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Determinants of the Bank Stability: Evidence of the Czech Republic

[Determinanty bankovní stability v České republice]

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Abstract: The aim of the paper is to estimate the determinants of bank stability in the Czech banking sector. The effect of selected bank-specific and macroeconomic variables on bank stability measured by Z-score is examined using econometric analysis. The data set consists of a sample of the Czech banks operating together with macroeconomic factors, and the period of observation is from 2001 to 2020 on an annual basis. Using generalized method of moments, it was found that the determinants that affect the banking stability include the ratio of classified loans to total loans of the bank, capitalization and inflation rate.

Keywords: capitalization, commercial banks, Czech Republic, financial stability, Z-score.

JEL classification: G21, C58

Introduction

There is no common or widely accepted definition of financial stability. Central banks and academics often provide their own interpretation of financial stability. For example, the European Central Bank (ECB) defines financial stability as a state in which the financial system (consisting of financial intermediaries, markets and market infrastructures) is able to withstand shocks, thereby reducing the likelihood of disruptions in the financial intermediation process that may adversely affect real economic activity. The Czech National Bank (CNB) defines financial stability as a situation in which the financial system performs its functions properly, without serious disturbances and undesirable consequences for the current and future development of the economy as a whole, while exhibiting high resilience to shocks.

It is very difficult to determine or measure the stability of the financial sector given the complex nature of the financial system and the existence of many linkages between financial market participants, non-financial sectors and financial institutions. The financial stability of banks has long been a subject of interest for academics and policy makers seeking to ensure that the banking sector is sound and resilient to shocks. The pursuit of financial stability has become one of the important objectives of financial market supervisors, especially after the financial crisis that began in the summer of 2007. Banks play a key role in the functioning of the financial system and their instability, as the financial crisis has just shown, can lead to destabilisation of the entire financial system in the current era of globalisation, i.e. the interconnectedness of markets. The banking sector is facing major challenges as a result of technological innovation, changes in customer preferences, bank risk reduction and new regulatory initiatives, among other factors. Banks need to be stable in order to weather all these changes. The effort to identify the main determinants of banks' financial stability is driven by the desire to prevent banking crises. This allows bank management, legislators and regulators to adjust the rules of banking activities so that the banking sector remains sound and resilient to shocks. Moreover,

identifying the determinants affecting bank stability allows supervisors to understand where they should focus their attention in supervising the banking system.

This paper focuses on the Czech banking sector and aims to estimate the determinants of bank financial stability. The paper begins with a brief introduction to the issues and motivations for examining financial stability. The first section reviews the available literature on the determinants of financial stability within Europe. The second section discusses the methodology and data. The last third chapter examines the analysis procedure and the results from the main estimation method, which was the generalised method of moments (GMM). The conclusion then summarises the results, recommendations and suggestions related to financial stability.

1 Literature Review

Current research on bank stability offers a wide range of possible determinants, from bank-level to country-level characteristics. The possible factors or determinants affecting bank stability are wide ranging. Studies often include variables that reflect the asset structure and size of the asset side of banks' balance sheets. Variables such as bank size, loan ratio or liquidity are commonly used. In the following section, a brief overview of the various studies examining possible determinants of bank stability within Europe will be presented.

Rupeika-Apoga et al. (2018) examine and identify the main determinants of bank stability in the Latvian banking sector. The authors of this study find that credit risk and efficiency ratio have a significant negative impact on bank stability. On the other hand, factors such as bank size, liquidity ratio, profitability, inflation and GDP growth have a significant positive effect on bank stability. Ivičić et al. (2008) investigate the impact of different variables on bank default risk in seven Central and Eastern European countries. The results of this study show that despite a considerable degree of heterogeneity across countries, there is evidence of some common features of bank stability. Bank stability appears to have increased on average since 1998, mainly as a result of a more favourable macroeconomic environment and banking sector consolidation, which has led to higher and less volatile bank returns. The stability of banks in CEE countries has on average declined in line with credit growth. This result highlights the problem of rapid credit expansion, which is associated with a number of micro (easing of credit policy and risk underestimation) and macro (creating domestic and external imbalances) risks. Higher loan loss provisioning is negatively associated with bank stability, mainly through lower profitability ratios. The authors also document a negative effect of inflation on bank stability. Price stability contributes to bank stability in both Hungarian and Czech banks, along with interest rate stability or GDP growth. Baselga-Pascual and Trujillo-Ponce (2015) find in their paper that capitalization, profitability, efficiency and liquidity are inversely and significantly associated with bank risk. Conversely, less concentrated markets, lower interest rates, higher inflation rates and the context of economic crisis (with declining GDP) increase bank risk. Regarding bank size, the authors reach two different results here. The baseline models show a negative relationship between bank size and risk, but some robustness checks (fixed effects equations and the Sharpe ratio) show a positive relationship between these variables, which the authors justify with a moral hazard problem consistent with the too-big-to-fail policy. Another interesting study (Pessarossi et al. 2020) addresses the question of whether high (excessive) bank profitability affects the incidence of banking distress. The authors find that high profitability can be a predictor of bank distress, especially with a lag of 3-4 years. These findings have positive and normative implications. On the positive side, they contribute to explaining the mystery observed during the financial crisis for distressed banks that were characterized by high profits before the crisis. On the normative side, the authors argue that

authorities should not consider high profitability as a general rule associated with better bank stability. In addition, indicators of high profitability could be added to early warning models. This study leads to the question whether high levels in all CAMELS components may be associated with lower financial stability. A paper by Louzis et al. (2012) examines the determinants of non-performing loans in the Greek banking sector. The results of this paper show that macroeconomic variables, namely real GDP growth rate, unemployment rate, lending rates and public debt, have a strong impact on the level of NPLs. Ćurak et al. (2013) examine the determinants of NPLs. The results show that lower economic growth, higher inflation and higher interest rate are associated with higher NPLs. Moreover, credit risk is affected by bank-specific variables such as bank size, performance and solvency. There is a positive relationship between the solvency ratio and bad loans. Banks with a higher level of capitalisation in the previous period have a higher level of bad loans in the following year because they are engaged in riskier activities. The negative relationship between bank size and bad loans suggests that larger banks are better able to deal with the information asymmetry problem, leading to a lower level of defaulted loans.

Table 1: A review of studies examining the determinants of bank stability in Europe

Authors	Countries	Period	Empirical findings
Rupeika-Apoga et al. (2018)	Latvia	2003-2016	Bank size, liquidity ratio, profitability, inflation (expected) and GDP growth have a significant positive impact on bank stability. The efficiency ratio and credit risk have a significant negative impact.
Ivičić et al. (2008)	Central and Eastern Europe	1996-2006	Price stability contributes to bank stability in both Hungarian and Czech banks, along with interest rate stability or GDP growth. Higher loan loss provisioning is negatively associated with bank stability.
Baselga-Pascual a Trujillo-Ponce (2015)	Eurozone countries	2001-2012	Capitalisation, profitability, efficiency and liquidity are inversely and significantly related to bank risk. Conversely, less concentrated markets, lower interest rates, higher inflation rates and declining GDP increase bank risk.
Pessarossi et al. (2020)	Europe	2001-2014	High profitability can be a predictor of bank distress especially with a 3-4 year lag.
Louzis et al. (2012)	Greece	2003-2009	Real GDP growth rates, unemployment rates, lending rates and public debt have a strong influence on the level of non-performing loans.
Ćurak et al. (2013)	Southeastern Europe	2003-2010	Lower economic growth, higher inflation and higher interest rates are associated with higher NPLs. Larger banks are better able to deal with the problem of information asymmetry.

Source: authors' compilation

Based on the paper by these authors, we can conclude that there is a general consensus in the empirical literature that a favourable macroeconomic environment supports bank stability. According to authors such as Ivičić et al. (2008), Rupeika-Apoga et al. (2018), Ćurak et al. (2013) and others, price stability together with interest rate stability or GDP growth is positively associated with bank stability. Conversely, high inflation and declining GDP increase bank risk. Louzis et al. (2012), also focusing on the Greek banking sector, conclude that real GDP growth rate, unemployment rate, lending rates and public debt, have a strong impact on the level of non-performing loans. A sound macroeconomic environment also contributes to borrowers being employed and having sufficient funds and thus more likely to repay their loans on time, which reduces the bank's credit risk.

These papers also agree that bank size has a positive effect on financial health and performance of banks. Ćurak et al. (2013) based on their findings state that larger banks are better able to address information asymmetry issues compared to their smaller counterparts, mainly due to

qualified staff and good quality information which leads to better credit analysis and borrower monitoring. Authors like Baselga-Pascual and Rupeika-Apoga et al. (2018) agree that even liquidity ratio, profitability have a positive impact on bank stability while credit risk has a significant negative impact. However, according to Pessarossi et al. (2020), excessive or too high profitability can be a predictor of bank distress especially with a lag of 3-4 years. Other important specific factors that have a significant impact on bank stability according to empirical findings include the market concentration index, namely Herfindahl-Hirschman index (HHI), efficiency ratio, funding risk and interest rates. Overall, the results suggest that both macroeconomic and bank-specific variables are important for the stability of the banking sector.

2 Methodology and Data

The dataset consists of 12 commercial banks (taking into account bank mergers and acquisitions) operating in the Czech Republic together with macroeconomic indicators. It is a balanced data panel with an annual frequency and the observation period is from 2001 to 2020. The selected banks represent a large part of the Czech banking sector. Their share in the total balance sheet of the Czech banking sector was approximately 83.55 % at the end of 2020. The data used in the empirical analysis come from two main sources. Bank-specific variables were obtained and collected from the annual reports of each commercial bank. Variables such as macroeconomic indicators (inflation rate, gross domestic product, unemployment rate) were obtained from the website of the Czech Statistical Office.

The main estimation method used in this paper is the system generalized method of moments (GMM) developed for dynamic panel data, which was fully developed by Blundell and Bond (1998). In this paper, we use a two-step GMM procedure with asymptotic standard deviations. GMM is a statistical method that combines observed economic data with the information in population moment conditions to produce estimates of the unknown parameters of this economic model. GMM addresses issues related to endogeneity, unobserved panel, heterogeneity, autocorrelation, omitted variable bias, and measurement errors (Ullah et al. 2018). GMM can be utilized without requiring diagnostic tests since it is inherently designed to address issues of endogeneity, autocorrelation, and heteroscedasticity (Yitayaw et al. 2023). Employing System GMM is preferable to detect and tackle the issue of endogeneity (Yitayaw et al. 2023), therefore System GMM was employed in this paper.

2.1 Dependent variable

Bank stability as the dependent variable is measured using the Z-score method. This method originated from a study entitled "Safety First and the Holding of Assets" by Andrew Donald Roy published in 1952 and was subsequently developed in later years by Boyd and Graham (1986), Hannan and Hanweck (1988) and Boyd, Graham and Hewitt (1993). The application of the Z-score method is negatively related to the probability of bank insolvency. That is, the higher the Z-score, the better the financial position of the bank and hence its solvency. Thus, it provides a direct measure of bank stability.

Banking stability is calculated via the following equation:

$$Z - score_{i,t} = \frac{ROA_{i,t} + \frac{Equity_{i,t}}{Asset_{i,t}}}{\sigma(ROA)_i} \quad (1)$$

ROA here represents the bank's return on assets, *Equity to asset* is the ratio of equity to total assets of the bank, and *σ(ROA)* is the standard deviation of return on assets calculated over the

entire time period. This calculation approach can be found, for example, in Beck and Laeven (2006), or Hesse and Čihák (2007), *i* denotes the bank *(i = 1, ..., N), t denotes time (t = 1, ..., T).*

Authors such as Noth and Tonzer (2017), Lepetit and Strobel (2015) agree that a log-transformed Z-score may be preferable given that the calculated values of that indicator are often biased. Based on this fact, we will use the natural logarithm of the Z-score to smooth out the higher values and avoid bias.

2.2 Independent variables

We have selected several factors that may affect the stability of the Czech banking sector as independent variables. We distinguish between bank-specific factors and macroeconomic factors. Among the bank-specific factors we included bank size, credit risk, net interest margin, liquidity risk, classified loan ratio and capitalisation. The macroeconomic factors selected were inflation, gross domestic product, unemployment and market concentration.

Bank size (size) is measured as the natural logarithm of total assets, credit risk is expressed as the ratio of total loans to total assets of the bank, net interest margin (nim) is defined as net interest income for a given period relative to the average volume of interest-earning assets, liquidity risk (lr) is expressed as the ratio of total loans to total deposits of the bank, classified loans ratio is expressed as the ratio of classified loans to total loans of the bank. The inflation indicator (infl) represents the inflation rate expressed as a year-on-year change, gross domestic product is calculated as the ratio of GDP at current prices to the median population in the relevant year, unemployment (unempl) represents the general unemployment rate and market concentration is expressed by the Herfindahl-Hirschman index. The natural logarithm was used for all variables. By applying the logarithm to the variables, there is a much more adjusted linear regression line through the base of the data points, resulting in better results. Logarithmic transformation is used as a convenient means of transforming a highly skewed variables into a more normalized dataset. Moreover, the logarithm transformation can help remove systematic changes in the spread of residuals or it can reduce the effect of outliers. The descriptive statistics of the variables are presented in Table 2 and the definition of each variable and its expected impact is described in Table 3.

Table 2: Descriptive statistics

	Mean	Median	Max	Min	Stdev.	Observation
ln_zscore	3,13	3,25	4,12	1,31	0,60	228
ln_size	15,32	15,49	18,04	10,33	1,65	228
ln_cr	4,01	4,09	4,58	2,66	0,39	228
ln_nim	0,85	0,82	1,95	-0,19	0,39	228
ln_lr	4,85	4,42	13,83	3,05	1,77	228
ln_nplr	1,37	1,57	3,44	-3,33	1,07	228
ln_cap	2,35	2,30	4,11	1,17	0,47	228
ln_infl	0,40	0,64	1,84	-2,30	0,97	228
ln_unemp	1,65	1,90	2,11	0,70	0,43	228
ln_hhi	7,00	7,00	7,10	6,92	0,05	228

Source: authors' compilation

Table 3: Variables and their expected impact

Variable type	Symbol	Variables description	Expected impact
Dependent variable	ln_zscore	Banking stability expressed using the Z-score method	
Bank specific independent variables	ln_size	Total assets	(+ / -)
	ln_cr	Total loans to total assets	(-)
	ln_nim	Net interest income to total assets	(+)
	ln_lr	Total loans to total deposits	(+ / -)
	ln_nplr	Classified loans to total loans	(-)
	ln_cap	Equity to total assets	(+ / -)
Macroeconomic independent variables	ln_infl	Annual inflation change	(+ / -)
	ln_unemp	General unemployment rate	(-)
	ln_hhi	Market concentration	(+ / -)

Source: authors' compilation

3 Analysis Process and Results

For all selected variables, stacinonarity was first examined. Levin, Lin and Chu test (LLC) was used to test each variable for the existence of unit roots, it is a panel data unit root test and according to Atoi (2018), it has more power than unit root tests used to test for stationarity of univariate time series. Variables such as ln_nim, ln_unemp and ln_hhi did not meet the stationarity condition and were therefore not applied further in the model. The assumption of multicollinearity was satisfied among the variables, which was tested using the correlation matrix.

The Arellano-Bond serial correlation test proposed by Arellano and Bond (1991) for models estimated by GMM was used to test the model fit. As reported by Kiemo et al. (2019), if the variables are independent and identically distributed, the AR (1) statistic should be significant with a negative autocorrelation coefficient, while the AR (2) statistic should be insignificant (Kiemo et al. 2019). Within our model, the error terms were not correlated with each other and these conditions were met, see Table 4.

Table 4: Arellano – Bond test for serial correlation

Ordering the test	m-Statistics	rho	SE (rho)	*p* – value
AR (1)	-3.5606	-0.3926	0.1103	0.0004
AR (2)	0.9417	0.0867	0.0921	0.3463

Note: the null hypothesis is that there is no serial correlation
In the context of the Arellano-Bond test for serial correlation rho is the estimated autocorrelation coefficient and SE(rho) is the Standard Error of the rho estimate. These values are used in the Arellano-Bond test to check for first and second order autocorrelation amongst the residuals of an equation estimated by GMM with first differences in a panel work file.
Source: authors' compilation

Another important test of the model's validity was the J-statistic test, also known as the Sargan statistic (test for overidentification). As shown in Table 5 the results indicate that there is no overidentification of the model and therefore the instruments used in the model are valid.

Table 5: J-statistic test

Test name	J-statistic test	*p* – value
J-statistics/Sargan statistics	5.8780	0.3183

Note: The null hypothesis is that the variables used are the correct instruments
Source: authors' compilation

Table 6 shows the results of the system GMM dynamic panel estimation and the impact of each variable on bank stability. The model results showed that the variable ln_cap has a positive statistically significant effect at the one percent significance level on bank stability. In the other hand, variables such as ln_nplr and ln_infl have a negative statistically significant effect on stability at the five percent significance level. The lagged value of ln_zscore (-1) is also found to have a statistically significant negative effect at the five percent significance level. The remaining variables such as ln_size, ln_cr, and ln_lr did not have a statistically significant effect on bank stability over the period of interest.

Table 6: GMM dynamic model results

Dependent variable: ln_zscore		
Independent variables	Coefficient	*p* – value
ln_zscore (-1)	-0.0432**	0.0412
ln_size	0.0212	0.2065
ln_cr	-0.0355	0.6301
ln_lr	-0.0272	0.3559
ln_nplr	-0.0138**	0.0335
ln_cap	1.0199*	0.0000
ln_infl	-0.0066**	0.0120

*Note: ***, **, * denotes significance at the 10%, 5% and 1% level*
Source: authors' compilation

Conclusion

The financial stability of banks plays a key role in the proper functioning of the financial system. In general, a strong and healthy banking system is a prerequisite for sustainable economic growth and bank instability can lead to destabilisation of the entire financial system in the current era of globalisation, i.e. the interconnection of markets. It is important for policy makers, central banks and bank management to control the factors that can destabilise the banking sector. This paper provides some insight and knowledge on the factors that can affect the financial stability of banks.

The aim of this paper was to estimate the determinants of bank financial stability. The Czech Republic was chosen as the country for this purpose. The dataset consisted of 12 banks together with macroeconomic indicators, with the observation period being from 2001 to 2020 on an annual basis. The share of the selected banks in the total balance sheet of the Czech banking sector was approximately 83,55 % at the end of 2020. Furthermore, the estimation methods used for this paper and the potential determinants of bank stability were specified and selected based on theoretical knowledge and empirical literature. The main estimation method was the system GMM estimator in the two-step variant, which solves to some extent the problem of endogeneity of variables and is suitable for panel data. Using this model, it was found that variables such as the ratio of classified loans to total bank loans, bank capitalization and inflation rate had a significant impact on the financial stability of banks in the Czech banking sector.

The ratio of classified loans to total bank loans had a statistically negative effect at the 5 % significance level. Thus, an increase in this ratio indicates that the bank is exposed to a higher risk of loss, which leads to a lower stability of the bank. According to Ćurak et al. (2013), deterioration in the quality of the loan portfolio, can affect the overall performance of banks, but also threaten bank capital and lead to insolvency. Another variable that had a statistically significant positive effect on the financial stability of banks at the 1 % significance level was

capitalization, expressed as the ratio of equity to total assets of the bank. The positive effect of capitalisation on bank stability is confirmed by a number of empirical studies. For example, as reported by Thakor (2014), higher capital is associated with higher loan volumes, higher liquidity creation, higher bank value and higher probability of surviving a crisis. Author Anh (2021) finds that better capitalized banks are generally more efficient and tend to reduce risk-taking, mainly because of the bank's shareholders. The last variable that had a statistically negative effect on bank financial stability at the 5 % significance level in the applied model was the inflation rate. Authors such as Jokipii and Monnin (2013) in their paper state that during periods of rising inflation, banks may charge higher prices for financial services offered to customers. Banks can benefit from higher price margins during periods of inflation and thus increase their profitability. However, Pessarossi et al. (2020) find that higher profitability does not equal higher financial stability. Rather, according to these authors' findings, high profitability may be a predictor of banking distress, especially with a lag of 3-4 years. The finding that the inflation rate negatively affects banks' financial stability is consistent with a paper by Fouejieu (2017), who finds that an increase in the inflation rate is usually accompanied by higher inflation volatility, which increases uncertainty in the economy about future price developments and blurs expectations. Increasing inflation volatility can be seen as a sign of deteriorating economic environment and financial stability. Other variables such as bank size, credit risk and liquidity risk had a statistically insignificant effect on banks' financial stability in the estimation model.

The results of the paper could help policy regulators and supervisory authorities, because the findings proposed several issues that can be considered. In the Czech Republic, the inflation rate has significantly increased since 2022 and also the interest rate significantly increase since 2022 in Czechia. As Espinoza and Prasad (2010) argued, the weakening economic conditions with an indicator of increasing interest rates could increase nonperforming loans and hence reduce bank stability. Ghosh (2015) added that while high interest rates will cause bank margins to increase, they could also head towards bank defaults and affect bank stability. Furthermore, the non-performing loans significantly influenced the Czech banking stability.

Inflation control and price stability is very important and should remain the main objective of monetary policy, while the objective of financial stability should be taken care of by macro-prudential and micro-prudential policies. Bank managements should try to take measures to limit the growth of problem loans as they threaten the financial stability of banks. It is also important that banks hold sufficient capital, as this provides a 'cushion' to absorb losses during a crisis or other bank difficulties. An interesting avenue for future research on bank financial stability for academics or policy makers would be to find out what impact the COVID-19 pandemic had on strongly capitalised and less capitalised banks.

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