Banks' Risk Preferences and Their Impact on the Loan Supply Function: Empirical Investigation for the Case of the Republic of Macedonia

RESEARCH PAPER

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Abstract

This paper empirically investigates the existence of a bank lending channel and its determinants in the Republic of Macedonia. The results suggest that there is robust statistical evidence in favour of the existence of a bank lending channel. The most influential bank-specific characteristic is the non-performing loans (NPL) ratio which might be a proxy for banks' risk preferences. This would imply that banks' risk preferences are among the most influential factors in determining banks' lending activities. However, an alternative interpretation of the NPL ratio suggests that it might serve as an indicator of the *ex-post* quality of the loan portfolio and, hence, may indicate an increase in banks' external financing premium. Regarding the rest of the bank-specific characteristics, empirical results show that bank liquidity has the opposite sign from what the theory suggests, while there is no strong evidence that bank capital has impact on the loan supply function as the results are sensitive to different estimation methods and the number of instruments created. Regarding the asset size, the results do not imply any statistically significant impact.

Keywords: bank lending channel, monetary policy, system GMM, non-performing loans
JEL classification: C23, E50

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1 Introduction[1]

This paper aims to empirically investigate the existence of a bank lending channel and its determinants in the case of Macedonia. More precisely, it examines how the bank lending channel operates and how bank-specific characteristics affect the loan supply function. According to the empirical literature that examines the determinants of bank lending channels, the most influential bank financial characteristics include asset size, level of liquidity and capitalisation ratio. Therefore, this paper investigates banks' loan reaction to changes in the reference interest rate, with regard to these three characteristics. Additionally, the model is augmented by another bank-specific characteristic, i.e. the ratio of non-performing loans (NPL) to total loans as a proxy for banks' risk preferences. However, an alternative explanation for the NPL variable is that it may serve as an indicator of the *ex-post* quality of the loan portfolio and may indicate an increase in the external financing premium of the banks.

The main intention of this analysis is to explore whether domestic monetary policy is effective and whether the monetary authorities can, to some degree, conduct an independent monetary policy bearing in mind the specific characteristics of the Macedonian economy and its banking system. Namely, the National Bank of the Republic of Macedonia (NBRM) conducts a strategy of a *de facto* fixed exchange rate regime where the domestic currency is pegged to the euro. One of the reasons for pegging the exchange rate to the euro is the relatively high trade openness of the Macedonian economy where the European Monetary Union (EMU) members are the major trading partners. Regarding the banking system, the banking capital is to a great extent foreign-owned, accompanied by a relatively high share of foreign currency substitution. Moreover, the banking

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system is to some extent dependent on foreign non-deposit funding and has been characterised, since 2000, by structural excess liquidity. Thus, all of these specific characteristics of the Macedonian banking system as well as the manner in which the monetary policy is conducted may raise the question of whether the domestic monetary policy may have any significant impact on banks' lending decisions. Consequently, we investigate whether the banks react to changes in the domestic policy stance by adjusting the quantity of loan supply.

The results indicate that banks in Macedonia significantly react to changes in the domestic reference rate by adjusting the quantity of loan supply. This may imply that due to the still not fully liberalised capital account, there is some room for conducting an independent monetary policy and that changes in the monetary policy stance may affect the quantity of loan supply. Regarding the banks' specific characteristics, the NPL ratio is estimated to be the most influential determinant. It might be a proxy for banks' risk preferences, or it may indicate the changes in banks' external financing premium and banks' reduced access to non-deposit funding. Moreover, the results point to the fact that liquidity is another significant determinant of the heterogeneous loan supply function, but its sign is contrary to the theoretical expectations, which may be due to the structural excess liquidity of the banking system. Regarding the bank capital, there is some empirical evidence that it may affect the heterogeneous loan supply function, but the results have to be taken with caution as their significance depends on the estimation method and the number of instruments selected.

This paper adds to the existing empirical literature in three ways: *first*, it is the first analysis of the bank lending channel in Macedonia. *Second*, it uses a different estimation method, the "system" generalised method of moments (GMM), compared to empirical studies for other countries that commonly use "difference" GMM; and *third*, unlike most studies, it augments the model by adding an additional bank-specific characteristic to the model, i.e. the ratio of NPL to total outstanding loans.

This paper is organised as follows: Section 2 presents stylised facts about the monetary developments and the structure of the Macedonian banking sector. Section 3 surveys the existing theoretical and empirical literature. Section 4 explains the model in detail while Section 5 describes the data. The empirical results and their interpretation are presented in Section 6, whereas a summary of the findings is presented in the final section.

2 Stylised Facts about the Monetary Developments and the Banking System in Macedonia

Since gaining its monetary independence in 1992, the National Bank of the Republic of Macedonia has changed its monetary policy regime once. Namely, in the initial period of transition until the end of 1995, the monetary policy regime was oriented towards money supply targeting. However, this monetary strategy (among other factors) coincided with unsatisfactory macroeconomic performance arising from unsuccessful price stabilisation, negative GDP growth, relatively high fluctuations of the nominal exchange rate and a relatively low level of foreign reserves (see Table 1). Consequently, due to the instability of the money demand function, high openness of the Macedonian economy and unfavourable monetary and macroeconomic performance, monetary authorities switched the policy regime at the end of 1995 towards a fixed exchange rate by pegging the domestic currency to the German mark and later to the euro. This new policy regime is considered to have changed the monetary policy and affected the macroeconomic performance of the economy. For example, as shown in Table 1, the price level has been relatively stable ever since; GDP growth has been positive (except in 2001) while foreign reserves have increased substantially.

During the period of a *de facto* fixed exchange rate regime, the NBRM has changed the main monetary policy instrument once, at the beginning of 2000, due to a shift in the specific characteristics of the banking system. More precisely, since the exchange rate was pegged to the German mark – from the end of 1995 to the end of 1999 – the banking system was characterised by deficient liquid assets. Consequently, the NBRM

had to maintain the stability of the nominal exchange rate by injecting liquid assets to the banking system, prompting auctions of bank credits to become the major monetary policy instrument. However, since 2000, the liquidity of the Macedonian banking system has gradually improved and has become characterised by structural excess liquidity. Thus, since 2000 the NBRM has had to intervene in the direction of withdrawing the liquidity from the banking system. Consequently, auctions of Central Bank (CB) bills have become the main monetary policy instrument and the CB bills rate has become the key policy rate. This way, the NBRM can partially conduct an independent monetary policy by setting the CB bills rate independently regardless of the changes in the foreign reference rate (the three-month EURIBOR rate), due to the still not fully liberalised capital account. This provides some room for the domestic monetary policy authorities in fulfilling their monetary policy aims.

Table 1 **Macroeconomic Indicators**

	Average annual inflation*	GDP (real growth rates)	Unemployment rate (in %)	Average exchange rate MKD/ DEM; from 2002 MKD/ EUR	Gross foreign reserves (millions of US dollars, stock - end of period)	Trade openness in % ((Exports f.o.b. + Imports f.o.b.) / GDP)
1993	349.8	-7.5	27.7	14.2	123.2	82.4
1994	121.8	-1.8	30.0	26.6	172.4	69.6
1995	15.9	-1.1	35.6	26.5	282.9	59.0
1996	3.0	1.2	31.9	26.6	277.5	59.1
1997	4.4	1.4	36.0	28.7	258.7	76.6
1998	0.8	3.4	34.5	31.0	323.9	86.5
1999	-1.1	4.3	32.4	31.0	449.9	78.3
2000	5.8	4.5	32.2	31.1	699.5	92.5
2001	5.5	-4.5	30.9	31.1	755.6	82.6
2002	1.8	0.9	31.9	61.0	725.3	80.4
2003	1.2	2.8	36.7	61.3	903.4	77.2
2004	-0.4	4.1	37.2	61.3	975.3	83.6
2005	0.5	4.1	37.3	61.3	1324.7	88.5
2006	3.2	4.0	36.0	61.2	1865.8	95.5
2007	2.3	5.9	34.9	61.2	2239.6	106.3

*Notes: * Up to 1999, the retail price index was used as official indicator for inflation, while since 2000 till present, the consumer price index is used.*
Source: NBRM (www.nbrm.gov.mk).

The Macedonian financial system is, as in other transition economies, bank-dominated. For example, bank assets comprised 91 percent of total financial assets in 2007 (NBRM, 2007b: 51). The development of the banking sector in the last ten years has been reflected in the continual growth of aggregate bank assets (see Figure 1). The largest portion of bank assets is constituted of outstanding loans to the non-financial private sector (49 percent of total bank assets in 2007[2]).

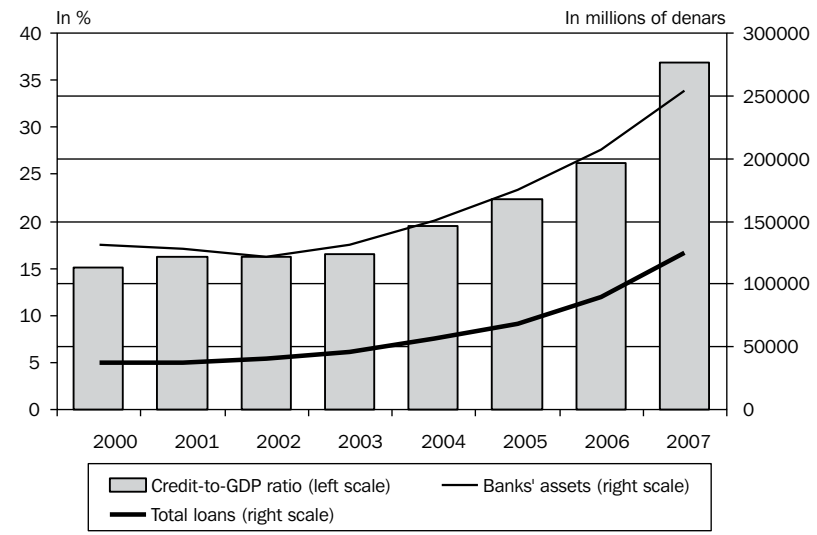
It is worth mentioning that foreign ownership in the total banking capital has been growing. For example, the share of foreign ownership in the total banking capital increased from 40 percent in 2000 to 69 percent in 2007 (NBRM, 2000; 2007a).

An additional characteristic of the Macedonian banking system is its structural excess liquidity since 2000. This characteristic has affected the way the monetary policy is conducted. Another specificity of the banking system is its dependence on foreign financing. For instance, the share of foreign liabilities in total bank liabilities has ranged between 8.5 percent in 2004 and 10.3 percent in 2007 (NBRM, 2009: 13). In addition, despite the declining trend of the Hirschman-Herfindahl index during recent years, the Macedonian banking system can still be considered highly concentrated. For instance, the three largest banks accounted for 67 percent of total bank assets in 2007.

As to the developments on the loan market, it should be mentioned that the stock of outstanding loans to the non-financial private sector in Macedonia has been increasing continually over the past ten years (see Figure 1), with an average annual growth rate during the period 2000-2007 of 19 percent. Annual growth rates in 2006 and 2007 amounted to 31 and 39 percent respectively, indicating an increasing level of financial intermediation. This is also apparent from the constant increase of the credit-to-GDP ratio as a proxy for the level of financial intermediation (see Figure 1).

[2] *Author's estimate based on NBRM data.*

Figure 1 **Bank Assets, Total Outstanding Loans to Non-financial Private Sector and Credit-to-GDP Ratio**



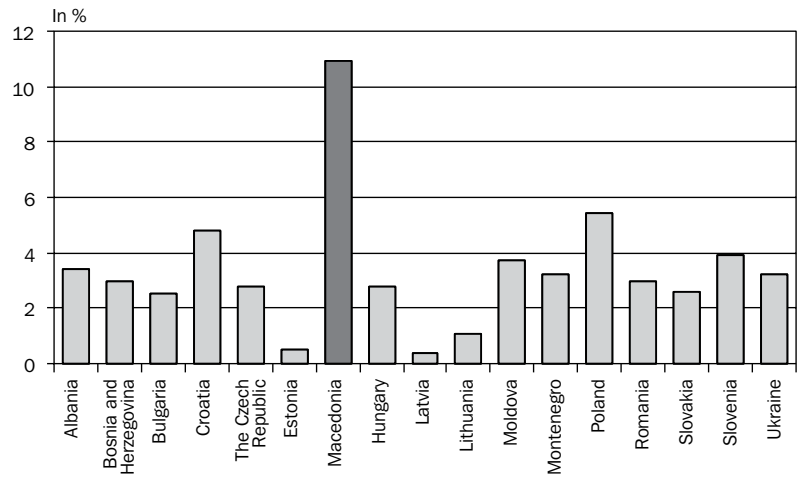
Source: NBRM (2007a).

Regarding the total outstanding loans, one of the most important characteristics is the relatively high proportion of NPL, which accounted for approximately 30 percent of total loans in the period 2000-2007. Compared to other Central and South-Eastern Europe (CSEE) economies, the NPL ratio in Macedonia was the highest in 2007 (see Figure 2), despite its declining trend. Namely, it declined from 46.5 percent in 2000 to 10.9 percent in 2007.[3]

In analysing the dynamics of the key policy rate (CB bills rate) during the period 2000-2007, a declining trend can be observed (see Figure 3). CB bills rate declined from around 10 percent at the beginning of 2000 to around 5 percent at the end of 2007. During the analysed period, it sharply increased in 2001, reaching a peak of almost 18 percent in September 2001, the main reason being the armed conflict in the country and related military expenditures that substantially increased liquidity.

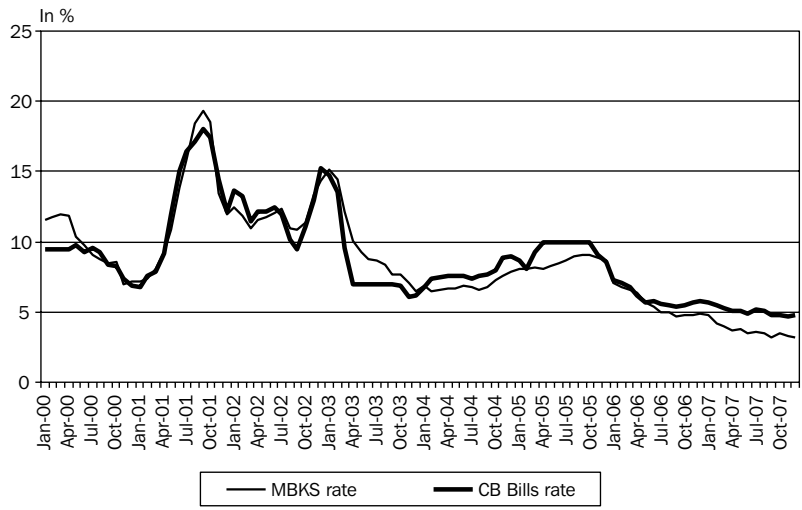
[3] *Author's estimate based on EBRD (2008).*

Figure 2 **Non-performing Loans Ratio, 2007**[4]



Source: EBRD (2008).

Figure 3 **CB Bills and MBKS Rates**



Source: NBRM (www.nbrm.gov.mk).

[4] The data regarding the NPL may differ from economy to economy, depending on the various specific accounting methodologies applied in each economy.

Consequently, in order to maintain a fixed nominal exchange rate, the NBRM had to intervene in the money market by withdrawing liquidity from the banking system through auctions of CB bills and by raising the interest rate (NBRM, 2001). After the end of the armed conflict, with the political and economic stabilisation of the country, and a reduction in the liquidity of the banking system, the CB bills rate in 2002 started to decline. Nevertheless, at the end of 2002 the NBRM had to raise the CB bills rate again to a level of 15 percent in order to neutralise the increased liquidity of the banking system and to reduce the depreciation pressures of the Macedonian denar that were caused by the large fiscal expenditures in the last quarter of 2002 (NBRM, 2002). From 2003 onwards the key policy rate has been decreasing

The dynamics of the money market rate (the average weighted interbank interest rate, i.e. MBKS), as shown in Figure 3, have been similar to the movements in the key policy rate, indicating that there is a relatively close relation between the two rates. This is confirmed by the estimated correlation coefficient for the period 2000-2007 which was around 95 percent. In general, similarly to the CB bills rate, the MBKS was falling continually over the analysed period. The MBKS declined from nearly 12 percent at the beginning of 2000 to nearly 3 percent at the end of 2007, reaching the highest peaks in September 2001 and January 2003 of nearly 19 percent and 15 percent respectively, as a result of the sharp increase in the key policy rate.

3 Literature Review

The theoretical background of the bank lending channel was developed by Bernanke and Blinder (1988a; 1988b)[5] who modified the traditional IS-LM model by relaxing some of its basic assumptions. Their starting point is that although the traditional IS-LM model can explain the money and interest rate channel of monetary transmission quite well, one of its main pitfalls

[5] *There had been earlier attempts in the literature to tackle the issue of the existence of a bank lending channel, but formally the first model that depicts the lending channel is that of Bernanke and Blinder (1988a; 1988b).*

is that it analyses the influence of various shocks in the economy only through the money function, giving a negligible role to the other financial instruments, i.e. loans and bonds. More precisely, the IS-LM model treats bank assets and liabilities asymmetrically, by assigning a special role to money as a bank liability in determining aggregate demand. On the other hand, it treats loans and bonds as perfect substitutes and both markets are suppressed by Walras's Law.

The main innovations of the Bernanke and Blinder model include the abandonment of the assumptions that loans and bonds are perfect substitutes and that financial markets clear only through price. They argue that loans should have different treatment in the economy than other financial instruments as they are provided by intermediary institutions, which are specialised in screening and monitoring borrowers in the presence of asymmetric information. These institutions can have an important impact on the monetary transmission mechanism in the economy where market clearance can be achieved not only by changes in the interest rates, but also by the quantity of loans supplied, i.e. credit rationing.

Bernanke and Blinder (1988a; 1988b) amend the IS-LM model by substituting the IS curve with the so-called credit-commodity curve (CC). The main difference from the IS-LM model is that now changes in the reference interest rate do not only affect the LM curve, but also the CC curve through the quantity of loan supply that may ultimately make monetary policy more effective. The main logic behind the CC-LM model is that monetary policy tightening reduces banks' deposit base. Consequently, banks adjust their balance sheets by cutting the quantity of loan supply. In other words, monetary policy tightening should ultimately result in the reduction of loan supply by banks mainly due to the reduction of their deposit base.

However, a new strand of literature has attempted to "reformulate" the main factors that drive the bank lending channel. For example, Disyatat (2010) offers an alternative model and argues that in economies with developed financial markets where banks are to a great extent dependent on non-deposit borrowing from the financial market, changes in the quantity of

loan supply are not driven by the changes in the deposit base but by changes in their balance sheet strength as well as changes in the external finance premium. The logic behind this explanation is that in the case when banks are dependent on non-deposit funding, an increase of the policy rate may lead to an increased external finance premium for banks' non-deposit funding. The explanation for the latter is that the financial institutions that provide non-deposit funds to the banks may perceive that banks are faced with higher risk of borrowers' default which may deteriorate their balance sheet strength. Consequently, the banks may pass the costs of the increased external finance premium to their borrowers by increasing the lending rates, which will discourage the borrowers from taking new loans. This will result in lower quantity of newly issued loans. However, even if the borrowers are eager to borrow at higher lending rates, the banks may refrain from granting new loans due to the increased asymmetric information on the loan market and, hence, the increased riskiness of borrowers' default. Although the model proposed by Disyatat (2010) offers an alternative way of interpreting the bank lending channel, it has some weaknesses. For example, the model is based on the assumption of developed financial markets and financial institutions that may not be relevant for the majority of transition and developing economies where banks still heavily rely on deposit funding. Moreover, the model is based on the assumption that "banks are risk neutral and operate in a competitive market" (Disyatat, 2010: 11). This assumption may not hold even in the case of developed economies because, as Rousseas (1985) and Ho and Saunders (1981) argue, banks actually operate in a non-perfect competitive loan market. Additionally, Disyatat's model has not been empirically tested.

Kashyap and Stein (1995) undertook one of the first empirical studies that explore the existence of the bank lending channel in the US. They examine banks' heterogeneous loan supply function, in relation to their asset size. Their results indicate a significant heterogeneous reaction of banks' loan supply function to changes in the reference interest rate depending on asset size, implying the existence of a bank lending channel. Moreover, Kashyap and Stein (2000) and Kishan and Opiela (2000 and 2006) examine the bank lending channel in the US by considering two more financial

characteristics: liquidity and capitalisation ratios. The results imply that not only size, but also liquidity and capitalisation ratios have a significant effect on the loan supply function.

In respect to the euro area (EMU), several studies analysing the bank lending channel have been conducted. The research undertaken by Ehrmann et al. (2001) and Altunbas, Fazylov and Molyneux (2002) point to the existence of a bank lending channel. Namely, banks in the EMU react significantly to changes in monetary policy by changing the quantity of loan supply. Regarding banks' heterogeneous loan supply reaction function in the EMU, depending on banks' financial characteristics such as level of liquidity, size and capitalisation, Ehrmann et al. (2001) argue that only the size of the banks matters. Regarding liquidity, it has the opposite sign from what was expected, while capitalisation does not have any significant impact. Somewhat different findings are presented in Altunbas, Fazylov and Molyneux (2002). The estimated results indicate that only the level of capitalisation has a significant influence over the lending decisions of banks in the EMU.

One of the first analyses that attempt to explore the functioning of the bank lending channel jointly for the eight new EU member states from CSEE is by Schmitz (2004). The results indicate that the bank lending channel is operational mainly through changes in the 3-month EURIBOR rate, but not through changes in the respective domestic reference interest rates. Related to the banks' specific characteristics (size, liquidity, capitalisation and ownership structure), only the ownership structure turned out to be a significant determinant of the loan supply function, implying that foreign-owned banks are more sensitive in adjusting the quantity of loan supply to changes in the EURIBOR rate than domestic banks.

In a similar vein, Matousek and Sarantis (2009) explore the bank lending channel for the same group of transition economies on an individual basis. The results indicate that, apart from Slovenia and partially Poland, changes in domestic reference interest rates do not have any significant impact on the loan supply function, consistent with Schmitz's (2004) findings. Related

to the bank-specific characteristics, size and liquidity indicators were the most influential factors over the loan supply function in most of the sample economies, which is contrary to Schmitz's findings.

Kohler, Hommel and Grote (2006) investigate the bank lending channel jointly for three Baltic states. Accordingly, by taking the EURIBOR rate as a reference rate and controlling for foreign ownership, the results show that the lending channel works through the changes in the EURIBOR rate, consistent with the findings of Schmitz (2004). The main determinants of banks' loan supply function turn out to be liquidity, capitalisation and ownership structure, while bank size remains insignificant.

There are several studies that analyse the bank lending channel at individual country level. Empirical evidence is mixed for Poland. For example, Wrobel and Pawlowska (2002), Havrylchyk and Jurzyk (2005) and Chmielewski (2006) find that the bank lending channel operates in Poland through changes in the domestic reference interest rate, which is in contrast to Schmitz (2004) and Matousek and Sarantis (2009). Regarding the bank-specific characteristics, all three studies provide evidence that liquidity has a significant impact on the bank lending channel, but with the opposite sign from what is predicted by theory, which authors explain by the structural excess liquidity of the Polish banking system (for more details, see Section 4). Related to the other bank-specific characteristics, the results of Wrobel and Pawlowska (2002) imply that size and capitalisation ratio have a significant impact on the banks' heterogeneous loan supply function as well. In contrast, the estimates of Havrylchyk and Jurzyk (2005) indicate that the most important determinant of banks' loan supply decisions is the ownership structure, but not the size and capitalisation. Additionally, Chmielewski (2006) argues that the NPL ratio is the major determinant of banks' loan supply function.

In the Czech Republic, Pruteanu-Podpiera (2007) investigates the bank lending channel for two subperiods, 1996-1998 and 1999-2001. The results show a significant reaction of the banks' loan supply function to changes in the domestic reference interest rate for the two subperiods, the reaction

being stronger for the second subperiod. Analysing the role of banks' specific characteristics, liquidity and capitalisation are found to be the major determinants of banks' heterogeneous reaction function in the first subperiod, but not in the second. Size, foreign ownership and NPL ratio had a significant impact on the banks' loan supply function but with contrary signs from what is expected, for which the author has not provided any explanation.

In the case of Hungary, Horvath, Kretko and Naszodi (2006) determine the existence of the bank lending channel through the domestic reference interest rate and not through the EURIBOR rate, which is contrary to the findings of Schmitz (2004). The most significant determinants of banks' heterogeneous loan supply function are foreign ownership, size and capitalisation ratios. Liquidity has an insignificant impact, which can be explained by the structural excess liquidity of the banking system.

In Estonia, the analysis conducted by Juks (2004) provides little evidence in favour of the existence of the bank lending channel. The author investigates the responses of bank loans to changes in the reference interest rate (the EURIBOR rate is taken as a reference interest rate due to the currency board regime). The estimates suggest that changes in the EURIBOR rate do not have any significant influence over the banks' loan supply function, suggesting the absence of an operational bank lending channel. The author argues that this result is related to many non-monetary and non-economic factors associated with the transition process.

Golodniuk (2006) has determined the existence of a bank lending channel in Ukraine. Regarding banks' financial characteristics, the capitalisation ratio is found to be a major determinant of the heterogeneous loan supply function. Nevertheless, the impact of capitalisation on the loan supply function is sensitive to the way it is measured.

The major weakness of the majority of above mentioned studies arises from the applied estimation technique, given the endogenous nature of the model. The majority of these studies deal with this problem by using a dynamic

panel estimated with difference GMM. This estimation technique used to be perceived as most appropriate in dealing with the endogenous problem of the model. However, following the rapid development of techniques used in dynamic panel analysis in recent years (Arellano and Bover, 1995; Blundell and Bond, 1998; Roodman, 2006), system GMM may be more appropriate in the presence of the unit root process. The major advantage of using system GMM over difference GMM, when estimating a model with non-stationary data, is that it is more efficient and provides better properties.

4 The Model and Estimation Method

In examining the bank lending channel and its determinants in the case of Macedonia, variations in banks' outstanding loans to changes in the reference interest rate will be investigated. The rationale for this, according to the Bernanke-Blinder model, is that a restrictive monetary policy (an increase in the reference interest rate) will reduce banks' deposit base. Consequently, this will affect banks' loan supply because banks cannot completely offset the reduction in deposits with other sources of finance; either it may be too costly for them to raise uninsured funds or they have restricted access to non-deposit funding.

Regarding the estimation technique, a dynamic panel model estimated in levels will be used. The reason for using a dynamic panel model lies in the fact that the theoretical model by Bernanke and Blinder is designed as a stock adjustment model that uses the stock of loans as the dependent variable. Therefore, it is expected that the stock of loans is dependent on its own past values due to the inertia in the adjustment process caused largely by the presence of long-term loans. The dynamic panel model is estimated with system GMM. The main caveat of this method is that it may provide biased estimates due to the large number of instruments created. In order to diminish the problem, the number of instruments per period is reduced by restricting and collapsing the instrument set(s) (Roodman, 2008).

The basic model used in this analysis is based on augmented model specification by Ehrmann et al. (2001). The stock of loans is regressed on its own lagged value(s), on the reference interest rate, real GDP, consumer price index (CPI), normalised values of each of the bank-specific characteristics and their interaction terms with the reference interest rate. The bank-specific characteristics are liquidity, size, capitalisation ratio, foreign ownership dummy variable and the ratio of non-performing loans to total loans.

The general (unrestricted) model has the following specification:

$$\log(\text{Loans}_{it}) = \beta_0 + \sum_{j=1}^{l}\beta_1\log(\text{Loans}_{it-1}) + \sum_{j=0}^{l}\beta_2\text{MPI}_t + \sum_{j=0}^{l}\beta_3\log(\text{GDP}_t) + \sum_{j=0}^{l}\beta_4\log\text{CPI}_t + \sum_{j=0}^{l}\beta_5\text{X}_{it} + \sum_{j=0}^{l}\beta_6\text{X}_{it}\text{MPI}_t + \sum_{j=0}^{l}\beta_7\text{ForOwnDum}_{it} + \sum_{j=0}^{l}\beta_8\text{MPI}_t\text{ForOwnDum}_{it} + \sum_{j=0}^{l}\beta_9\text{MPI}_t(\text{NPL}_{it}/\text{Loans}_{it}) + \varepsilon_{it} \quad (1)$$

where:

- β_0 is the intercept term;
- *Loans* is banks' outstanding loans;
- *MPI* is the reference interest rate (the money market rate);
- *GDP* is the real gross domestic product;
- *CPI* is the consumer price index;
- *X* refers to each bank-specific characteristic such as liquidity, size and capitalisation ratio;
- $X_{it}MPI_t$ is the interaction term between each bank-specific characteristic and the reference interest rate;
- $ForOwnDum_{it}$ and $MPI_tForOwnDum_{it}$ are foreign ownership dummy variable and the interaction term with the reference interest rate, respectively;
- $MPI_t(NPL_{it}/Loans_{it})$ is the interaction term between the NPL ratio and the reference interest rate;
- ε_{it} is the error term composed of v_i (group-specific time-invariant unobservable bank-specific effects) plus u_{it} (errors);

- i and t refer to the bank- and time-specific subscripts;
- l indicates the number of lags used of each variable;
- β_1, β_2, β_3, β_4, β_5, β_6, β_7, β_8 and β_9 are parameters to be estimated.

The parameters of greatest interest are β_2, β_6 and β_9. Their statistical significance and the expected sign (as explained later in this section) are indications of the existence of the bank lending channel and the heterogeneous bank reaction to changes in the reference interest rate. More specifically, parameter β_2 indicates whether bank loans are responsive to changes in the reference interest rate, while parameters β_6 and β_9 estimate whether banks' loan supply function differs among banks, depending on their specific characteristics. The Bernanke-Blinder model assumes that inflation and inflationary expectations are constant. However, in the empirical studies this assumption cannot be made and, therefore, we include in our empirical model all variables, except GDP, in nominal terms in order to make the empirical model as close as possible to the theoretical one. The argument for including GDP in real terms is that we are interested in examining how the aggregate demand (GDP) affects the credit growth. If we included nominal GDP, we could not determine whether changes in credit growth are caused by real output changes or by inflation.

The reasons for using lagged dependent variable have been discussed earlier in this section. The sign of the parameter is expected to be positive.

The reference interest rate is included to indicate whether there is a direct response of loans to changes in the reference interest rate. The expected sign is negative. The representative reference interest rate refers here to the money market rate (MBKS), which is consistent with Worms (2001), Ehrmann et al. (2001), Topi and Vilmunen (2001) and Havrylchyk and Jurzyk (2005). One of the reasons for choosing the MBKS rate instead of the CB bills rate is because the MBKS rate may serve as a proxy for the "cost of funds" rate, i.e. rate for financing banks' lending activities. In contrast, the CB bills rate serves more as a rate of alternative investment for the banks because it represents the price of the CB bills. Namely, due to the *de facto* fixed exchange rate regime, the major monetary policy instrument

conducted by the NBRM are auctions of CB bills through which the NBRM regulates the liquidity of the Macedonian banking system. Thus, the commercial banks may decide to invest in CB bills only if they have excess liquid assets, unlike the MBKS rate that represents the "costs" of their lending activities.

We have also considered including the 3-month EURIBOR rate as a reference interest rate in the model, as done in other studies for CSEE. The argument for using the EURIBOR rate is that, due to the high foreign ownership of the banking capital in Macedonia and relatively high proportion of foreign currency and foreign currency indexed loans to total loans, it is expected that foreign-owned banks may react more strongly to changes in the EURIBOR rate than to changes in the domestic reference interest rate.[6] However, since the capital account is still not fully liberalised in Macedonia, we do not expect the EURIBOR rate to have any significant impact on the loan supply function and, therefore, we do not use it in the empirical model.

The reasons for including GDP and CPI in the model are to control for the demand side effects and the business cycle in the economy. Namely, higher price level and GDP are expected to positively influence loans. However, it is not clear in the literature whether they should be taken as exogenous or endogenous in the model. Some studies assume that they are exogenous, while others assume that they may be endogenous. We assume that they are endogenous because in the framework of the Bernanke-Blinder model, changes in loans may affect the overall economic activity. For instance, a higher level of loans may result in higher aggregate demand through higher investment and/or personal consumption which may induce higher output and *vice versa*. This may also create a demand pressure that may affect the price level. The estimated sign and size of these two variables should be taken with caution. Namely, CPI and GDP are macroeconomic control variables for the loan demand side, under the assumption of homogenous elasticity of loan demand among the borrowers. This assumption has been criticised in the literature because it may capture factors that are not

[6] *We consider the EURIBOR rate to be a reference foreign rate as the majority of the foreign-owned banks in Macedonia are from the EMU economies.*

included in the model. For example, GDP and CPI may capture some other non-economic factors that influence the loan demand. Particularly in the case of Macedonia, the loan demand may also be affected by the transition process which was characterised by chained banking failure in the initial period of transition, with another chained failure of saving houses in the later period. The loan demand may also be affected by political instability in the region, i.e. NATO intervention in Serbia and Kosovo in 1998 and the armed conflict in Macedonia in 2001.

The three bank-specific characteristics (liquidity, size and capitalisation) and their interaction terms with the reference interest rate are added as proxy variables for the informational frictions that banks face in the financial market. The rationale for considering the liquidity variable is that, according to Kashyap and Stein (2000), in periods of restrictive monetary policy when banks face a withdrawal of deposits, those banks with more liquid assets can more easily offset the withdrawal of deposits. The sign of this variable and its interaction term with the reference interest rate, according to the theory, is expected to be positive, but in the case of Macedonia where banks have structural excess liquidity, it cannot be *a priori* determined. As already mentioned, in Poland (Wrobel and Pawlowska, 2002; Havrylchyk and Jurzyk, 2005; Chmielewski, 2006; Matousek and Sarantis, 2009) and in Baltic states (Kohler, Hommel and Grote, 2006), where banking systems also have structural excess liquidity, the estimated sign of liquidity and/or the interaction term between liquidity and reference interest rate is found to be negative. A possible explanation for this, according to Wrobel and Pawlowska (2002), is that in Poland liquidity may not be the best distinguishing financial characteristic among banks. Namely, when the banking system is characterised by surplus liquidity, it is difficult to distinguish between the heterogeneous loan supply reaction function of benchmark banks that have a below-average level of liquid assets and those banks that have an above-average level of liquid assets. Namely, in the case of persistent liquidity, almost all banks keep a higher level of liquid assets than is needed. A different explanation is suggested by Chmielewski (2006) who argues that banks that have accumulated a large amount of securities (liquid assets) and have not hedged against the interest rate risk, find that

their opportunity costs increase when monetary policy tightens. Therefore, those banks reduce the quantity of loan supply proportionately more than less liquid ones.

Kohler, Hommel and Grote (2006) argue that a negative sign of the estimated coefficient with liquidity variable reflects the large accumulation of non-performing loans in some banks, due to the informational asymmetry on the loan market. Consequently, these banks intentionally build up a higher buffer of liquid assets in order to hedge against borrowers' default in case of deposit withdrawal. For these reasons, these banks are more vigilant about their lending activities and they actually cut the loan supply proportionately more when monetary policy tightens, due to worsening of the informational frictions on the loan market.

The explanation for using the asset size and capitalisation ratio is that banks with a higher asset size and/or more capitalised banks have greater access to, and can more easily raise, non-deposit funds in order to offset the withdrawal of deposits in periods of monetary policy tightening. More precisely, bigger and/or more capitalised banks in the case of withdrawal of deposits can issue time deposits or can more easily borrow from other financial institutions compared to the smaller and/or less capitalised ones, because they are seen as less risky for investors. This directly affects their risk premium and, consequently, the non-deposit sources of funding become cheaper for them compared to the smaller and/or less capitalised banks (Kashyap and Stein, 1995; Kishan and Opiela, 2000). Therefore, the sign of these two variables and the signs of their interaction terms with the reference interest rate are also expected to be positive. In our model we follow the conventional empirical approach in treating these three variables (liquidity, size and capitalisation) as endogenous.

The rationale for adding the interaction term between the ratio of NPL to total loans and the monetary reference interest rate is that it may indicate banks' attitudes towards risk. When a bank has a certain proportion of NPL in its asset portfolio, it usually compensates for the risk of default of its borrowers with a higher mark-up margin between the yield of the risk-free

portfolio (risk-free rate) and the current lending rate (Chmielewski, 2006). However, when the monetary policy tightens (an increase in the reference interest rate), the risk-free rate increases as well. On the other hand, the bank cannot fully increase its lending rates in order to restore the previous mark-up margins, for the reason that some of the loan contracts have fixed lending rates that make them sticky. Another reason why a bank cannot fully raise its lending rates is because in periods of monetary tightening informational frictions on the loan market worsen and, therefore, raising the lending rates in the same proportion will attract even riskier borrowers due to adverse selection and moral hazard problems (Stiglitz and Weiss, 1981). Thus, all of the aforementioned factors will result in a reduction of the current mark-up margin that ultimately increases the risk of a bank default (failure).

The management and/or shareholders of the bank, in order to restore the previous level of risk present in the asset structure (the asset risk), under the assumption that their risk preferences are constant, have three options: a) to reallocate the bank's own funds, i.e. the reserve fund, in order to compensate for the potential default of borrowers; b) to get additional non-deposit funding and/or to raise additional capital and c) to change the asset structure by reducing the newly issued loans. The first option does not give much room for manoeuvre because of the binding legal capital requirements. Banks usually keep the level of capital (own funds) equal or slightly above the regulatory capital requirements in order to maximise the rate of return. The second option is not desirable for the bank management because in such conditions, bank costs will be higher due to the high risk premium that the bank has to offer to the potential investors. There are two reasons for this: *first*, the risk premium is directly affected by the higher risk-free rate and *second*, the bank is now perceived as riskier for potential investors due to the presence of NPL and increased borrowers' default that puts additional pressure on the risk premium. Moreover, the alternative of raising additional capital may also not be feasible in the short run because, as argued by Bolton and Freixas (2006), it takes time for the legal procedures to be fulfilled. This also seems to be relevant for the case of Macedonia. In order to restore the previous level of risk, banks will generally choose

the third option (changing their asset structure), mainly by reducing the quantity of loan supply, which is the most likely scenario especially in the short run.

However, the quality of the loan portfolio measured by the NPL ratio can be significantly influenced by factors that are beyond the bank's control. For instance, a loan that was considered relatively safe two years ago might have turned into a non-performing loan due to adverse economic conditions. To that effect, the recent strands of literature argue that the banks' so-called "risk-taking channel" may be determined by various factors outside the banks' control. For example, Altunbas, Gambacorta and Marques-Ibanez (2010), Angeloni, Faia and Lo Duca (2010) and Borio and Zhu (2008) suggest that banks' risk preferences may be determined by the monetary policy stance and the overall economic activity of a certain economy. Moreover, Altunbas, Gambacorta and Marques-Ibanez (2010) indicate that an additional factor that may also affect banks' risk preferences may be the volatility of asset prices. Angeloni, Faia and Lo Duca (2010) suggest that an additional factor beyond banks' control with significant influence over banks' risk preferences may be changes in the fiscal policy stance. Consequently, the NPL ratio is likely to be an incomplete measure of banks' risk preferences. Hence, an alternative way of interpreting the NPL ratio is that it may actually indicate the *ex-post* quality of the loan portfolio of the banks. More precisely, changes in the NPL ratio may affect the banks' external financing premium because banks with a higher NPL ratio are perceived as riskier by the investors on the financial markets and have restricted access to non-deposit funding. Accordingly, when the monetary policy tightens banks would have to react by reducing the quantity of loan supply.

Bearing in mind the relatively high level of the NPL ratio in the CSEE economies, especially in the Macedonian banking system, and the unpleasant experience of borrowers' default particularly during the initial period of transition, amending the model with a proxy variable for banks' risk preferences, or alternatively, for an indicator suggesting the increase of their external finance premium, might be the essential factor in

determining the bank lending channel. This variable may be an indicator of the healthiness of the banking sector. Thus, the sign of the interaction coefficient β_9, no matter whether we interpret the NPL ratio as a proxy for banks' risk preferences or as an indicator of an increase in their external finance premium, is expected to be negative. More precisely, when monetary policy tightens, those banks that have a higher NPL ratio are expected to reduce the quantity of loan supply proportionately more than banks with a lower NPL ratio.

The foreign ownership dummy variable and its interaction term with the reference interest rate are incorporated in the model in order to control for the effect of foreign ownership in the banking sector. This is seen as an important determinant in the studies conducted for the transition and emerging market economies due to the relatively high level of foreign ownership of total banking capital, which is also true in the case of Macedonia. The signs of both parameters are expected to be positive as higher foreign involvement in the banking sector indicates better management of the banks and more favourable conditions for granting loans. Furthermore, foreign-owned banks may use their internal capital markets and may act counter-cyclically when the monetary policy tightens (De Haas and Lelyveld, 2006) which should additionally affect the loan growth. However, due to the divergence between the legal definition *(de jure)* of foreign-owned banks and the one in practise *(de facto)*, this variable may not have significant impact on the bank lending channel. Namely, the bank lending channel can be affected by the foreign-owned banks mainly through the existence of internal capital markets where the parent bank may give financial resources to its subsidiary when the monetary policy tightens. Nevertheless, this might not be the case in Macedonia because some of the *de jure* foreign banks are owned by domestic residents who have established their own companies abroad. An additional factor that could complicate the definition of foreign ownership in the banking sector is the banks' dependence on foreign financing that may either be in the form of short- or long-term foreign currency borrowings and/or subordinated deposits. These types of funds may not only affect foreign-owned banks, but also the domestically-owned banks because the latter

may also borrow on the international markets or from another financial institution. Accordingly, in the case of Macedonia, the impact of foreign ownership in the banking sector may not be clearly distinguished. Namely, we are interested primarily in the existence of the possibility for foreign-owned banks to more easily get access to non-deposit funding and to more easily offset the reduction in the deposit base when the monetary policy tightens. However, in the case of the Macedonian banking sector, getting non-deposit funding from abroad may apply not only to the foreign-owned banks but also to the domestically-owned banks, which might flaw the definition of foreign ownership. Due to the aforementioned reasons, we could expect that the foreign-ownership dummy variable is flawed and might not significantly affect the bank lending channel.

5 Data Issues

We use annual bank balance sheet data obtained from the NBRM. The sample period is 2000 to 2007. The balance sheet items for each individual bank over this period are constructed according to the same accounting methodology with only minor modifications. The balance sheet data before 2000 are not available for all banks and were compiled according to a different methodology. Auctions of CB bills were the main policy instrument over the whole period analysed, whereas before 2000 the main policy instrument were auctions of credits.

The original unbalanced data set comprises all 26 banks in Macedonia[7]. The sample is adjusted for mergers and acquisitions among banks by backward aggregation of the balance sheet items. Backward adjusting the data for mergers ensures that the data are comparable before and after the merger occurred. Although this is the most commonly used approach in the literature (Ehrmann et al., 2001; Gambacorta, 2005; De Haan, 2001; Havrylchyk and Jurzyk, 2005; Prutenau-Podpiera, 2007; Juks, 2004) one should be aware that mergers may introduce bias as changes in the management of

[7] *We do not consider the Macedonian Bank for Development Promotion a.d. Skopje for the reason that it is state-owned and is established only for the purpose of supporting underdeveloped industrial areas. Consequently, this bank is not working according to the market principles and is therefore excluded from the analysis.*

the merged bank and the gained know-how are not controlled for. Hence, over the whole sample period we work with an unbalanced data set of 20 banks. Over this sample period, three banks terminated their operations – in 2002, 2005 and 2007 respectively. Their loan market share at the time of their termination was 5.5, 2 and 1.2 percent respectively[8]. Additionally, during the sample period, two banks were established as greenfield banks in 2001 and 2003 respectively, whose loan market share in 2007 reached 1 and 5.4 percent, respectively[9]. A detailed description of the data set is given in Table 2.

Table 2 **Data Description and Sources**

Variable	Description	Value	Source
LoansT	Total outstanding loans to non-financial private sector.	Nominal	NBRM
MBKS	Average weighted interbank interest rate.	In % annualised	NBRM
GDPr	Real Gross Domestic Product.	In denars from 1997	SSO and NBRM staff calculations
CPI1	Consumer price index.	Index, base year 2000=100	SSO and NBRM staff calculations
Liquid1	Ratio of liquid over total assets. It includes: cash in vault at the NBRM+short term deposits in accounts in banks abroad+CB bills and treasury bills with maturity up to 1 year.	Nominal	NBRM
Liquid2	Ratio of liquid over total assets. It includes: liquidity1+cheques and overdrafts+short term restricted deposits in accounts in banks abroad+short term security holdings issued by banks and saving houses+short term bonds issued by the state+short term credits granted to banks abroad.	Nominal	NBRM
Liquid3	Ratio of liquid over total assets. It includes:liquidity2+cash in vaults in domestic banks+short term restricted deposits in accounts in domestic banks+short term loans granted to domestic financial institutions (banks and saving houses).	Nominal	NBRM
Size	Log of total assets.	Nominal	NBRM
Capital	Ratio of equity plus reserves over total assets.	Nominal	NBRM
ForOwn	Foreign ownership dummy variable. 1 if foreign-owned, 0 otherwise.	Dummy	NBRM
NPLTratio	Ratio of NPL over total outstanding loans.	Ratio	NBRM

Sources: NBRM and State Statistical Office of the Republic of Macedonia (SSO).

The bank-specific characteristics (liquidity, size, capital and NPL ratio) have been normalised according to their averages across all banks in the

[8] *Author's estimate based on NBRM data.*

[9] *Author's estimate based on NBRM data.*

sample and they sum up to zero over all observations (Ehrmann et al., 2001). In other words, they are expressed as deviations from their cross-sectional means. The size variable has been additionally normalised to each period mean in order for the general trend to be removed from this variable because it is in nominal terms (Ehrmann et al., 2001). The normalisation procedure of bank-specific characteristics is undertaken according to the following equations:

$$\text{Size}_{it} = \log A_{it} - \frac{1}{N_t}\sum_i \log A_{it} \tag{2}$$

$$\text{Liq}_{it} = \frac{L_{it}}{A_{it}} - \frac{1}{T}\sum_t \left(\frac{1}{N_t}\sum_i \frac{L_{it}}{A_{it}}\right) \tag{3}$$

$$\text{Cap}_{it} = \frac{C_{it}}{A_{it}} - \frac{1}{T}\sum_t \left(\frac{1}{N_t}\sum_i \frac{C_{it}}{A_{it}}\right) \tag{4}$$

$$\text{NPLratio}_{it} = \frac{\text{NPL}_{it}}{\text{LoansT}_{it}} - \frac{1}{T}\sum_t \left(\frac{1}{N_t}\sum_i \frac{\text{NPL}_{it}}{\text{LoansT}_{it}}\right) \tag{5}$$

where:

- *A*, *L* and *C* represent bank assets, liquidity and size respectively;
- *N* and *T* indicate the size and the time length of the sample respectively;
- *NPL* is the value of non-performing loans, while *LoansT* are the total outstanding loans;
- *i* and *t* are group- and time-specific subscripts.

The main reason for normalisation is that the average of the interaction term $X_{it}MPI_t$ from Equation (1) equals zero and, consequently, the coefficient β_6 is interpreted as the direct impact of the reference interest rate on bank loans, conditional on the bank-specific characteristics (Ehrmann et al., 2001; Gambacorta, 2005). The sign of this coefficient is expected to be positive. Another reason for normalisation is that in this way any disturbances

caused by minor methodological changes in the balance sheet data can be reduced (Chmielewski, 2006).

There are some limitations of the data in terms of their reliability, methodological consistence and the way they have been collected and backward revised. However, these are perceived as minor and unlikely to affect the results significantly.

6 Estimation Results

This section discusses the estimation results of different model specifications for the banks' loan supply function.

In selecting the lag length, we have decided to include only the current values of independent regressors and the dependent variable with one lag. This is due to two reasons: *first*, we use annual observations and including more lags would not be appropriate from the economic viewpoint as adjustment in the financial sector is relatively quick; and *second*, to get a better specification in the statistical sense, we select the most parsimonious model.

All model specifications are modifications of the general form presented in Equation (1). In our specification search we were aware of the need to specify as parsimonious a model as possible, given the need to keep the number of instruments relatively low. For instance, the interaction term with foreign ownership dummy variable was insignificant at 10 percent significance level. Moreover, even when including dummy variables for those banks that are *de facto* foreign-owned (as defined in Section 4), again this variable was statistically insignificant at 10 percent.[10] Hence, we have decided to exclude this variable from the model and thus we proceed with the more parsimonious model specification.

[10] *This was done according to the suggestions of an anonymous referee. These results are available from the author upon request.*

By estimating the more parsimonious model specification with system GMM, in order to circumvent the problem of too many instruments due to a relatively small N, we have restricted and collapsed the instrument set. Thus, the total number of instruments ranges from 23 to 35.

In estimating each equation, a battery of diagnostic tests are undertaken and special attention is paid to the Hansen test for validity of the instruments and the Arellano-Bond test for second order serial correlation in error terms (Arellano and Bond, 1991). The Hansen test is preferred over the Sargan test because the former is robust in the presence of heteroscedasticity and/ or autocorrelation.

The two-step results with Windmeijer (2005) corrected standard errors for total outstanding loans, classified according to the interaction term of each bank-specific characteristic (size, liquidity and capitalisation), are presented in Tables A1, A2 and A3 in Appendix 1. All model specifications satisfy the criteria of no second order serial correlation in residuals. The null hypothesis of the Arellano-Bond test cannot be rejected at 10 percent level of significance. Regarding the validity of the instruments, the results of the Hansen test point to non-rejection of the null hypothesis of validity of the over-identifying restrictions at 10 percent significance level.

In the interpretation of the results, the main emphasis is given to the short-run estimates. The 3-year long-run cumulative effect will be only briefly discussed. The rationale for choosing this period is that in the process of economic transition, other non-economic factors, such as legal reforms, are likely to affect the impact of the right-hand side variables over a longer time period. The 3-year cumulative effect, the overall long-run effect[11] and the respective multipliers are provided in Tables A4, A5 and A6 in Appendix 2.

[11] *The overall long-run effect is calculated in the following way:* $\sum_{t} \beta_t / (1 - \sum_{l=1} y_{t-l})$, *where* β *is the coefficient(s) of the independent variable,* y *is the coefficient(s) of the lagged dependent variable,* t *is the time subscript and* l *indicates the number of lags.*

6.1 Interpretation of the Estimation Results: Variables Common for All Model Specifications

The estimated coefficient with the first lag of outstanding loans is, as expected, highly significant and has a positive sign. The coefficient varies from 0.4 (Tables A2 and A3, Appendix 1) to 0.9 (Regression 3, Table A1, Appendix 1), being the highest in the models containing the interaction term of size. The magnitude of this coefficient implies high inertia in the adjustment process, suggesting that high proportion of the current value is determined by its past value, which may be due to the growing proportion of long-term loans. Compared to estimates for other economies, this coefficient is much higher. For example, for Czech Republic estimates range from -0.11 to -0.08 (Pruteanu-Podpiera, 2007) based on quarterly data. For Ukraine, the estimate is 0.12 (Golodnuik, 2006) while for Slovenia, Poland and Hungary the highest estimates are 0.2, 0.3 and 0.3, respectively (Matousek and Sarantis, 2009), based on annual data. This may suggest that in the case of Macedonia the stock of loans exhibits much higher inertia compared to the other transition economies, probably due to higher dependence of the private sector on long-term external financing as a result of still undeveloped financial markets.

The money market rate (MBKS) in all regressions enters negatively as expected and is highly significant. The size of the estimates ranges from -5 percent (Tables A1 and A2, Appendix 1) to -11 percent (Regression 3, Table A3, Appendix 1), depending on the model specification. This indicates the existence of a bank lending channel, implying that banks' loan supply function is responsive to changes in the reference interest rate. The estimated sensitivity of loan supply to changes in the reference interest rate is much higher for other economies in CSEE, i.e. for the Baltic states it ranges from -12 percent to -20 percent (Kohler, Hommel and Grote, 2006). However, a more sluggish reaction of loan supply to changes in the reference interest rate from -1.3 percent to -2.2 percent is estimated for Poland (Havrylchyk and Jurzyk, 2005). For the aggregate level of the CSEE economies it has been estimated to be around -2 percent (Schmitz, 2004). The 3-year long-run cumulative effect of the MBKS rate is stronger and

ranges from -10 percent (Table A5, Appendix 2) to -20 percent (Table A4, Appendix 2) with the 3-year multipliers ranging from 1.6 to 2.8 (see Tables A4, A5 and A6 in Appendix 2). This may suggest that, although the NBRM conducts a strategy of a *de facto* fixed exchange rate regime, due to the still not fully liberalised capital account, the NBRM can still conduct an independent monetary policy through setting the key policy rate. Namely, the results imply that banks indeed significantly react to changes in the domestic reference rate by adjusting loan supply.

The price level (CPI1) enters positively as expected in all model specifications. However, whether it is significant depends on the benchmark balance sheet item taken and the definition of liquidity used. The CPI has a statistically significant impact in two out of three model specifications containing the interaction term with size (Table A1, Appendix 1), depending on the definition of liquidity. In the model specification containing the interaction term with capital, it enters significantly only in the regression with the second definition of liquidity (Regression 2, Table A3, Appendix 1) while it does not enter significantly in any models containing the interaction term with liquidity (Table A2, Appendix 1). In the regressions where the price level coefficient enters with statistical significance, the variation in magnitude of the estimated coefficient is relatively low and ranges from 2.2 (Regression 2, Table A3, Appendix 1) to 4.9 (Regression 1, Table A1, Appendix 1), indicating a high elasticity of the stock of total loans to changes in the price level. The 3-year long-run cumulative effect of the price level is much stronger. The coefficients range from 4.4 (Table A6, Appendix 2) to 12.2 (Table A4, Appendix 2).

The estimated coefficient with the other macroeconomic control variable, GDP, in most of the estimates has a negative sign, which is contrary to what is expected. However, GDP has also been estimated to have a negative effect in many other studies. For example, it enters with a negative sign in most of the estimates for Poland (Chmielewski, 2006), Slovenia and Hungary (Matousek and Sarantis, 2009) and in some of the estimates for the Netherlands (De Haan, 2001) as well as for France and Spain (Ehrmann et al., 2001). In this study, the effect of GDP enters significantly only in the

third regression containing the interaction term with size (see Table A1 in Appendix 1). In this specification the size of the coefficient indicates a high elasticity of the stock of loans to output fluctuations. Namely, a one-percent increase in GDP, on average *ceteris paribus*, results in reduction of the stock of total loans by 3 percent. For similar specifications, other studies have estimated coefficients of a comparable size: Poland (Chmielewski, 2006), Slovenia and Hungary (Matousek and Sarantis, 2009). The 3-year long-run cumulative effect of GDP is stronger with multipliers ranging from 1.6 to 2.8 (see Tables A4, A5 and A6 in Appendix 2). Hence, the significant estimates in respect to the macroeconomic control variables (CPI and GDP) suggest that variations in domestic macroeconomic conditions (especially the price level) are relevant for the banks with regard to adjusting the quantity of loan supply.

6.2 Interpretation of the Estimation Results: Bank-Specific Variables

Regarding the bank-specific characteristic that is taken as a proxy measure for the banks' attitude towards risk (the interaction term of NPL with the reference interest rate), it appears to play an important role in the banks' loan supply function (Tables A1, A2 and A3 in Appendix 1). The estimated coefficient with this variable is highly significant and negative, as expected, in all regressions. It is robust to different model specifications, regardless of the bank-specific characteristics. Thus the results indicate that the ratio of non-performing loans may be one of the major determinants of banks' loan supply decisions. These results may suggest that this variable may serve as a proxy measure for banks' risk preferences. The alternative interpretation of the interaction term of the NPL variable might be that this variable is an indicator of the *ex-post* quality of the loan portfolio and may indicate an increase in the external finance premium of the banks for raising non-deposit funds. Overall, the interaction term of the NPL variable implies that when monetary policy tightens, those banks with a higher NPL ratio reduce the quantity of loan supply proportionately more than banks with lower NPL ratio. These results are broadly in line with Chmielewski (2006),

where this variable was estimated to be an important determinant for the bank lending channel in Poland, but not with Pruteanu-Podpiera (2007) for the case of the Czech Republic, where it had the contrary sign from what was expected.

The interaction term of size with the reference interest rate is insignificant in all three regressions presented in Table A1, Appendix 1. This suggests that differences in size among banks do not play any significant role in banks' loan supply adjustment when the monetary policy changes. Hence, the asset size may not be taken as a distinguishing bank-specific characteristic of the heterogeneous loan supply reaction function.

The interaction term with liquidity is significant in all three model specifications presented in Table A2, Appendix 1, being slightly stronger for the second/broader definition of liquidity. Liquidity may be a proxy variable for the different degrees of informational frictions that banks face in the loan market. However, the sign is negative and contrary to the economic theory. This coefficient indicates that banks with higher liquidity cut the quantity of loan supply proportionately more when monetary policy tightens compared to less liquid banks.

Similar results, where the interaction term of liquidity is estimated with a negative sign, are presented in the studies by Wrobel and Pawlowska (2002), Havrylchyk and Jurzyk (2005), Chmielewski (2006) and Matousek and Sarantis (2009) conducted for the Polish banking sector and in Kohler, Hommel and Grote (2006) for the Baltic states. Overall, it seems that the explanation provided by Kohler, Hommel and Grote (2006) coincides with the developments on the Macedonian loan market.

The estimates from the three model specifications in respect to the interaction term with capital are statistically significant, as reported in Table A3, Appendix 1, indicating that banking capital may be an important determinant of the loan supply function. Moreover, this coefficient turns out to be statistically significant and positive as expected in the estimation controlling for the narrowest definition of liquidity (liquid1) estimated with

a one-step system GMM estimator and in all three model specifications estimated with difference GMM[12]. However, this variable is statistically insignificant in all three regressions estimated with a two-step system GMM with Windmeijer (2005) corrected standard errors estimated only by restricting the number of lags used as instruments.[13] In summary, the empirical evidence presented in respect to banking capital as a determinant of the bank lending channel in Macedonia varies with the estimation method and the instruments used for the endogenous variables. There is no strong evidence in favour of banking capital being a distinguishing proxy characteristic among banks for the different degrees of informational frictions they face on the loan market.

6.3 Robustness of the Results[14]

The robustness of the results has been checked by using different GMM estimators. More precisely, we have re-estimated the same model specifications for the two-step system GMM estimator with Windmeijer (2005) corrected standard errors by restricting the number of lags used as an instrument for each endogenous and/or predetermined variable(s), using the STATA default command xtdpd. We have also re-run the same model specifications with the one-step system GMM estimator with robust standard errors. An additional informal robustness check of the estimates that is suggested by Roodman (2006) and Bond (2002) serves to verify whether the estimates of the lagged dependent variable lie between the estimates using FE and OLS. The first method tends to bias the estimates downwards, while the second method tends to bias the estimates upwards.

In re-estimating the same regressions by restricting the number of lags used as instruments, the results regarding the significance and sign of the coefficients are broadly consistent with the two-step estimates reported in the previous subsections and the magnitude of the coefficients is quite

[12] *These results are available from the author upon request.*

[13] *These results are available from the author upon request.*

[14] *The results discussed in this section are available from the author upon request.*

similar as well. The most noticeable difference is that now the interaction term between capital and the reference interest rate enters insignificantly in all three regressions, unlike before (see Table A3 in Appendix 1), indicating that the estimates are affected by the greater number of instruments created.

In the estimated results with a one-step system GMM estimator with robust standard errors, the results regarding the significance, signs and size of the estimates are in line with the two-step system GMM estimates presented in the previous subsections.

The previously mentioned informal check of robustness indicates that the estimates reported in the previous two subsections may be acceptable because the estimates of the lagged dependent variables (the stock of total loans) lie between the estimates obtained by FE and OLS (see the last two columns in Tables A1, A2 and A3 in Appendix 1) in all but one model specification (the exception is Regression 3 in Table A1, Appendix 1).

7 Conclusions

The aim of this paper was to empirically investigate the bank lending channel and its determinants in the Republic of Macedonia in order to draw a conclusion whether the NBRM can still to some extent conduct an independent monetary policy.

Given the recent developments in econometric techniques, we used a different estimation method than the other empirical studies in this area, which is arguably preferable considering the non-stationarity of our data. The factors that were considered to affect the bank lending channel were bank size, liquidity and capitalisation ratio. Unlike most studies, this analysis has included in the model the NPL ratio as a possibly important factor affecting the loan supply function in Macedonia.

The estimates provide evidence in favour of the existence of a bank lending channel. Changes in the reference interest rate do have significant influence on the loan supply function. This may suggest that, although the NBRM conducts a strategy of a *de facto* fixed exchange rate regime, due to the still not fully liberalised capital account there might be some space for conducting an independent monetary policy.

Among the bank-specific factors that were explored, the NPL ratio is estimated to be the most influential bank-specific characteristic. This may indicate that the NPL ratio as the indicator of banks' risk preferences may be one of the most important determinants of banks' lending decisions. An alternative interpretation might be that the NPL ratio may point to the *ex-post* quality of the loan portfolio which may be an indicator of an increase in banks' external financing premium and, thus, banks' reduced access to non-deposit funding. Regarding the rest of the bank-specific characteristics, bank liquidity was estimated with a contrary sign from what is usually argued in the literature, but bearing in mind that the Macedonian banking system has persistent excess liquidity, the results are in line with the findings of Wrobel and Pawlowska (2002), Havrylchyk and Jurzyk (2005) and Chmielewski (2006) for Poland and Kohler, Hommel and Grote (2006) for the Baltic states whose banking systems also have persistent excess liquidity. These findings are robust to different model specifications and different estimation methods.

The evidence regarding the effect of banking capital is mixed. There is not strong evidence that bank capital may have an influence over the loan supply function; the results are sensitive to different estimation methods and the number of instruments created. The results suggest that asset size does not have any significant influence over the bank lending channel. Bank size was not found to play an important role in the banks' loan supply decisions.

In summary, this analysis has presented empirical evidence indicating that banks in the Republic of Macedonia are indeed sensitive to changes in the reference interest rate and react by adjusting their quantity of loans

supplied. This may suggest that the domestic monetary policy has some impact on banks' lending decisions, although its impact is quite limited. Hence, in order to have a comprehensive overview of the effectiveness of the domestic monetary policy, a recommended topic for future research is to investigate the effectiveness of the interest rate pass-through. Examining the size and speed of the adjustment of banks' retail rates to changes in the domestic reference rate may give an indication of whether the interest rate channel, as an important part of the monetary transmission mechanism, is effective and whether the domestic policy rate has any impact on banks' retail rate-setting decisions.

Overall, the domestic monetary policy authorities are faced with the challenge of whether they will still be able to conduct an independent monetary policy in the future due to the forthcoming full capital account liberalisation and the process of EU integration. The interest rate differential between the domestic and foreign reference rates, adjusted for the country's risk premium that at present is relatively high, may cause large capital movements. This might ultimately violate the sustainability of maintaining the fixed exchange rate regime. Hence, the monetary policy authorities should re-assess the possibility of having an independent key policy interest rate and, if necessary, linking the key policy interest rate to the changes in the foreign reference rate in order to avoid speculative capital movements.

Appendix 1[15]

Table A1 **Estimates of Outstanding Loans with Interaction Effects in Respect to Size**

	Regression 1	**Regression 2**	**Regression 3**
Variables	**Controlling for liquid1**	**Controlling for liquid2**	**Controlling for liquid3**
L.lLoansT	0.794*	0.811**	0.921**
W-C S.E.	-0.402	0.345	-0.406
MBKS	-0.066**	-0.049*	-0.07**
W-C S.E.	-0.024	0.025	-0.028
ICPI1	4.906*	3.386*	4.213
W-C S.E.	-2.447	1.894	-3.885
IGDPr	-1.621	-1.603	-3.181**
W-C S.E.	-1.458	2.656	-1.513
CapitalNorm	0.487	-0.039	-0.755
W-C S.E.	-1.905	1.372	-0.705
Liquid1Norm	-0.319		
W-C S.E.	-1.656		
Liquid2Norm		-0.598	
W-C S.E.		0.626	
Liquid3Norm			-0.404
W-C S.E.			-1.591
SizeMBKS	-0.005	-0.011	-0.019
W-C S.E.	-0.015	0.014	-0.019
NPLTMBKS	-0.018*	-0.011*	-0.019***
W-C S.E.	-0.009	0.006	-0.006
Constant	0.189	6.827	20.840
W-C S.E.	-18.980	24.252	-21.910
Number of observations	125	125	125
Number of banks	20	20	20
Number of instruments	23	35	29
Number of lags for the differenced equation	4-5	2-5	3-5
Number of lags for the level equation	1	1	2
F test (p-value)	F(8, 19) = 72.64 (0.000)	F(8, 19) = 46.71 (0.000)	F(8, 19) = 112.09 (0.000)
AR(1)/(p-value)	-1.04 (0.297)	-1.82 (0.069)	-1.86 (0.063)
AR(2)/(p-value)	-1.44 (0.150)	-1.27 (0.203)	-1.39 (0.165)
Hansen (p-value)	chi2(14) = 9.88 0.771)	chi2(26) = 5.77 (1.00)	chi2(20)=10.54(0.957)
Diff. in Hansen (p-value)	chi2(8) = 3.92 (0.864)	chi2(8) = -3.54 (1.00)	chi2(8) = 2.39 (0.967)
Estimates of L.lLoansT with FE	0.586	0.415	0.392
Estimates of L.lLoansT with OLS	0.858	0.907	0.864

*Notes: Two-step system GMM with Windmeijer (2005) corrected standard errors by restricting and collapsing the instrument set with the command xtabond2; *** / ** / * denotes significance at 1, 5 and 10 percent level of significance, respectively.*

[15] *Computations have been done in STATA 10.*

Table A2 **Estimates of Outstanding Loans with Interaction Effects in Respect to Liquidity**

	Regression 1	Regression 2	Regression 3
Variables	**Liquidity 1**	**Liquidity 2**	**Liquidity 3**
L.lLoansT	0.577***	0.390**	0.534***
W-C S.E.	-0.180	-0.181	-0.132
MBKS	-0.061**	-0.064*	-0.054***
W-C S.E.	-0.022	-0.034	-0.019
lCPI1	4.670	2.223	3.032
W-C S.E.	-3.444	-1.881	-2.066
lGDPr	-0.136	1.397	0.590
W-C S.E.	-1.508	-1.759	-1.296
SizeNorm	0.422	0.810***	0.543**
W-C S.E.	-0.293	-0.177	-0.202
CapitalNorm	0.325	0.340	0.246
W-C S.E.	-0.906	-0.554	-0.733
Liquid1MBKS	-0.132*		
W-C S.E.	-0.074		
Liquid2MBKS		-0.200*	
W-C S.E.		-0.102	
Liquid3MBKS			-0.091*
W-C S.E.			-0.048
NPLTMBKS	-0.02***	-0.018***	-0.016***
W-C S.E.	-0.006	-0.005	-0.004
Constant	-14.030	-18.730	-14.650
W-C S.E.	-17.060	-15.200	-14.630
Number of observations	125	125	125
Number of banks	20	20	20
Number of instruments	34	24	23
Number of lags for the differenced equation	4-6	3-4	4-5
Number of lags for the level equation	2-3	1	1
F test (p-value)	F(8, 19) = 180.68 (0.000)	F(8, 19) = 207.47 (0.000)	F(8, 19) = 112.54 (0.000)
AR(1)/(p-value)	-1.56 (0.207)	-1.45 (0.146)	-1.35 (0.177)
AR(2)/(p-value)	-1.56 (0.119)	-1.18 (0.237)	-1.49 (0.135)
Hansen (p-value)	chi2(25)=11.63(0.989)	chi2(15) = 9.62 (0.843)	chi2(14)=10.21(0.747)
Diff. in Hansen (p-value)	chi2(14) = 1.45 (1.00)	chi2(8) = 0.74 (0.999)	chi2(8) = 6.12 (0.634)
Estimates of L.lLoansT with FE	0.369	0.326	0.294
Estimates of L.lLoansT with OLS	0.733	0.847	0.811

*Notes: Two-step system GMM with Windmeijer (2005) corrected standard errors by restricting and collapsing the instrument set with the command xtabond2; *** / ** / * denotes significance at 1, 5 and 10 percent level of significance, respectively.*

Table A3 **Estimates of Outstanding Loans with Interaction Effects in Respect to Capital**

	Regression 1	**Regression 2**	**Regression 3**
Variables	**Controlling for liquid1**	**Controlling for liquid2**	**Controlling for liquid3**
L.lLoansT	0.623***	0.563***	0.389*
W-C S.E.	-0.139	-0.118	-0.215
MBKS	-0.060***	-0.056**	-0.113***
W-C S.E.	-0.020	-0.027	-0.033
lCPI1	0.742	2.248*	0.067
W-C S.E.	-1.800	-1.142	-1.581
lGDPr	0.388	0.730	-0.317
W-C S.E.	-0.994	-1.164	-1.487
SizeNorm	0.581***	0.715***	0.824***
W-C S.E.	-0.135	-0.210	-0.239
Liquid1Norm	0.045		
W-C S.E.	-0.331		
Liquid2Norm		-0.424	
W-C S.E.		-0.409	
Liquid3Norm			-1.457
W-C S.E.			-0.917
CapitalMBKS	0.085***	0.093***	0.067*
W-C S.E.	-0.021	-0.017	-0.035
NPLTMBKS	-0.014***	-0.019***	-0.015***
W-C S.E.	-0.004	-0.005	-0.002
Constant	-2.576	-13.130	12.960
W-C S.E.	-8.778	-13.410	-17.900
Number of observations	125	125	125
Number of banks	20	20	20
Number of instruments	24	30	24
Number of lags for the differenced equation	2-3	2-4	2-3
Number of lags for the level equation	1	1	1
F test (p-value)	F(8, 19) = 153.79 (0.000)	F(8, 19) = 101.74 (0.000)	F(8, 19) = 139.04 (0.000)
AR(1)/(p-value)	-0.96 (0.336)	-0.98 (0.327)	-1.56 (0.120)
AR(2)/(p-value)	-1.60 (0.110)	-1.62 (0.106)	-0.92 (0.360)
Hansen (p-value)	chi2(15) = 3.97 (0.998)	chi2(21) = 6.45 (0.999)	chi2(15) = 6.95 (0.959)
Diff. in Hansen (p-value)	chi2(8) = 1.57 (0.991)	chi2(8) = -9.77 (1.00)	chi2(8) = -3.02 (1.00)
Estimates of L.lLoansT with FE	0.452	0.367	0.330
Estimates of L.lLoansT with OLS	0.685	0.726	0.706

*Notes: Two-step system GMM with Windmeijer (2005) corrected standard errors by restricting and collapsing the instrument set with the command xtabond2; *** / ** / * denotes significance at 1, 5 and 10 percent level of significance, respectively.*

Table A4 **Long-Run Estimates of Total Outstanding Loans with Interaction Effects in Respect to Size**

Variables	1st year	2nd year	3rd year	3-year cumulative	3-year multiplier	Long-run	Long-run multiplier
MBKS	-0.066	-0.052	-0.046	-0.165	2.494	-0.320	4.854
lCPI1	4.906	3.895	3.436	12.238	2.494	23.816	4.854
lGDPr	-1.621	-1.287	-1.135	-4.043	2.494	-7.869	4.854
CapitalNorm	0.487	0.387	0.341	1.215	2.494	2.364	4.854
Liquid1Norm	-0.319	-0.253	-0.223	-0.796	2.494	-1.549	4.854
SizeMBKS	-0.005	-0.004	-0.003	-0.012	2.494	-0.024	4.854
NPLTMBKS	-0.018	-0.014	-0.013	-0.045	2.494	-0.087	4.854
MBKS	-0.049	-0.040	-0.036	-0.124	2.539	-0.259	5.291
lCPI1	3.386	2.746	2.464	8.596	2.539	17.915	5.291
lGDPr	-1.603	-1.300	-1.167	-4.070	2.539	-8.481	5.291
CapitalNorm	-0.039	-0.032	-0.028	-0.099	2.539	-0.206	5.291
Liquid2Norm	-0.598	-0.485	-0.435	-1.518	2.539	-3.164	5.291
SizeMBKS	-0.011	-0.009	-0.008	-0.028	2.539	-0.058	5.291
NPLTMBKS	-0.011	-0.009	-0.008	-0.028	2.539	-0.058	5.291
MBKS	-0.070	-0.064	-0.063	-0.197	2.819	-0.886	12.658
lCPI1	4.213	3.880	3.784	11.877	2.819	53.329	12.658
lGDPr	-3.181	-2.930	-2.857	-8.968	2.819	-40.266	12.658
CapitalNorm	-0.755	-0.695	-0.678	-2.129	2.819	-9.557	12.658
Liquid3Norm	-0.404	-0.372	-0.363	-1.139	2.819	-5.114	12.658
SizeMBKS	-0.019	-0.018	-0.017	-0.054	2.819	-0.243	12.658
NPLTMBKS	-0.019	-0.017	-0.017	-0.054	2.819	-0.241	12.658

Notes: Two-step system GMM with Windmeijer (2005) corrected standard errors.

Table A5 **Long-Run Estimates of Total Outstanding Loans with Interaction Effects in Respect to Liquidity**

Variables	1st year	2nd year	3rd year	3-year cumulative	3-year multiplier	Long-run	Long-run multiplier
MBKS	-0.061	-0.035	-0.025	-0.121	1.980	-0.144	2.364
ICPI1	4.670	2.695	1.882	9.246	1.980	11.040	2.364
IGDPr	-0.136	-0.078	-0.055	-0.269	1.980	-0.322	2.364
SizeNorm	0.422	0.243	0.170	0.836	1.980	0.998	2.364
CapitalNorm	0.325	0.188	0.131	0.643	1.980	0.768	2.364
Liquid1MBKS	-0.132	-0.076	-0.053	-0.261	1.980	-0.312	2.364
NPLTMBKS	-0.020	-0.012	-0.008	-0.040	1.980	-0.047	2.364
MBKS	-0.064	-0.025	-0.014	-0.103	1.612	-0.105	1.639
ICPI1	2.223	0.867	0.494	3.584	1.612	3.644	1.639
IGDPr	1.397	0.545	0.310	2.252	1.612	2.290	1.639
SizeNorm	0.810	0.316	0.180	1.306	1.612	1.328	1.639
CapitalNorm	0.340	0.133	0.076	0.548	1.612	0.557	1.639
Liquid2MBKS	-0.200	-0.078	-0.044	-0.322	1.612	-0.328	1.639
NPLTMBKS	-0.018	-0.007	-0.004	-0.029	1.612	-0.030	1.639
MBKS	-0.054	-0.029	-0.019	-0.102	1.889	-0.116	2.146
ICPI1	3.032	1.619	1.077	5.728	1.889	6.506	2.146
IGDPr	0.590	0.315	0.210	1.115	1.889	1.266	2.146
SizeNorm	0.543	0.290	0.193	1.026	1.889	1.165	2.146
CapitalNorm	0.246	0.131	0.087	0.465	1.889	0.528	2.146
Liquid3MBKS	-0.091	-0.049	-0.032	-0.172	1.889	-0.195	2.146
NPLTMBKS	-0.016	-0.009	-0.006	-0.030	1.889	-0.034	2.146

Notes: Two-step system GMM with Windmeijer (2005) corrected standard errors.

Table A6 **Long-Run Estimates of Total Outstanding Loans with Interaction Effects in Respect to Capital**

Variables	1st year	2nd year	3rd year	3-year cumulative	3-year multiplier	Long-run	Long-run multiplier
MBKS	-0.060	-0.037	-0.027	-0.125	2.081	-0.159	2.653
ICPI1	0.742	0.462	0.340	1.544	2.081	1.968	2.653
IGDPr	0.388	0.242	0.178	0.807	2.081	1.029	2.653
SizeNorm	0.581	0.362	0.266	1.209	2.081	1.541	2.653
Liquid1Norm	0.045	0.028	0.020	0.093	2.081	0.118	2.653
CapitalMBKS	0.085	0.053	0.039	0.177	2.081	0.225	2.653
NPLTMBKS	-0.014	-0.009	-0.006	-0.029	2.081	-0.037	2.653
MBKS	-0.056	-0.032	-0.022	-0.109	1.950	-0.128	2.288
ICPI1	2.248	1.266	0.870	4.384	1.950	5.144	2.288
IGDPr	0.730	0.411	0.282	1.423	1.950	1.670	2.288
SizeNorm	0.715	0.403	0.277	1.394	1.950	1.636	2.288
Liquid2Norm	-0.424	-0.239	-0.164	-0.827	1.950	-0.970	2.288
CapitalMBKS	0.093	0.052	0.036	0.181	1.950	0.213	2.288
NPLTMBKS	-0.019	-0.011	-0.007	-0.037	1.950	-0.043	2.288
MBKS	-0.113	-0.044	-0.025	-0.182	1.610	-0.185	1.637
ICPI1	0.067	0.026	0.015	0.108	1.610	0.109	1.637
IGDPr	-0.317	-0.123	-0.070	-0.510	1.610	-0.519	1.637
SizeNorm	0.824	0.321	0.182	1.327	1.610	1.349	1.637
Liquid3Norm	-1.457	-0.567	-0.322	-2.346	1.610	-2.385	1.637
CapitalMBKS	0.067	0.026	0.015	0.108	1.610	0.110	1.637
NPLTMBKS	-0.015	-0.006	-0.003	-0.024	1.610	-0.025	1.637

Notes: Two-step system GMM with Windmeijer (2005) corrected standard errors.

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