A MACROPRUDENTIAL SUPERVISION MODEL. EMPIRICAL EVIDENCE FROM THE CENTRAL AND EASTERN EUROPEAN BANKING SYSTEM

Trenca Ioan, Balogh Peter, Mutu Simona
Finance Department, Faculty of Economics and Business Administration, Babes-Bolyai University, Cluj-Napoca, Romania
ioan.trenca@econ.ubbcluj.ro
petibalogh@yahoo.com
simona.mutu@ubbcluj.ro

Abstract: *One of the positive effects of the financial crises is the increasing concern of the supervisors regarding the financial system's stability. There is a need to strengthen the links between different financial components of the financial system and the macroeconomic environment. Banking systems that have an adequate capitalization and liquidity level may face easier economic and financial shocks. The purpose of this empirical study is to identify the main determinants of the banking system's stability and soundness in the Central and Eastern Europe countries. We asses the impact of different macroeconomic variables on the quality of capital and liquidity conditions and examine the behaviour of these financial stability indicators, by analyzing a sample of 10 banking systems during 2000-2011. The availability of banking capital signals the banking system's resiliency to shocks. Capital adequacy ratio is the main indicator used to assess the banking fragility. One of the causes of the 2008-2009 financial crisis was the lack of liquidity in the banking system which led to the collapse of several banking institutions and macroeconomic imbalances. Given the importance of liquidity for the banking system, we propose several models in order to determine the macroeconomic variables that have a significant influence on the liquid reserves to total assets ratio. We found evidence that GDP growth, inflation, domestic credit to private sector, as well as the money and quasi money aggregate indicator have significant impact on the banking stability. The empirical regression confirms the high level of interdependence of the real sector with the financial-banking sector. Also, they prove the necessity for an effective macro prudential supervision at country level which enables the supervisory authorities to have an adequate control over the macro prudential indicators and to take appropriate decisions at the right time.*

1. Introduction

In the recent years, the banking sector has experienced various crises at national, regional or international level. One of the positive effects of these crises is the increasing concern of the supervisors regarding the financial system stability. The onset of a financial crisis has always been difficult to predict, but there are some signals that indicate financial vulnerabilities in the banking system. These enable policy formulation and implementation of tools for the prevention and mitigation of financial imbalances.

Schou-Zibell, Albert and Song (2010) have highlighted the need to strengthen the links between different financial components of the financial system. Excessive risk-taking combined with weak prudential supervisory framework and reckless monetary policies are considered the major roots of the financial crisis. If risks are well managed, the banking institutions can lead to prosperity, but if we consider the macro level of all banks from the system, we must take into account the overwhelming role of central banks and regulators.

The identification by supervisors of properly risk managed banks turned to be a difficult task. Prudential supervision should not be focused only on individual banks. It should have a macro prudential perspective that examines the risk distribution within the financial system in time and also the negative externalities.

The purpose of this empirical study is to identify the main determinants of the banking stability and soundness in the Central and Eastern Europe (CEE) banking systems. We asses the impact of different macroeconomic variables on the quality of capital and liquidity conditions and examine the behaviour of these financial stability indicators, by analyzing a sample of 10 banking systems during 2000-2011. The methodology is based on the empirical work of Schou-Zibell, Albert and Song (2010), which developed a supervisory framework for monitoring and examining the macro financial soundness.

This paper is organized as follows. Section 2 summarizes the literature review. Section 3 describes the data. Section 4 details the methodology. Section 5 presents the empirical findings. Finally, Sections 6 concludes.

2. Literature Review

A great amount of studies in the literature demonstrated that certain developments in macroeconomic indicators may be associated with banking crises. To name a few, the decline of GDP, excessively high real interest rates and high inflation rate may significantly increase the probability of developing a systemic banking crisis.

Shocks or negative externalities from trade imbalances can also stimulate the occurrence of banking problems. Gavin and Hausmann (1998), Morris et al. (1990), as well as a report from IMF (1993) highlight that adverse shocks in trading activity have a significant impact on the banking systems of Argentina, Chile, Colombia and Uruguay. They show that in some cases substantial decline of commercial activity precedes a banking crisis (Norway, Finland and Spain). However this claim has not been verified for Japan or Sweden. Demirguc-Kunt and Detragiache (1998) haven't found evidence of negative externalities from trade to banking stability.

The evolution of domestic credit to the private sector (as % in GDP) may be a an early warning signal of problems in the banking system. A sharp increase of the domestic credit leads to financial vulnerability especially in situations of credit quality deterioration and risks incensement. Evans et al. (2000) shows that a sharp increase in lending capacity of banks is an indication of a poor credit rating and therefore of poor credit quality. However there is a significant number of studies that found that a too optimistic credit expansion could lead to a financial crisis (Kaminsky and Reinhart, 1999; Gavin and Hausmann, 1998).

In different studies was found that the ratio of money and quasi money (M2) to total reserves (international reserves, gold and currencies under the control of monetary authorities) has a significant influence on banking sector vulnerability. Banking system problems may be related to sudden withdrawals of capital. Demirguc-Kunt and Detragiache (1998), as well as Calvo (1996) show that this indicator is a good

predictor of a country's vulnerability to balance of payments crises, which could affect the whole banking systems.


3. Data Analysis
The data is representative for ten CEE banking systems: Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia. The analysis covers the period 2000-2011. Table 1 presents the variables used. They can be grouped into the following categories: financial stability indicators, macroeconomic indicators, monetary indicators and market indices.

Table 1: Variables used in the study

| Indicator	Symbol	Type	Source
Bank capital to assets ratio (%)	CAPA	Financial Stability Indicator	WDI
Bank liquid reserves to bank assets ratio (%)	LIQU	Financial Stability Indicator	WDI
Bank nonperforming loans to total gross loans (%)	NPER	Financial Stability Indicator	WDI
Inflation, GDP deflator (annual %)	GDPD	Macroeconomic	WDI
GDP growth (annual %)	GDPG	Macroeconomic	WDI
Money and quasi money (M2) to total reserves ratio	MQM	Monetary	WDI
Domestic credit to private sector (% of GDP)	PRVT	Macroeconomic	WDI
Trade (% of GDP)	TRD	Macroeconomic	WDI
Real interest rate (%)	RINR	Market	WDI

The historical evolution of the bank capital to total assets ratio in each country is illustrated in Figure 1. During 2010-2011 the highest capitalization ratios of banks were registered in Bulgaria (from 2000 to 2004 and from 2009 to 2011) and Romania (2005-2008). The smallest capitalization ratio was recorded in the Czech Republic (from 2001 to 2011). In Bulgaria the maximum capitalization rate was reached in 2000 (15.30%). In Romania the maximum capitalization ratio was reached in 2006 when it was 12.90%. The bank capital to total assets ratio register an average rate of 8.72% over the entire period analyzed. This shows a good level of capitalization of the banking system in Eastern and Central Europe. The minimum value is recorded by Slovakia in 2000 (4.6%) and the maximum value is recorded by Bulgaria in 2000 (15.3%).
During 2005 - 2008 there is a reduction of the capital to total assets ratio, which can be explained by an increase in financial intermediation through less conventional sources. After the 2007-2008 crises, banks have started to pay attention again to capitalization. The level of this rate increased after 2008 in all countries, except Romania, where the ratio decreased from 10.70% in 2007 to 7.80% in 2011.
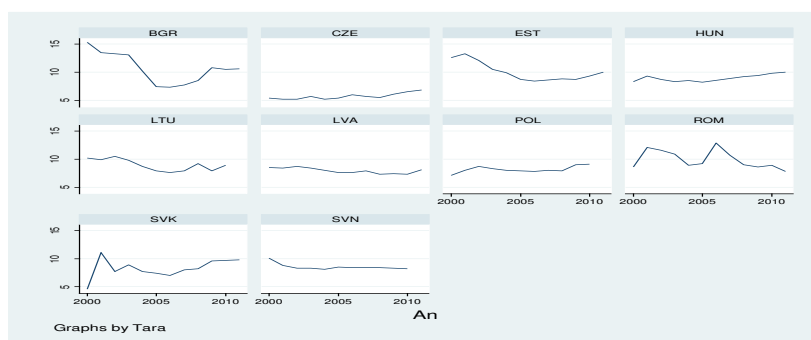
Figure 1: The evolution of bank capital to total assets ratio
Source: authors' processing

Regarding the bank liquid reserves to total assets ratio during the period 2000-2011, the highest values of these rates were recorded in Romania (in 10 of the 12 years analyzed) and the minimum values were recorded in Latvia during 2001-2005 (between 4.3% and 6.24%) and Slovenia in the period 2007-2010 (the rate lies between 1.12% and 2.32%). Over the entire period analyzed, Romania registered the highest average value of this indicator (47%), followed by Slovakia (41%).

Analyzing the annual evolution of the indicator, the maximum value of the bank liquid reserves to bank assets ratio was recorded in 2005 in Romania (77.21%) and minimum in Slovenia in 2007 (1.12%). The average value of this indicator is 18.38%. Interesting evolutions are recorded in Romania and Slovenia that register the extremes of these values. In Romania, the liquid bank reserves to total assets ratio increased from 51.49% in 2001 to 77.21% in 2005 and gradually decreased to 23.63% in 2011. In Slovenia, the liquid reserves to total assets ratio decreased from 39.68% in 2002 to 25.07% in 2005 and then fall sharply to 3.08% in 2011 (Figure 2).
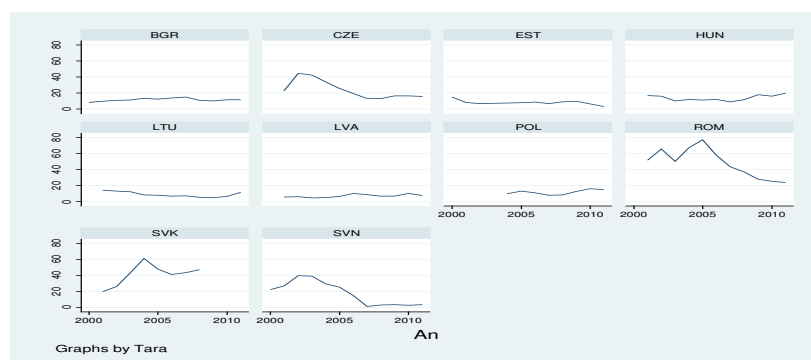
Figure 2: The evolution of the bank liquid reserves to total assets ratio
Source: authors' processing

4. Empirical Methodology

The empirical analysis regarding the impact of macroeconomic indicators on the financial stability of the banking system is made using the panel regression technique, through the least squares method. The panel regression model allows determining the macroeconomic variables that underlie movements in the financial

1136

stability of the banking system. Panel regression models are estimated for two major macro prudential indicators: the capital adequacy to total assets ration and the liquid reserves to total assets ratio.

The panel consists of 10 cross-sections corresponding to Central and Eastern European banking systems and 12 years from 2000 to 2011. To capture the specific characteristics of each analyzed banking system were introduced individual fixed effects for each cross-section. They take into account the particularities of each country's banking system that are constant over time. In order to detect the existence of fixed effects we applied the F test. Its null hypothesis states that the dummy variables associated with the sections are equal to 0 ($H_0:\mu_1=...=\mu_{n-1}=0$). The null hypothesis is rejected. Thus, the test result indicates the existence of fixed effects.

The use of fixed effects regression allows us to control for omitted macroeconomic variables that differ among countries but are constant over time. An underlying assumption in such models is that the model error does not display autocorrelation (Schou-Zibell, et al., 2010). Panel regressions are often used with fixed effects to allow the possibility of the dependent variable to interact between countries regardless of the explanatory variables included in the regression (Demirgüç-Kunt and Detragiache 1998).

In the present research, the panel regression model with fixed effects takes the following form:

$$IMacroP_{it} = \alpha_0 + \alpha_1 MacroI_{it} + \alpha_2 X_{it} + \theta_i + \varepsilon_{it} \qquad (1)$$

where $IMacroP_{it}$ represents the macro prudential indicators (the bank capital to total assets ratio and the bank liquid reserves to total assets ratio), categorized as financial stability indicators (FSI) of the i banking system at time t. α is the constant of the regression equation. $MacroI_{it}$ represents the ith country-specific macroeconomic indicators at time t, X_{it} is a set of control variables for the banking system i at time t, θ_i is the fixed effect for the banking system i and ε_{it} is the error term.

5. Empirical Results

5.1. Determinants of Capital to Total Assets Ratio

The availability of banking capital signals the banking system's resiliency to shocks. Capital adequacy ratio is the main indicator used to assess the banking fragility. In analyzing the determinants of the capital to total assets ratio we start from a basic regression that includes as explanatory variables the GDP growth, the inflation rate and the domestic credit to the private sector as percentage in GDP. In the second model we add the nonperforming loans ratio, which is expected to exert a negative influence on bank capital to total assets ratio. Finally, we account for the international trade activity of the countries analyzed in the third model, introducing it as a control variable (Table 2).

Table 2: Determinants of bank capital to assets ratio

Indic./model	Model 1	Model 2	Model 3
GDPG	-0.025 (0.031)	-0.023 (0.020)	-0.063** (0.028)
GDPD	-0.026 (0.023)	-0.004 (0.038)	-0.006 (0.032)
PRVT	-0.035** (0.014)	-0.036** (0.014)	-0.046*** (0.012)
NPER		0.023 (0.034)	0.020 (0.031)
TRD			0.028* (0.015)
constant	10.630*** (0.848)	10.407*** (0.709)	7.744*** (1.665)
N	112.000	109.000	109.000
N_g	10.000	10.000	10.000
R^2 within	0.225	0.236	0.279
R^2 overall	0.030	0.031	0.020
R^2 between	0.045	0.029	0.046

Note:
Unbalanced panel with fixed effects on cross-sections (banking systems) and correction for error robustness;
Standard errors in parentheses;
* significant at 10%; ** significant at 5%; *** significant at 1%;
N is the number of observations;
N_g number of cross-sections;
R^2 within is the coefficient of determination within a baking system during the analyzed period;
R^2 overall is the total coefficient of determination;
R^2 between is the coefficient of determination between the banking systems analyzed.
Source: authors' calculation

The determinants of the capital to total assets ratio for the analyzed banking systems are shown in the table above. Analyzing Student t statistic, we observe that several variables are significant in explaining the dependent variable. The share of the private domestic credit to GDP has a significant negative impact on the rate of bank capital to total assets in all of the three regression models. By introducing the nonperforming loans ratio in the model the intensity of the relationship between the private domestic credit in GDP ratio and the ratio of bank capital increases (Model 2). This means that an increase in bad loans, especially in the private credit sector, may possibly damage the quantity and quality of the bank capital. Thus, adding to the basic equation the nonperforming loans ratio and an increase of 1% in the domestic credit to private sector (as share in GDP), determine the capital to total assets ratio to decrease by 0.036%. Introducing in the regression model the percentage of international trade in GDP as explanatory variable, the impact of the private domestic credit ratio is higher, resulting a decrease of 0,046% of the capital to total assets ratio (Model 3).

These three regression models highlight that in countries where an important part of the credit is allocated to private domestic sector there is a greater possibility of deteriorating the quality and the quantity of bank capital. A sudden increase in the domestic credit to private sector as percentage in GDP ratio can create problems in the banking sector. This can cause financial vulnerabilities and the erosion of bank capital.

By introducing trade activity as a control variable, a rise in the GDP growth significantly influences the capital to total assets ratio in a negative manner. Thus, in the third model an increase by 1% in the GDP growth reduces the ratio of capital to total assets by 0.063%. A possible explanation for this finding is that if the GDP growth rate increases, banks use a higher proportion of their capital to finance loans and implicitly economic growth rate increases. On the other hand in case of a decreasing GDP, banks are increasing their capital in order to prevent some possible financial imbalances caused by the economic downturn.

An absolutely normal result that justifies the robustness of the regressions is revealed in the positive relationship between the capital to assets ratio and the trade activity. Thus, an increase in import and export activity of a country can improve the bank capital. On the other side, possible shocks on a country's trade activity can lead to deterioration of the bank capital. The regressions did not revealed significant influences of the nonperforming loans ratio and the inflation rate on bank capital to assets ratio.

5.2. Determinants of Bank Liquid Reserves to Total Assets Ratio

One of the 2008-2009 financial crisis causes was the lack of liquidity in the banking system which led to the collapse of several banking institutions and macroeconomic imbalances. Given the importance of liquidity for the banking system, we propose several models in order to determine the macroeconomic variables that have a significant influence on the liquid reserves to total assets ratio (Table 3). We propose this liquidity proxy as dependent variable, because it includes the most liquid reserves of banking systems such as: bank holdings in national currency and the bank deposits at central banks. The bank assets considered include claims against other governments, non-public enterprises, private sector and other banking institutions.

Table 3: Determinants of bank liquid reserves to bank assets ratio

Indicator/model	Model 1	Model 2	Model 3	Model 4
INFLATION	0.469*	0.759***	0.617***	0.682***
	(0.214)	(0.219)	(0.175)	(0.185)
GDPD	0.189	0.435*	0.118	0.106
	(0.168)	(0.193)	(0.213)	(0.266)
NPER		-0.141	-0.053	-0.303
		(0.300)	(0.333)	(0.299)
RINR		1.034**	0.640**	0.516
		(0.320)	(0.274)	(0.389)
PRVT			-0.130	-0.030
			(0.103)	(0.054)
MQM				-8.458***
				(2.481)
constant	15.127***	9.423**	19.112**	30.334***

Indicator/model	Model 1	Model 2	Model 3	Model 4
	(1.667)	(3.540)	(6.763)	(7.259)
N	107.000	98.000	98.000	94.000
N_g	10.000	10.000	10.000	10.000
R^2 within	0.078	0.132	0.178	0.264
R^2 overall	0.157	0.288	0.379	0.207
R^2 between	0.307	0.493	0.591	0.271

Note:
Unbalanced panel with fixed effects on cross-sections (banking systems) and correction for error robustness;
Standard errors in parentheses;
* significant at 10%; ** significant at 5%; *** significant at 1%;
N is the number of observations;
N_g number of cross-sections;
R^2 within is the coefficient of determination within a baking system during the analyzed period;
R^2 overall is the total coefficient of determination;
R^2 between is the coefficient of determination between the banking systems analyzed.
Source: authors' calculation

In order to identify the determinants of bank liquid reserves we start from a basic regression that includes as independent variables the inflation and GDP growth rate. Inflation is introduced as explanatory variable because it is an indicator of a vulnerable macroeconomic environment. We found a direct significant relationship between liquid reserves of the banking system and inflation. The sign of this relationship is as expected because the inflation reduces the value of bank guarantees (Evans et al., 2000). However a decrease in the inflation rate has the effect of reducing the nominal income of banks, affecting their liquidity.
In Table 3 (Model 4) it could be seen that, by including in the regression model more macroeconomic variables, the impact of inflation on liquidity ratio increases, from 0.469% to 0.682%. After introducing in the regression the ratio of nonperforming loans to total gross loans and the real interest rate, the GDP growth becomes significant (Model 2). As expected, the GDP growth rate influences in a positive manner the liquid reserves to total assets ratio.
The real interest rate has a positive significant impact on the liquidity. The sign of this relationship is as expected. Under conditions of low liquidity in the market the real interest rates increases (Stracci, 2005). Those who observe the liquidity deficit are expecting greater returns, which anyway are eroded by high intermediation costs in terms of poor liquidity. Generally, in such cases, central banks intervene by injecting liquidity to reduce the real interest rate and to improve market liquidity.
Banking systems may be vulnerable in the presence of sudden outflows of capital, especially in countries with fixed exchange regime (Demirguc-Kunt and Detragiache, 1998). To check this hypothesis in Central and Eastern European banking systems we include as explanatory variable a monetary indicator, the share of the money and quasi money aggregate indicator (M2) in total reserves. We found a strong negative relationship between the liquid reserves in total assets ratio and the M2 in total reserves ratio. A 1% increase in the money supply to total international reserves ratio determines a decrease with 8.45% of the liquid reserves to total assets ratio.

6. In Conclusion

The empirical study confirms the interdependency between the economic sector and the banking sector. Business cycle captured by GDP growth evolution has a significant influence on the capital to total assets ratio and on the liquidities to total reserves ratio. During economic booms bank capital erosion occurs due to increased bank assets during those periods, but there is an increase of bank liquid reserves. On the other hand, higher inflation increases bank reserve liquid. Bank capital to total assets ratio is negatively influenced by the evolution of the domestic credit to the private sector (as percentage in GDP) and positively influenced by the development of a country's international trade activity. However, an increase of the real interest rate determines the liquid reserves to total assets ratio to increase. Also, the increasing of the share of the monetary aggregate M2 in the total international reserves determines the significant decreasing of the liquid reserves to total assets ratio. Even if in Romania were registered good levels of capital adequacy and bank liquidity indicators, we consider that high attention is needed in the administration of the bank capital and liquidity, because of the high fluctuations observed in our analysis. As a final conclusion, we consider that there is a real need for an effective macro prudential supervision at country level which enables the supervisory authorities to have an adequate control of macro prudential indicators depending on the macroeconomic evolutions and to take appropriate decisions, at the right time, on the appropriate macro prudential policy in order to avoid financial crises.

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