0,0226	0,0448	0,0162*			1						
ROE	0,0721*	−0,2335*	−0,0761*			0,0541*	0,0187			0,4109*	1					
HHI	−0,4073*	0,2161*	−0,0805*	0,1073*	0,1210*	−0,1297*	−0,0626*	0,0616*	0,0459*	0,0258*		1	−0,3756*	−0,0240*	0,7091*	−0,7091*
lnGDPPCAPITA	0,2875*	−0,3203*	0,4410*	0,1233*	−0,1617*	0,3672*	0,1618*	−0,0929*			0,0253*		1			
CPIINDEX	0,0645*	0,2025*	0,07026*		−0,3508*	−0,1619*		0,0337*	−0,0687*	−0,0948*	−0,1253*		0,1922*	1		
EUSTATE	0,1807*	−0,2402*	0,4545*		0,0618*	0,4408*	0,1930*	−0,1065*	−0,0275*		0,0191		0,7091*	0,1172*	1	
NOEUSTATE	−0,1807*	0,2402*	−0,4545*		−0,0618*	−0,4408*	−0,1930*	0,1065*	0,0275*		−0,0191		−0,7091*	−0,1172*		1

* indicates statistical significance at the level of 1%; highlighted values suggest a correlation to 0.8.
Source: Preparation of authors according to STATE/SE calculations 13.0.