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Investigating credit transmission mechanism in the Republic of Macedonia: Evidence from Vector Error Correction Model

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National Bank of the Republic of Macedonia

Working Paper No. 2/2018

Investigating credit transmission mechanism in the Republic of Macedonia: evidence from Vector Error Correction Model

Milan Eliskovski[1]

Abstract

Research subject of this paper is the credit transmission mechanism in the Republic of Macedonia or in other words this paper investigates the effects of the monetary signals by the National Bank of the Republic of Macedonia on banks' lending. The credit transmission is analyzed through its narrow nature or so called bank lending channel. In order to explain how the bank lending channel operates in Macedonia, two theoretical models are considered and econometrically tested. The first one is the traditional bank lending channel explained by Bernanke and Blinder model and the second one is the credit rationing model by Stiglitz and Weiss. The econometric technique employed is the vector error correction model or known as Johansen cointegration technique which is appropriate for empirical testing based on time series. The empirical results suggest that the Stiglitz and Weiss model better explains the banks' behavior in the Republic of Macedonia, that is the banking sector is risk averse and rations loans with an aim not to deteriorate its' profitability. Therefore, monetary tightening signals clearly affect the banks to restrict lending. On the other hand, the monetary expansionary signals have to be supported by favorable balance sheet structure of the banks as well as by favorable macroeconomic conditions in order to encourage lending.

JEL Classification: C22, E52, E58, G21

Keywords: bank lending channel, monetary transmission, credit rationing, VECM analysis

[1] Monetary Policy and Research Department, National Bank of the Republic of Macedonia. The views expressed herein are those of the author and do not necceseraly represent the views of the National Bank of the Republic of Macedonia. The author expresses gratitude to Aneta Krstevska, Ana Mitreska, Sultanija Bojcheva-Terzijan, Tanja Jakimova, Neda Popovska-Kamnar, Egzona Hani, one anonymous reviewer and Gerti Shijaku from the Bank of Albania for their comments.

1. INTRODUCTION

Among many channels through which central banks transmit monetary signals to real economic activity, the credit channel is very important especially for the economies where banks are important source of finance[2]. The credit channel incorporates two dimensions: the narrow one or known as bank lending channel and broader one or known as balance sheet channel. The bank lending channel primarily explores the lending behavior of the banks only, while the balance sheet channel beside banks' lending behavior includes firms' investment decisions and therefore encompasses all credit market interactions. Banks are in the middle of the relationship between the central bank on one side and firms and households on the other side, and therefore, the strength of the monetary transmission depends on central bank's ability to affect the banks to provide loans.

Subject of research of this paper is the bank lending channel of the monetary transmission in the Republic of Macedonia (RM), specifically what is the mechanism through which the National Bank of the Republic of Macedonia (NBRM) affects the banks' lending. One mechanism considered in this paper is the traditional bank lending channel explained by Bernanke and Blinder (1988) which explains the loan market behavior and the manner through which the banks reduce the loan supply as a response to restrictive monetary measures. The other considered mechanism is credit rationing as explained by Stiglitz and Weiss (1981) which also explains the behavior of the loan market, or concretely whether the banks decrease availability or ration the loans to the borrowers as a result to restrictive signal given by the NBRM. In order to provide evidence within this paper which of these mechanisms better explains the bank lending channel for the RM, the vector error correction model (VECM or Johansen cointegration technique) will be exploited for empirical testing. The VECM technique is appropriate for dealing with time series and endogenous variables. Also, the VECM is appropriate for modeling the loan market behavior because assumes long run equilibrium relationship between variables, similarly as the equilibrium on every market. Furthermore, this technique allows for estimating loan demand and loan supply by imposing restrictions to the variables when it estimates more than one cointegrating vector.

The contribution of this research is to identify which of these two mentioned mechanisms is valid for the monetary transmission in Macedonia regarding bank loans. By proper identification of the bank lending channel, both the NBRM and banks may get better

[2] Beside equity instruments and reserves (Mitreska et al, 2017) bank loans are important source of funds for majority of the firms and usually main finance provider for households in the transition economies.

insight into the credit monetary transmision mechanism and may undertake proper measures for improvement.

Within the paper, the theoretical literature overview will be explained in the second section. Afterwards, explanation of the stylized facts and indicative analysis about Macedonian monetary transmission will be provided in the third section. The fourth section is about methodology and data. The final two sections refer to the empirical research results and the conclusion.

2. OVEREVIEW OF THE THEORETICAL LITERATURE

The monetary transmission mechanism explains how the changes of the nominal monetary variables such as: the money stock or the short-term interest rate, affect the real sector variables such as: loans, output, employment and inflation (Ireland, 2005). The monetary transmission mechanism is ussually referred to as "black box". The term "black box" is usually used to explain the uncertain relationship between the monetary policy signals of the central bank and the real economy i.e. the influence of the nominal monetary policy variables on the real sector variables (Bernanke and Gertler, 1995). The credit channel view or more concretely the bank lending channel through which the central bank affects the banks' loan supply is also part of the so called "black box". The clarification of the concept of the "black box" depends upon the manner or the mechanism through which the central bank stimulates the banks to increase or decrease the lending to the firms and households.

Bernanke and Blinder (1988), Kashyap and Stein (1995), Stein (1998), among others, explain and provide various theoretical and empirical basis of this issue. Mainly, these papers explain that monetary policy affects the banks' deposits as source for providing loans which in turn has an appropriate effect on the reserves and consequently the loan supply is affected. Van den Heuvel (2002) and Markovic (2006) explain the bank capital channel implying that the monetary policy affects the banks' profit as potential for capital enhancement and consequently the banks adjust the loan supply in order to maintain the sufficient level of capital adequacy ratio. Also, Disyatat (2010) provides overview of the bank lending channel and concludes that monetary policy affects risk perceptions of the banks which might influence on their stability and accordingly the loan supply is adjusted.

Thus, the theoretical literature usually tackles one separate concept or mechanism of the bank lending channel and therefore the "black box" of the monetary transmission is in

fact the uncertain nature of the bank lending channel throughout the time due to various factors and regulations affecting it. However, the only certainty regarding the bank lending channel is that each measure of the central bank affects the banks to restructure the financial statements and to reassess the risk-return profile, specificaly minimizing the risk given the return (profit) or maximizing the return given the risk. Thus, the banks weigh every monetary signal in a sense of what risk they might undertake in future and whether such measure could improve or worsen their future profit. Based on this, the banks alter the structure of the balance sheet within which they properly adjust the loan portfolio in order not to deteriorate the profit and loss account which in turn affects the capital base and the overall value of the bank.

The rest of the section explains the traditional model of bank lending channel by Bernanke and Blinder (1988) and the credit rationing model by Stiglitz and Weiss (1981). Both models provide simple and clarifying framework for analyzing the monetary policy transmission because they incorporate the effects on the banks' financial statements and their risk-return perceptions.

2.1. THE TRADITIONAL BANK LENDING CHANNEL BY BERNANKE AND BLINDER

The traditional bank lending channel explained by Bernanke and Blinder (1988) considers simplified balance sheet structure of the banks composed of excess of reserves (E), bonds[3] (B) and loans (LS) on the assets side and deposits (D) excluding the required reserve (τ) on the liabilities side in order to derive the loan supply. This model gives priority to the return on assets' items (loans and bonds), relative to their riskiness (Bernanke and Blinder, 1988 and Ahtik, 2010). Therefore, the banks restructure the assets in order to maximize the return given the risk.

$$E + B + LS = D(1 - \tau) \qquad (1)$$

In monetary restrictive case, the increase of the reference interest rate (interest rate of risk-free bonds) affects depositors to withdraw their deposits from the banks and search for more profitable investment opportunity in other financial assets under assumption that banks would not change the deposit interest rates. As deposits decrease and assuming that banks are not able to replace them by other non-deposit sources without substantial costs, consequently they are left without potential for lending. Additionally, the open market

[3] Bonds are composed of risk free bonds for open market operations and corporate bonds.

operation by the central bank affects banks to restructure the assets side of the balance sheet as well. Namely, banks guided by the return motive, invest their excess of reserves in the risk-free bonds (banks buy bonds from the central bank or the central bank sells bonds to the banks) because their interest rate has increased. Thus, the excess of reserves available for lending have decreased. The reduction of the banks' potential for lending affects loan interest rates to increase. Also, the lack of lending and higher loan interest rate reduces the economic growth, increases credit risk, probability for bankruptcies rises and makes the business environment riskier and uncertain affecting the loan demand to drop. The opposite happens during expansionary monetary signal and that is the central bank lowers the interest rate of the risk-free bonds from the banks and provides higher level of excess of reserves and therefore deposits increase due to the monetary multiplication effect. Moreover, banks' bonds holding decrease due to the lower risk-free interest return relative to the loan interest rate.

From formal mathematical point of view, Bernanke and Blinder (1988) formulate the supply of loans (LS) as positively determined by the deposits (D) after the imposed required reserve (τ), negatively determined by the reference interest rate or the bond rate which is risk-free interest rate (r) and positively determined by the loan interest rate (rl).

$$LS = f\big(+rl, -r, + D(1-\tau)\big) \quad (2)$$

From the loan demand side, higher reference interest rate stimulates the economic agents to borrow from the banks instead of issuing securities by higher interest rate. Similarly, higher loan interest rate deters the economic agents from banks' borrowing and motivates them to indebt by issuing securities on the financial market. Also, higher income stimulates economic agents to increase their indebtedness affecting positively the loan demand. Hence, the loan demand (LD) is mathematically expressed as a function that is affected negatively by rl, positively by r and positively by the income.

$$LD = f(-rl, +r, +income) \quad (3)$$

The loan market is in equilibrium when equation 2 equals equation 3. Thus, the equilibrium loan interest rate (rl) the price that banks charge for lending funds to borrowers, according to the arithmetic derivation in Bernanke and Blinder (1988), positively depends on the bond interest rate (r) and GDP, while negatively depends on the banks' excess of reserves (E).

$$rl = f(+r, +GDP, -E) \quad (4)$$

Ahtik (2010) states that this mechanism of the bank lending channel explained by Bernanke and Blinder (1988) was valid for the United States of America (USA) because the so called Regulation Q was in force[4] and it limited the adjusting of checking accounts interest rate. This prevented the banks to increase the deposit interest rate with an aim to reduce the deposit withdrawal in a case of monetary tightening signal. Additionally, banks were not capable to replace deposits with other non-deposit sources due to the lack of the alternative sources at that time.

2.2. THE CREDIT RATIONING MODEL BY STIGLITZ AND WEISS

The model by Stiglitz and Weiss (1981) considers the phenomenon of credit rationing. Credit rationing is defined as rejection of the borrowers by the banks or providing smaller amounts of loans to the borrowers regardless of the borrowers' will to obtain loan at the expense of higher interest rate although the banks have available loanable funds for approving loans (Freixas and Rochet, 1997; and Mishkin, 2010). The credit rationing operates through the non-price elements that limit the availability of the banks' loans to firms and households (Freixas and Rochet, 1997). The non-price elements are banking criteria such as: liquidity, profitability and collateral performances that the borrowers have to fulfill in order to be granted loans. The credit rationing does not mean that the loan market is in disequilibrium because of the not satisfied loan demand. In fact, according to Blanchard and Fischer (1993), the market is in so called credit rationing equilibrium because banks provide maximum loans by set and unchanged loan interest rate that maximizes the banks' profit given the conditions with the creditworthiness of the borrowers that compose the loan demand, banks' risk perceptions and their expectations about the future profit (risk-return profile). The credit rationing is sufficient, but not necessary condition for existing the bank lending channel because affects the availability of the loans for the borrowers even though the banks have disposable loanable funds as potential for granting loans.

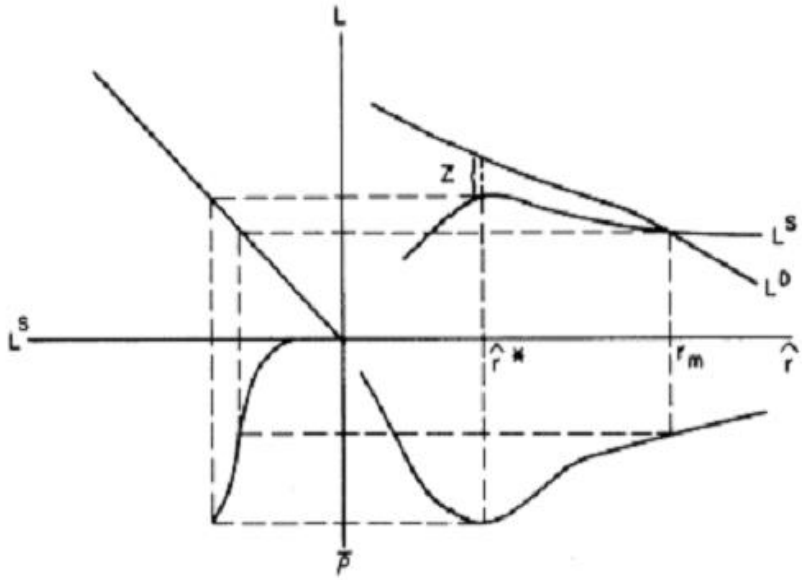
Stiglitz and Weiss (1981) model of the credit rationing takes into account that loan market is imperfect due to the information asymmetry between the banks as lenders and the borrowers. Hence, the problems of adverse selection and moral hazard appear and contribute the loan demand to be composed by risky and non-risky borrowers. Due to the information asymmetry, it is difficult for the banks to distinguish between good and bad borrowers and therefore they will not provide whole amount of loans to satisfy the loan demand. Thus, unlike the Bernanke and Blinder model, this model gives priority to the risk

[4] Various versions of the regulation Q were in force in USA, from 1933 to 2011.

relative to the return. Hence, the banks restructure the assets in order to minimize the risk given the return. Namely, the banks set the loan interest rate at level that maximizes the profit and they do not increase the loan interest rate to meet higher loan demand but rather ration loans and decrease the availability of the loans for the borrowers. The rationale for such banks' behavior is that the loan interest rate serves as screening device helping to distinguish non-creditworthy from creditworthy borrowers. As loan interest rate increase, the creditworthy borrowers leave the loan market because they do not want to indebt by higher interest rate. Unlike them, the non-creditworthy borrowers remain on the loan market and make the adverse selection problem because they are usually persistent for obtaining financial funds regardless of the high loan interest rate in order to overcome their business difficulties.

Banks are aware that an increase of the loan interest rate will stimulate the non-creditworthy borrowers to apply for loans. Consequently, by approving loans to them, the probability of default will increase leading to higher non-performing loans in the banks' portfolio in the future and costs in terms of loan-loss provision. Additionally, as the banks approve loan by higher interest rate, moral hazard problem appears in a sense that borrowers will deviate from the contract and enter into risky projects with banks' money in order to earn sufficient amount for them and to repay the loan obtained by higher loan interest rate. Therefore, banks have higher risk perceptions and expectations for deteriorating of the quality of their loan portfolio that would lead to higher loan-loss provisions and decrease of the expected profit or creating a loss that cannot be compensated by the higher loan interest rate. Additionally, the lower profit or higher loss affects the depositors to withdraw their money and consequently the loanable funds or the funds for lending are decreasing. In terms of the risk-return profile, this means that approving loans above some point of the loan interest rate, it will cause the risk to outweigh the return. The model of the credit rationing by Stiglitz and Weiss (1981) is presented in the below given four quadrant's figure 1.

Figure 1. Stiglitz and Weiss credit rationing model (1981)



Source: Stiglitz and Weiss (1981)

Having in mind the above said, from the north-east quadrant in the figure 1 can be seen that the loan supply (L^S) is backward bending curve and the loan demand (L^D) is decreasing curve. Namely, banks set loan interest rate at certain level $\hat{r}^*$ (right-hand horizontal axis $\hat{r}$) and approve certain volume of loans (upward vertical axis L) given that they maximize their profit (downward vertical axis $\bar{p}$) in the south-east quadrant. Thus, any increase of the loan interest rate level above $\hat{r}^*$ and going towards the loan interest rate r_m where L^S and L^D intersect, will stimulate the non-creditworthy clients to apply for the loans leading to the adverse selection and the moral hazard problems and contributing to higher probability of default that deteriorates the loan portfolio quality and finally the profit ($\bar{p}$) decreases as indicated by the south-east quadrant. Also, the deterioration of the loan portfolio quality and the decrease of the profit, makes banks to decrease L^S (the intersection between L^S and L^D at r_m is at lower level on L axis compared to the point $\hat{r}^*$). Therefore, it is not rational for the banks to increase lending when loan interest rate grows but rather they would be better off to ration loans. Although the banks ration the loans at the point of $\hat{r}$, yet the loan market is in state of equilibrium or so called credit rationing equilibrium because this is the point where the L^S and $\bar{p}$ are maximized. The south-west quadrant explains the relation between the deposits or referred to as loanable funds L^S (left-hand horizontal axis L^S) and profitability (downward vertical axis $\bar{p}$). Namely, as long as the banks create profit, then depositors are interested to deposit money in the banks and thus banks obtain

loanable funds or funds for lending. The final quadrant, the north-west one, indicates 45 degrees relation between loanable funds L^S (left-hand horizontal axis L^S) and loans (upward vertical axis L) meaning that the 1 unit of deposit is provided as 1 unit of loan.

When restrictive monetary signal is given by the central bank by increasing the reference interest rate, banks are reluctant to increase the loan interest rate in order not to attract non-creditworthy borrowers. Therefore, the banks either reject the borrowers or approve them smaller amount of loans than required, despite the fact that the banks possess sufficient loanable funds. Thus, the situation is clear from monetary transmission point of view when the monetary policy restricts. However, the things are not so clear in opposite situation when monetary easing is put in place. Namely, as the central bank reduces the reference interest rate usually in economic recession to boost lending and overcome the crises, then the banks are once again reluctant to decrease the loan interest rate and increase the availability of the loans because of the high macroeconomic uncertainty and still present information asymmetry between the banks and the borrowers. Due to the high macroeconomic uncertainty and still present information asymmetry, the banks are unable to properly assess the creditworthiness of the borrowers and the risk perceptions remain high. In order not to increase the credit risk exposure and deteriorate the return, the banks continue to adjust the loan portfolio by credit rationing rather than decreasing the loan interest rate. Thus, the interest rate spread (the difference between the loan interest rate and the reference risk-free interest rate) remains high and it is considered by the banks as risk premium which primarily reflects the higher risk expectations relative to the higher return that could be provided. Hence, it is inconclusive whether banks can be motivated to provide sufficient volume of loans when expansionary monetary signal is provided given the high macroeconomic uncertainty and the high risk perceptions. One solution in situation like this is to increase loanable funds (shift to the left of the loanable supply L^S in the south-west quadrant of figure 1) and thus the banks will obtain more potential that could affect the availability of the loans (Blanchard and Fisher, 1993). In terms of the north-east quadrant of the figure 1, this would mean shifting upward of the loan supply curve L^S. Other solution is reducing banks' risk perceptions by providing positive productivity shock by the government capital expenditures contributing to higher income and saving in the economy and thus the banks will make loans more available for the households and firms (Bernanke and Gertler, 1986).

***

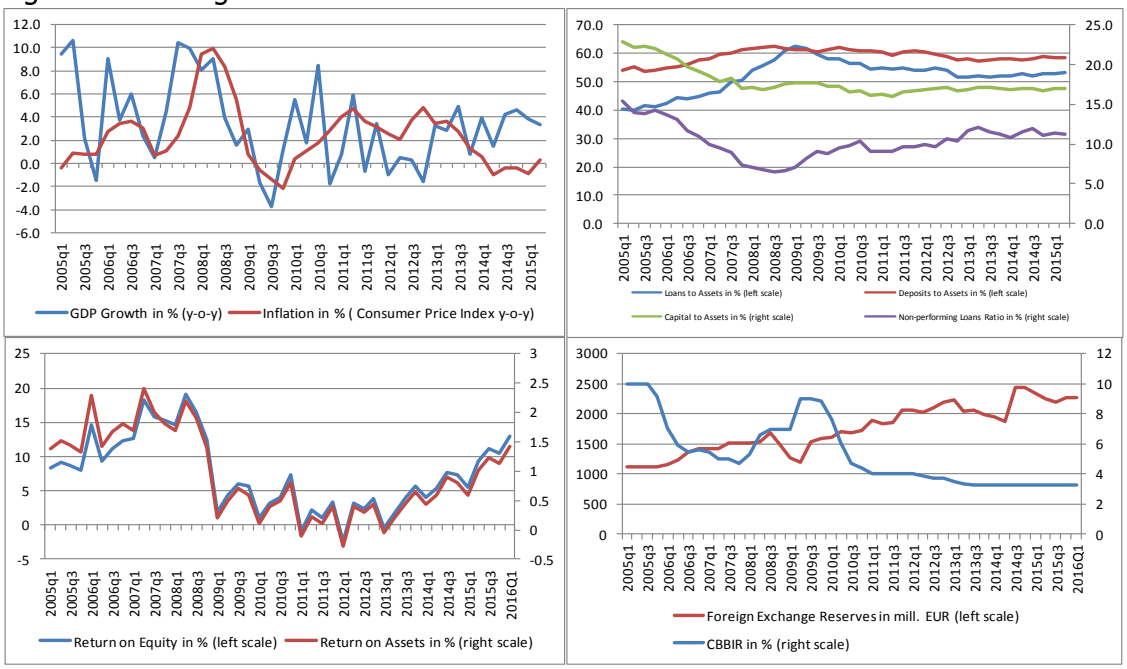
Hence, both models provided above describe the banks' operations in simplified manner and take different perspectives into account. Namely, both models consider the loan market as composed by loan demand and loan supply, but they differ in the shape of the loan supply curve. Additional joint feature of both models is that the banks are balancing between the risk and the return profile when providing loans and properly adjust the financial statements in order either to minimize the risk or maximize the return. By taking these two models as starting point for describing the bank lending channel for the RM, the monetary transmission analysis would be relatively easier for explaining the banks' behavior and the analysis would be more comprehensive. Therefore, the further analysis in this paper will be based on these two models.

3. STYLIZED FACTS AND INDICATIVE ANALYSIS ABOUT THE BANK LENDING CHANNEL IN THE REPUBLIC OF MACEDONIA

3.1. STYLIZED FACTS

The banking sector is important source for financial support of the firms and households in RM. The figure 2 below graphically depicts the evolution of the banking sector operation in the RM. Also, the papers by Jovanovic et al (2014), Jovanovic et al (2015) and Kabashi and Suleva (2016) provide overview of the banking sector progress in the RM.

Figure 2: Banking and macroeconomic indicators in RM



Source: NBRM and State Statistical Office

The banking sector of the RM and other countries[5] were grouped as a "sleeping beauties" by Cottarelli et al (2003) because of the low lending, but it experienced rapid loan growth especially from 2005 to the end of 2009. Namely, the strong gross domestic product (GDP) growth amid strong global economy in the period before the global crisis contributed to favorable macroeconomic conditions in Macedonian economy. Moreover, the banking sector succeeded to restore the credibility from the economic agents due to joint undertaken reforms by the policy makers and banks that led to introducing better working practices. The reforms undertaken and restored credibility affected positively the loans, deposits, capitalization and profitability and reduced the non-performing loans ratio (NPL ratio) up to 2009. Additionally, taking into account the favorable macroeconomic situation, the NBRM relaxed the monetary policy by decreasing the reference interest rate and that is the central bank bills interest rate (CBBIR). The continuous improvement of the banking practices as well as the prompt macroprudential measures[6] undertaken by the NBRM in 2008, with an aim for reinforcing stability contributed the banking sector to strengthen its' liquidity and capitalization and consequently it became more resilient to shocks. Therefore, the effects of the global financial crisis from 2009[7] and later on European debt crisis were relatively easily mitigated by the banks. Notwithstanding all undertaken measures, the global crises introduced uncertainty and affected negatively the foreign effective demand and subsequently GDP, by causing lower net export. Moreover, banks' profitability measured by the return on equity (ROE) and the return on assets (ROA) reduced as well. Furthermore, the NBRM increased the CBBIR considering higher inflation amid impact of the main commodity prices on the world markets and risks regarding external position in 2008, followed by additional increase in 2009 due to the demand pressure on the foreign exchange market which affected negatively the foreign exchange reserves. Moreover, in order to maintain stable de facto fixed exchange rate and to underpin attractiveness of the local currency, the NBRM increased the reserve requirement ratio for foreign currency liabilities of the banks. Considering the macroeconomic environment, increased uncertainty and macroprudential measures by the NBRM, the banks decreased the loans relative to the assets and focused to protect the quality of their loan portfolio. As the foreign exchange

[5] Other countries are: Albania, Czech Republic, Romania and Slovakia.

[6] Macroprudential measures were undertaken to prevent the high credit growth risk, to enhance capital, liquidity and regulate the lending in foreign currency. Some of the macroprudential measures were of temporary character such as compulsory deposit with the NBRM for preventing high credit growth risk for credit exposure to households whereas the other measures have been updated in the future period and still being in force. More details of these macroprudential measures one can see from the presentation on the following link http://www.nbrm.mk/WBStorage/Files/Regulativa_Makroprudentni_merki_NBRM_Svetska_banka.pdf.

[7] In this year the effects of the global financial crises were mostly felt in the Macedonian economy.

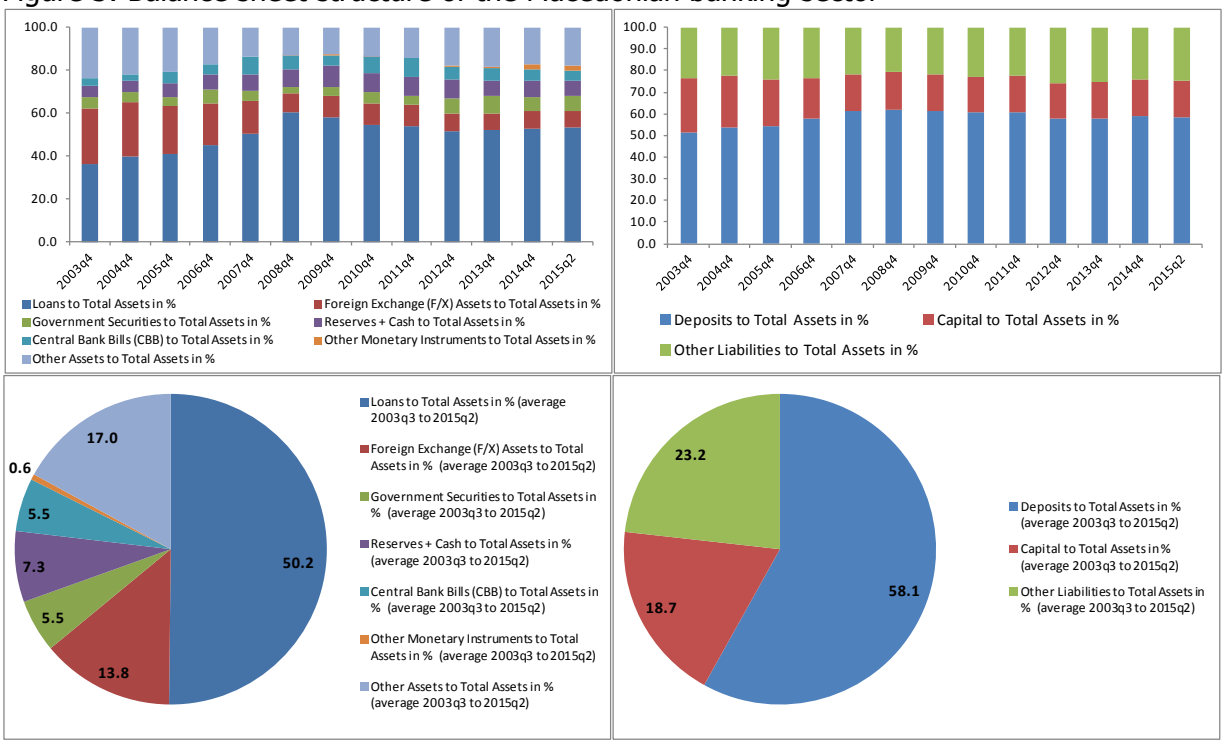
market situation stabilized, the NBRM relaxed the monetary policy and starting from the end of 2009 it decreased the CBBIR. Nevertheless, despite the monetary easing measures provided by the NBRM[8], the banks' lending moderately rose after 2009 mainly due to higher risk perceptions.

The Macedonian banking sector is stable from balance sheet perspective. It is easily observed from the balance sheet structure (Figure 3) that banks dispose with high liquidity and capitalization items. According to the figure 3, the average participation of the liquid assets such as: foreign exchange (F/X) assets, government securities, reserves + cash, central bank bills (CBB) and other monetary instruments is 32.8% out of the total assets in the period from 2003q3 to 2015q2. The loans compose the dominant share of the total assets with average participation of 50.2%. On the liabilities and capital side, the level of deposits has been maintained on stable level with average share of 58.1%. The deposits have been continuously higher compared to the loans throughout the mentioned period indicating that banks have loanable funds for providing loans to the firms and households. Furthermore, the average capitalization is 18.7% of the total assets for the mentioned period or more than double compared to the regulatory[9] prescribed level of 8%.

[8] The NBRM also undertoke other measures to support the bank lending such as release in the reserve requirement for the banks that provide loans to net exporters and domestic electricity producers, at the end of the 2012 effective from 2013 and with the last extension, it will be in force until 2019.

[9] The calculation for the Capital Adequacy Ratio is different than the capital to asset ratio calculated in the figure 3. However, the correlation coefficient between these two ratios is 0.94 and therefore the capital to assets could be used as proxy for the Capital Adequacy Ratio.

Figure 3: Balance sheet structure of the Macedonian banking sector



Source: NBRM

Hence, it is evident from the balance sheet structure that Macedonian banking sector has favorable balance sheet structure. It is well funded with deposits and capital and moreover, the assets side contains large share of liquid assets. Therefore, the Macedonian banking sector has potential for lending.

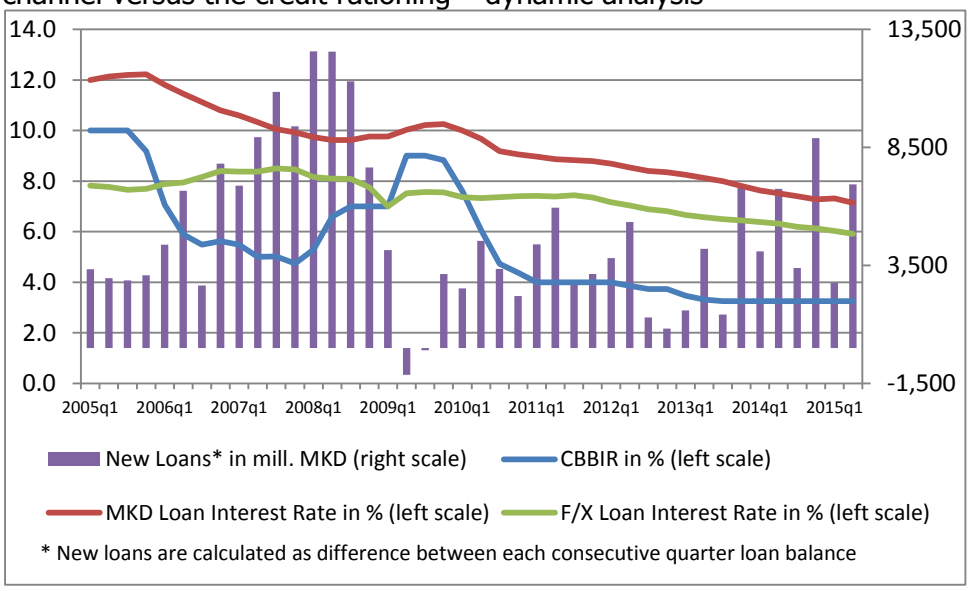
3.2. INDICATIVE ANALYSIS ABOUT THE BANK LENDING CHANNEL IN THE REPUBLIC OF MACEDONIA

Concerning the bank lending channel, it is important to consider movements in the CBBIR, banks' loan interest rates and new loans because they can indicate the presence of the traditional bank lending channel by Bernanke and Blinder or the credit rationing by Stiglitz and Weiss. According to the equation 4 presented above in the Bernanke and Blinder model, the reference or the bond risk-free interest rate positively affects the loan interest rate. Having in mind this relation in the equation 4, Morris and Sellon (1995) claim that the traditional bank lending channel is indicated when tightening of the monetary policy increases the loan interest rates by higher proportion compared to the increase of the reference (money market) interest rate and as a result the new loans reduce. Moreover, according to the authors, the credit rationing is implied when the monetary policy tightening decreases the new loans similarly to the traditional bank lending channel, but the loan interest rates increase less than the increase of the reference interest rate in order not to

cause the adverse selection and moral hazard problems immediately and to crowd out the creditworthy borrowers and stimulate the current borrowers to undertake risky projects.

This interest rate adjustment is a little bit in contrast with the Stiglitz and Weiss presumption that the banks are reluctant to change the loan interest rates as a response to the change of the reference interest rate, but rather they ration the loans to prevent the information asymmetry problems. In addition to this, Scholnick (1991) analyzes the determinants of the loan interest rates for the case of Malaysia and disagrees with the mentioned presumption made by Stiglitz and Weiss. According to this author, from a long run point of view, it is a stylized fact that the banks adjust the loan interest rates in same direction, but with smaller proportion as the central banks increase the reference interest rates. This stylized fact is valid even when the banks ration the loans. Thus, when applying the credit rationing, the banks properly adjust the loan interest rates in response to the adjustment of the reference interest rate, but the adjustment is gradual over time, meaning that the loan interest rates are adjusted with smaller variance relative to the variance of adjustment of the reference interest rate. Namely, given the monetary restrictive signal, the banks do not increase the loan interest rates in a short run in order not to face the adverse selection problem. However, considered from a long run perspective, the banks gradually increase the loan interest rate relative to the reference interest rate, because the costs of loanable funds are gradually rising in long run as well.

Figure 4: Dynamic indicative evidence on the traditional bank lending channel versus the credit rationing – dynamic analysis



Source: NBRM

The figure 4 indicates that new loans sharply rose from 2005q1 to the end of 2008. This period coincides with favorable both macroeconomic and banking sector conditions and thus interest rates declined as well. As soon as the effects of the global financial crisis were felt in causing higher macroeconomic uncertainty, the NBRM in 2008-2009 tightened the monetary policy and introduced macroprudential measures, that together with higher risks perception by banks affected banks' lending. As can be seen from the figure 4, the loan interest rates did not increase as much as the CBBIR in this period, however the new loans sharply declined. Starting from the 2009q2 up to 2013q2, the NBRM decreased the CBBIR from 9.0% to 3.3% and kept it unchanged further during the period considered in the figure. The loan interest rates declined as well, but with less intensity relative to the decline of the CBBIR and the new loans recorded volatile movements during this period. As a consequence of the global financial crisis accompanied by the European debt crisis, there was slight GDP decline in 2009 and 2012 and uncertainty rose. Moreover, as indicated by the figure 2, the NPL ratio started to grow. Thus, the banks were reluctant to decrease the loan interest rates by higher percentage because of their high risk expectations. Furthermore, the calculated variance of the CBBIR is 4.83 percentage points (p.p.), the calculated variance of the denar (MKD) loan interest rate is 2.13 p.p. and the calculated variance of the foreign currency (F/X) loan interest rate is 0.53 p.p., in the period encompassed in the figure 4 (2005q1 to 2015q2). As it is implied by Scholnick (1991), the meaning of the variance comparison of the interest rates is that high variance of the CBBIR is not accompanied with as much high variance in the loan interest rates. Thus, this provides evidence of credit rationing because as it is implied by the studies by Morris and Sellon (1995) and Scholnick (1991), the credit rationing is implied when monetary policy tightening decreases the new loans, but the loan interest rates increase less than the increase of the reference interest rate.

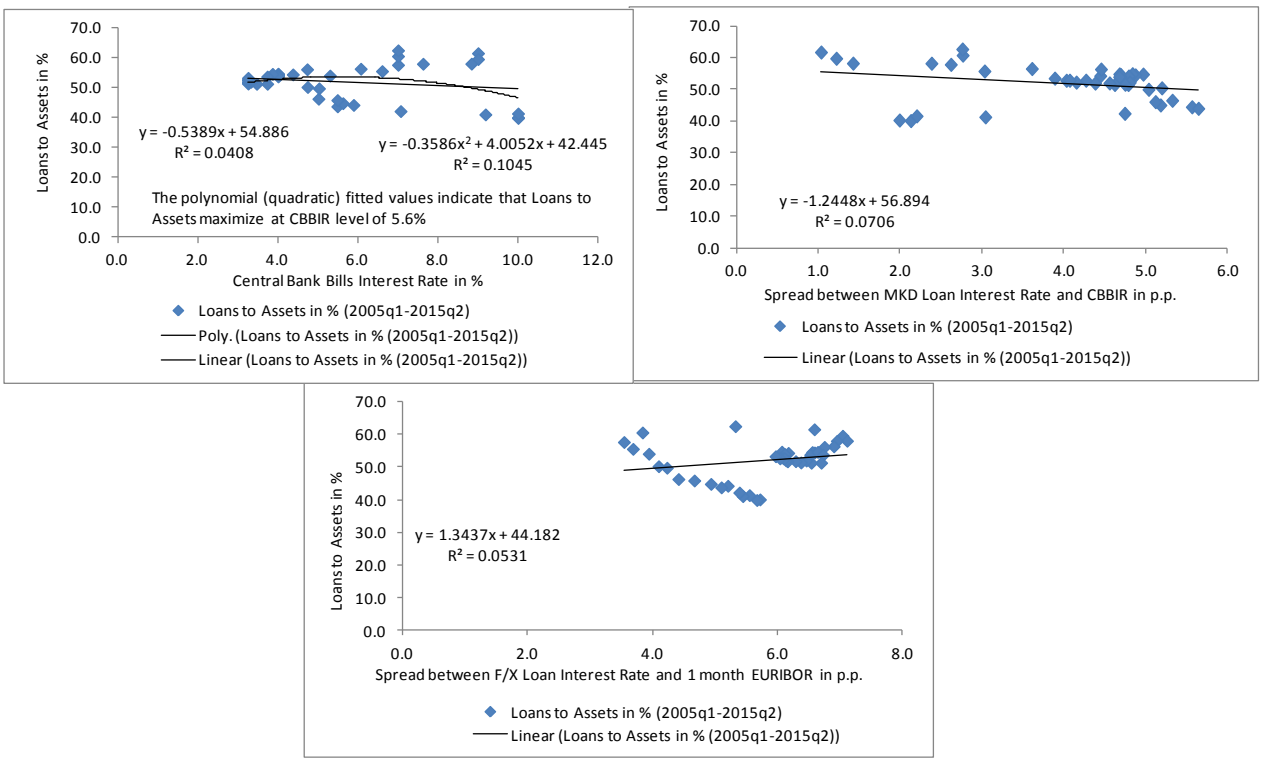
In addition to the indicative analysis in the figure 4, it should be considered the econometric response of the loan interest rates relative to the CBBIR. Therefore, the NBRM assess the interest rates monetary transmission on regular basis. According to the NBRM (2015), the increase of the CBBIR positively affects loan and deposit interest rates. The estimations of the NBRM indicate that 1 p.p. increase of the CBBIR has a smaller than one proportion effect or 0.64 p.p. on the denar credit interest rate and an effect of 0.8 p.p. on the foreign currency credit interest rate. Also, the CBBIR positively influences the deposit interest rates. The estimations cover the period from January 2005 to December 2014 and are based on panel data. Thus, the indicative analysis depicted in figure 4 and the analysis

by the NBRM (2015) provide more evidence in favor of the credit rationing relative to the traditional bank lending channel.

The figure 5 below also provides indicative analysis for the traditional bank lending channel by Bernanke and Blinder versus the credit rationing model by Stiglitz and Weiss. The figure 5 below, presents scatter diagrams of the loans to assets relative to the CBBIR (the left-hand top diagram); the loans to assets relative to the spread between MKD loan interest rate and CBBIR (the right-hand top diagram); and the loans to assets relative to the spread between F/X loan interest rate and 1 month EURIBOR (the lower centered diagram).

The backward bending loan supply curve in the north-east quadrant of the figure 1, and backward bending profit curve in the south-east quadrant of the figure 1 are quadratic functions from mathematical point of view. The quadratic functions should be with the following form $y = \beta 1x - \beta 2x^2$ where y is loans to assets/profitability and x is the CBBIR. It contains positive linear term ($\beta 1x$) that affects positively the dependent variable (y) as the independent variable (x) rises and negative quadratic term ($\beta 2x^2$) that would outweigh the linear term ($\beta 1x$) at some point of x and thus the dependent variable (y) will decrease.

Figure 5: Scater diagrams



Source: NBRM, European Central Bank and Author's Calculations

As indicated by the left-hand top diagram in the figure 5, the quadratic (polynomial) function between the loans to assets and the CBBIR better fits the actual data as indicated

by the higher coefficient of determination[10]. It implies that as the CBBIR increases, primarily the loans to assets also increase, driven by the positive linear term. Economically explained, this means that the banks increase lending guided by higher return incentive. Moreover, an increase of the CBBIR above certain level (threshold) causes loans to assets to decrease, because the negative quadratic term starts to dominate over the linear term after the passed threshold. In economic terms, this means that banks anticipate higher risk by lending at higher interest rate and therefore lend less.

This movement resembles the north-east quadrant of the figure 1 where Stiglitz and Weiss model is depicted. The point of the CBBIR where the loans to assets bends or specificaly the level of the CBBIR that provides maximum loans to assets is 5.6%. This point is obtained by taking the first derivative of the quadratic trend (y is loans to assets and x is the CBBIR) and solving for x when the derivative is set to 0, similarly as in Herath (2010). This calculation is presented in the Appendix 1. Thus, the loans to assets increase up to the calculated point of the CBBIR and above this point the movement of the loans to assets becomes negative.

The right-hand top diagram of the figure 5 implies that increase of the spread between the MKD loan interest rate and the CBBIR or the risk premium is accompanied by decreasing trend of the loans to assets. The relationship between the risk premium and the loans to assets could be considered as an indication of validity of either the traditional bank lending channel or the credit rationing. Namely, having in mind the less proportionate response of the interest rate monetary transmission for Macedonia as indicated by the estimations of the NBRM (2015) provided above, then the increase of the risk premium might be attributed to the following: increase of the loan interest rate while keeping the CBBIR unchanged, decrease of the CBBIR while keeping the loan interest rate unchanged and decrease of the loan interest rate by smaller proportion compared to the decrease of the CBBIR. If the banks consider the widening of the risk premium as an opportunity for making higher return from approving loans and there is no high potential for occurring the adverse selection and the moral hazard, then lending will rise. This is also clearly indicated by the equation 2 given above where the supply of loans positively depend on the loan interest rate and negatively depend on the reference interest rate. Thus, the direct proportionate or positive relationship between the risk premium and the loans to assets would be pure case of the Bernanke and Blinder traditional bank lending channel. In contrast, if the banks perceive the wider risk premium as higher risk for approving loans to

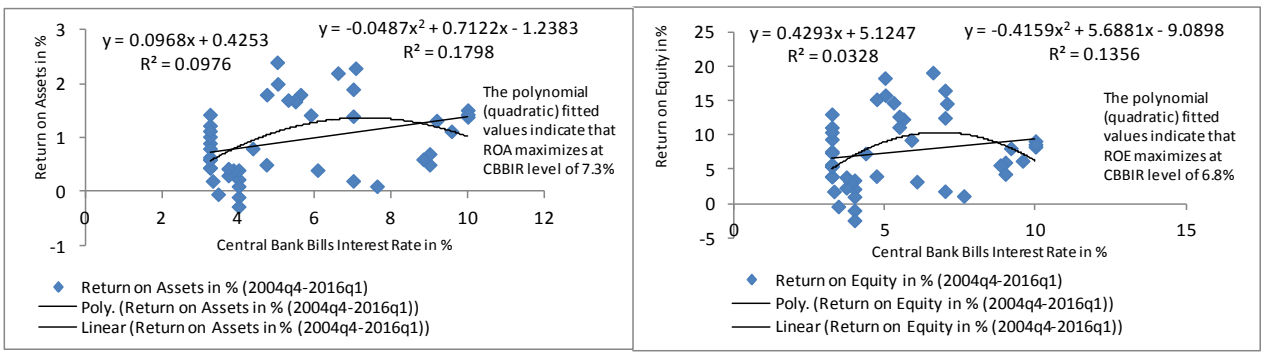
[10] R^2 of the quadratic trend is 10.5% relative to the R^2 of the linear trend which is 4.1%.

non-creditworthy borrowers and borrowers with risky behavior, then lending will decrease and thus it would mean that the banks ration the loans. The right-hand top diagram implies that increase of the spread or the risk premium between the MKD loan interest rate and the CBBIR is negatively associated with the loans to assets by 1.24 p.p. on average. Thus, the inverse relationship between the risk premium and the loans to assets could be considered as an indication of the credit rationing. As a support of this indication, Barran et al (1995) consider the inverse relationship between the loans and the interest rate spread/the risk premium as a proxy for credit rationing.

As indicated by the figure 4, the CBBIR decreased by higher intensity, from 9.0% as of 2009q2 to 3.3% as of 2013q2 and remained unchanged up to the 2015q2, the end of the period considered. From the same figure, it is indicated that the MKD loan interest rate decreased by lower intensity, from 10.2% as of 2009q2 to 8.1% as of 2013q2 and 7.1% as of 2015q2 considering the deteriorated macroeconomic and NPL movements as implied by the figure 2. Therefore, the domestic risk premium widened and most probably it is considered by the banks as higher risk perceptions for the period considered, affecting the banks to ration the loans.

Since the Macedonian banks provide foreign currency loans, the relationship between loans to assets and the foreign interest rate spread or the foreign risk premium (difference between the F/X loan interest rate and 1 month EURIBOR[11]) has been considered in the lower scatter diagram of the figure 5. However, the lower centered diagram does not indicate negative trend between the considered variables.

Figure 6: Scater diagrams with linear and quadratyic trend



Source: NBRM and Author's Calculations

[11] Most of the Macedonian banks have been using the EURIBOR rates as a benchmark rate when approving loans in foreign currency. The 1 month EURIBOR is taken as representative because it is comparable to the CBBIR which refers to 28 days period of time.

Also, as indicated by the south-east quadrant of the figure 1, similar relationship is expected between the profitability and the CBBIR. The figure 6 above contains scatter diagram presenting the relationship between the CBBIR and the profitability measures such as: ROA and ROE. Both diagrams in the figure 6 indicate better fit of the quadratic trend measured by R^2 (R^2 is 18.0% in the left-hand and 13.6% in the right-hand) compared to the linear trend (R^2 is 9.8% in the left-hand and 3.3% in the right-hand). Hence, the both diagrams are similar to the south-east quadrant of the figure 1 and the levels of the CBBIR where the ROA and the ROE bend are 7.3% and 6.8% respectively. Again, these points are obtained by applying the approach represented in Herath (2010), more concretely the points of 7.3% and 6.8% are obtained by taking the first derivative of the quadratic trend (y is ROA/ROE and x is the CBBIR) and solving for x when the derivative is set to 0. The calculation is provided in the appendix 1.

Thus, the figures 4, 5 and 6 given above provide more indicative evidence in favor of the credit rationing compared to the traditional bank lending channel in the RM. The credit rationing appears at the level of the CBBIR between 5.6% and 7.3%. Nevertheless, the econometric methodology utilized further in this paper will have to confirm or reject this indicative conclusion.

4. ECONOMETRIC SPECIFICATION, DATA AND METHODOLOGY

4.1. ECONOMETRIC SPECIFICATION AND DATA

The econometric specification for estimating the bank lending channel in RM will be based on the traditional bank lending channel by Bernanke and Blinder and the credit rationing model by Stiglitz and Weiss. Both models incorporate the loan demand and the loan supply, but the main difference is in the form of the loan supply relative to the loan interest rate, and that is positive sloping in the former and backward bending in the latter. Therefore, the Eq. 2 and 3 from the Bernanke and Blinder theory given above (p. 5) are the starting point for specifying the econometric regressions for both models because they include the basic variables that affect the loan demand and the loan supply. Nevertheless, the regressions will be properly adjusted when estimating the Stiglitz and Weiss model in order to allow backward bending loan supply curve. Additionally, the regressions will be augmented with other variables in order to encompass other factors and to obtain reliable estimations.

The regressions for estimating both the Bernanke and Blinder model and the Stiglitz and Weiss model will encompass banking sector variables, macroeconomic variables and central bank variables.

The banking sector variables are the following:

- Loans to assets ratio as dependent variable, taken in logit transformed form denoted as $loans\ to\ non-loans = ln\left(\frac{loans\ to\ assets\ in\ \%}{100\%-loans\ to\ assets\ in\ \%}\right)$,
- Deposits to assets in % as independent variable,
- Capital to assets as independent variable and
- Non-performing loans ratio as independent variable.

The above given banking sector variables are taken as ratios based on the items in the balance sheet. The section above concerning the overview of the theoretical literature explains that each central bank's measure affects the banks to reassess the risk-return profile and to appropriately adjust and restructure the financial statements. Due to that, the banking sector variables are taken as balance sheet proportions.

Furthermore, the loans to assets or denoted as loans to non-loans is the so called logit transformed variable which is very often used in the stress test literature where either the NPL ratio or the loan-loss reserves to loans are used as a dependent variable (Ceca and Shijaku (2011), IMF, Country Report on Croatia (2007), Kucukozmen and Yuksel (2006), Vazquez et al (2010) and Wezel et al (2014)). Since the loans to assets (in %) variable has been limited between 0% and 100%, an econometric problem of technical nature might arise with non-Gaussian errors as suggested by the mentioned literature. Therefore, the logit transformation provides unrestricted variable ranging between $-\infty$ and $+\infty$ and the potential non-Gaussian errors would be avoided. More importantly, estimating regression with limited ranging dependent variable reduces its forecasting power. Namely, estimating regression with limited ranging variables is not wrong by itself and it is feasible. However, such estimated regression would indicate only the magnitude with which the independent variable affects the dependent variable, but the predictive power of such estimated regression might be low. Namely, sometimes the estimated regression might predict loans to assets with negative value or above 100% which is not logical having in mind the limited range. One of the reasons for such illogicality, sometimes might be the estimated intercept term that might contribute the values of the dependent variable to exit from the specified limit between 0% and 100%. Therefore, the logit transformation of the loans to assets

allows such limited variable to be unrestricted and thus it would mitigate the potential predictiveness disadvantage.

From economic point of view, the deposits and capital variables are representatives of the funding potential of the Macedonian banking sector while the NPL variable is representative of the quality of the loan portfolio. An increase of the deposits creates higher funding potential for the banks and leads to more loans. The relationship between capital to assets ratio and the dependent variable might be positive or negative. Namely, an increase of the banking sector capital to assets ratio might also contribute to higher funding potential for providing more loans. However, this ratio might increase as a result of lending restrictions when banks perceive higher risks in the economy or the price of the capital has increased. Therefore, the banks might reduce loans in order to decrease the assets (denominator) and accordingly to increase the capital to assets ratio. Concerning the NPL variable as a measure of the loan portfolio quality, it was mentioned above that as the loan portfolio quality worsens, then loan-loss provisions and costs increase affecting negatively the profit. Therefore, depositors are not interested to deposit money in non profitable banks and loanable funds decrease and affect negatively the loans.

What lacks within the above given independent banking specific variables is a liquidity variable. However, this potential deficiency is corrected by taking the ratio of loans to non-loans assets as dependent variable which includes the liquid assets. Namely, the denominator in the loans ratio $(100\% - loans\ to\ assests\ in\ \%)$, which equals to the non-loans to assets are dominantly the liquid assets. Therefore, as the nominator or the loans to assets in the dependent variable grows, accordingly the denominator or the liquid assets decline. Thus, such defined dependent variable has dual nature meaning that it encompasses loan side and liquidity side of the banks.

The macroeconomic variables are the following:

- Real GDP at 2005 prices in millions of denars as independent variable, taken as natural logarithm,
- Industrial production index as independent variable, taken as natural logarithm and
- Inflation rate in % as independent variable, calculated as year on year growth of the consumer price index (CPI).

As it is specified in the equation 3 of the Bernanke and Blinder model given above, the income positively affects the loan demand. GDP and industrial production are proxies for

the general income. Namely, as GDP rises, the economic agents earn more income and thus their creditworthiness improves and gives them potential to borrow more money from the banks. However, the GDP affects the loan supply as well because the banks follow this macroeconomic indicator and assess it from the risk-return approach because the positive GDP is perceived by the banks as an opportunity for increased lending to creditworthy borrowers and eventually realizing higher profit. The industrial production variable could be considered as a proxy of the income and it is expected to have same effect on the lending as the GDP variable. The inflation rate is representative of the macroeconomic risks and its effect on the banks' lending might be inconclusive or more concretely positive or negative depending on whether the banks perceive the inflation level as contributory to high or low macroeconomic uncertainty.

The central bank variables are the following:

- Nominal CBBIR in % as independent variable,
- Reserve requirement ratio[12] in % as independent variable and
- Nominal 1-month EURIBOR (independent variable).

The focus will be put on the CBBIR variable as a key variable for the monetary transmission and its effect should indicate whether the NBRM affects negatively the bank lending channel. The key variable is taken as nominal variable because the NBRM provides its' monetary signal by adjusting the nominal CBBIR. The reserve requirement ratio is also adjusted by the NBRM and it negatively affects the deposits availability as a source for the banks' lending. The 1-month EURIBOR[13] is taken to control for the exogenous effects on the loans that are provided by the Macedonian banking sector in F/X loan interest rate. Most of the Macedonian banks use the EURIBOR rates as a benchmark rate when approving loans in foreign currency. The 1-month EURIBOR is taken as representative because it is comparable to the CBBIR which refers to 28 days period of time.

The banking sector variables and the central bank variables are taken from the monetary statistics reports published by the NBRM with exception for the 1 month EURIBOR

[12] The reserve requirement ratio used in this paper had to be unified because there are different reserve requirement ratios for banks' obligations depending on the currency structure and that is obligations in MKD, in MKD with F/X clause and in F/X. Therefore, the unified reserve requirement ratio was calculated as a weighted average among the separate currencies' reserve requirement ratios.

[13] Nominal 1-month EURIBOR variable is taken as exogenous variable in the econometric testing while all other independent variables are taken as endogenous variables.

which is taken from the statistics of the European Central Bank. The source of the macroeconomic variables is the State Statistical Office of the Republic of Macedonia.

The dataset consists of quarterly observations for the period from 2003q3 to 2015q2 for the RM. The quarterly data for the industrial production, inflation, the nominal CBBIR, the reserve requirement and the nominal 1 month EURIBOR are calculated as average of the corresponding months within each quarter. Also, all the series are seasonally adjusted by using the additive Census X12 option in EViews 8, with the exception only made for the CBBIR, the reserve requirement ratio and the 1 month EURIBOR. Moreover, the unit root tests provide evidence that the variables are non-stationary indicating that they are integrated of order 1 - I(1)[14].

The Bernanke and Blinder model will be specified as a function of the following endogenous variables[15]:

$$loans\ to\ non-loans_t = f\begin{pmatrix} Deposits\ to\ assets_t, Capital\ to\ assets_t, \\ Non-performing\ loans\ ratio_t, GDP_t, Industrial\ production_t, \\ Inflation_t, CBBIR_t, Reserve\ requirment\ ratio_t \end{pmatrix} \quad (5)$$

Furthermore, the Stiglitz and Weiss model will start from the Bernanke and Blinder specification and it will be augmented with quadratic term of the CBBIR. Thus, the expected sign of the coefficient in front of the linear term should be positive while the expected sign of the coefficient in front of the quadratic term should be negative similarly to the quadratic trend obtained in the left-hand scatter diagram in the figure 5. If the estimated coefficients of both the linear and quadratic CBBIR are as expected and statistically significant, then backward bending loan supply curve will be estimated as indicated by the north-east quadrant of the figure 1. Hence, the indications will be confirmed that the Macedonian banking sector rations the loans as provided in the above given indicative analysis.

The Stiglitz and Weiss model will be specified as a function of the following endogenous variables[16]:

$$loans\ to\ non-loans_t = f\begin{pmatrix} Deposits\ to\ assets_t, Capital\ to\ assets_t, \\ Non-performing\ loans\ ratio_t, GDP_t, Industrial\ production_t, \\ Inflation_t, CBBIR_t, CBBIR_t^2, Reserve\ requirment\ ratio_t \end{pmatrix} \quad (6)$$

[14] Results are available upon request from the author and they are not presented in order to save space.
[15] The 1-month EURIBOR is not contained here because it is taken as an exogenous variable.
[16] The 1-month EURIBOR is not contained here because it is taken as an exogenous variable.

The above given econometric specifications 5 and 6 do not consist the loan interest rates because the data[17] are not available for the period from 2003q3 to 2004q4. The published data on the NBRM website for the interest rates are available from 2005 onwards. Therefore, an additional econometric specification 7 is made below, mainly based on the variables included in the specifications 5 and 6, and it additionally includes the domestic and the foreign risk premiums. The dataset for estimating the equation 7 spans from 2005q1 to 2015q2.

$$loans\ to\ non-loans_t = f\begin{pmatrix} Deposits\ to\ assets_t, Capital\ to\ assets_t, \\ Non-performing\ loans\ ratio_t, GDP_t, Industrial\ production_t, \\ Inflation_t, MKD\ loan\ interest\ rate_t - CBBIR_t, \\ F/X\ loan\ interest\ rate_t - 1\ month\ EURIBOR_t, Reserve\ requirment\ ratio_t \end{pmatrix} \quad (7)$$

Thus:

- The domestic risk premium in p.p. - it is defined as a difference between the MKD loan interest rates and the CBBIR and
- The foreign risk premium in p.p. - it is defined as a difference between the F/X loan interest rates and the 1-month EURIBOR.

Both risk premium variables have dual nature because they represent the influence of the risk-return profile on the banks' lending. Their effect on the lending implies whether the Macedonian banking sector more weighs the return or the risk. Especially important variable for considering is the domestic risk premium variable which contains the CBBIR as reference interest rate. Direct proportionate or positive relationship between the risk premium and the loans to non-loans would mean that banks weigh the return more relative to the risk. Namely, such direct proportionate relationship indicates that the banks are not concerned about the possible adverse selection and moral hazard problems as the loan interest rate rises relative to the reference interest rate, but they perceive this as an opportunity for higher return. Thus, this effect is an indication of the Bernanke and Blinder model. In contrast, the indirect proportionate or negative relationship between the risk premium and the loans to non-loans means the opposite or concretely that the banks weigh more the risk relative to the return. This relationship would imply that the banks ration the loans as the loan interest rate increases compared to the reference interest rate in order to avoid the mentioned problems. Therefore, this is an indication of the Stiglitz and Weiss model. Hence, the estimated positive or negative coefficient in front of the risk premiums

[17] The data for the interest rates are based on the new methodology from 2015 and previous methodology from 2005 to 2014.

within the equation 7 differentiates between the traditional Bernanke and Blinder bank lending channel and the Stiglitz and Weiss credit rationing model.

Also, all data are seasonally adjusted by using the additive Census X12 option in EViews 8, with the exception only made for the components of domestic and foreign risk premium. Additionally, the unit root tests provide evidence that the variables are non-stationary, indicating that they are integrated of order 1 - I(1)[18].

4.2. METHODOLOGY

The econometric testing of the bank lending channel in the RM will be done by employing the vector error correction model (VECM). The VECM is based on maximum likelihood multivariate estimation approach. It is sophisticated technique and is widely used for estimating the bank lending channel and assessing the monetary transmission (Cyrille (2010), De Mello and Pisu (2009), Hulsewig et al (2002), Kakes (2001), Ludi and Ground (2006) and Sun et al (2010).

Clearly from economic point of view, this technique is appropriate for analyzing market behavior because the essence of each market is its equilibrium. The VECM technique is a cointegration technique that assumes long-run equilibrium relationship between the variables (Davidovska-Stojanovska et al, 2008). Additionally, every deviation from the long run equilibrium is temporary and it is corrected by the error correction mechanism (ECM) which presents the speed of adjustment of the disequilibrium towards the long-run equilibrium. Thus, the utilization of the VECM technique is appropriate because the loan market is also in equilibrium according to Bernanke and Blinder model or so called credit rationing equilibrium according to the Stiglitz and Weiss model. Moreover, the loan market movements are determined by many factors that affect the market equilibrium in the long run as well as contribute to short-run deviations from the market equilibrium.

Furthermore, the implementation of the VECM technique in this study is also justified because it is closely aligned with the economic theory. Namely, this technique allows for estimating multiple regressions, specificaly estimating more than one cointegrating vector implying that the loan demand and the loan supply can be separately estimated. If the VECM indicates more than one cointegrating vectors, then restrictions should be assigned to the coefficients of the variables in order to estimate the regressions. The assigning of the

[18] Results of the Augmented Dickey-Fuller test and Phillips-Perron test are available upon request from the author and they are not presented in order to save space.

restrictions to the variables' coefficients means some of them to be excluded from the first cointegrating vector and to appear in the second one and vice versa, if in case two cointegrating vectors are suggested by the cointegration tests. Nevertheless, it is desirable the assigning of the restrictions to the coefficients of the variables to be based on economic theory. In our case, it is based on Bernanke and Blinder model because concretely specifies which variables affect the loan demand and the loan supply. Thus, the loan demand and the loan supply in this model can be considered as two cointegrating vectors in a sense of the VECM technique. For instance, the assigning of the restrictions in a case of two cointegrating vectors would mean the GDP coefficient to be restricted to zero effect on the loans to non-loans (not to appear) in the cointegrating vector that would represent the loan supply and to appear in the loan demand only. The theoretical justification for restricting the GDP coefficient in the loan supply is that the Bernanke and Blinder theory considers the GDP as a determinant of the loan demand according to the equation 3 given above, not as determinant of the loan supply even though the GDP can affect the banks risk-return perceptions and accordingly the loan supply. Also, relying on the Bernanke and Blinder theory, the banking sector variables or deposits to assets for example, can be restricted to zero coefficient and have no effect on the loans to non-loans (not to appear) in the loan demand and to appear in the loan supply only as suggested by the equation 2. Therefore, the utilization of the VECM for estimating the bank lending channel is very appropriate because it can be closely aligned to the solid theoretical foundation presented in the Bernanke and Blinder model, when more than one cointegrating relation is suggested.

From technical or more precisely econometric point of view, the VECM technique allows variables to be taken with same order of integration and uses lags in order to mitigate the problem that might arise of the endogenous variables (Haris and Sollis, 2003). Thus, when the theoretical relationship between the selected variables is analyzed, then the problem of endogeneity arises. For example, the GDP is an important factor that affects bank lending and vice versa, credit activity contributes towards higher GDP. From econometric point of view, the problem of endogeneity occurs when the independent variables are connected with the residuals in a regression model and subsequently the results obtained might be biased and inconsistent (Gujarati, 2004). The presence of endogenous variables in the model and the fact that the data series are non-stationary and are integrated of the same order; are the econometric-technical arguments why the VECM technique is appropriate for analyzing the bank lending channel.

5. ESTIMATION RESULTS

5.1. BERNANKE AND BLINDER VERSUS STIGLITZ AND WEISS

In order to estimate the coefficients in front of the independent variables, each of the specifications 5, 6 and 7 will be developed into more regression equations by making proper combinations of the independent variables. The development of the regressions will enable achieving double purpose and that is, firstly, not over-parametarizing the regressions and secondly, check of the robustness of the results. Namely, estimating more regressions by combining few variables will not overburden them with too many parameters, having in mind the limited time period subject of investigation. Consequently, the regressions will not suffer from loosing of too many degrees of freedom and the possibility for estimating biased results will be reduced. Moreover, the various regressions and the different time period encompassed in the specifications 5 and 6 on the one hand and 7 on the other hand, will also allow for checking the robustness of the estimated results or concretely whether the estimated coefficients in front of the independent variables have proper positive or negative influence on the dependent variable.

The procedure for applying the VECM technique requires technical formalities[19] to be accounted for such as: choosing the appropriate level of VAR or determining the number lags that are going to be included and determining the number of the cointegrating vectors. The level of VAR is arbitrarily set to 2 and again the reason is not to over-parameterize the regressions with too many lags and loose degrees of freedom that might lead to obtain biased results. Regarding the determination of the number of the cointegrating vectors, the trace test and the maximum eigenvalue test are considered. Both tests yield different results and therefore choice between one of them has to be made. Lutkepohl et al (2000) explains that the trace test is more reliable and has greater power performance compared to the maximum eigenvalue test. On the other hand, Hossain (2008, p. 5) mentions that according to Banerjee et al (1993), the maximum eigenvalue test is more preferred compared to the trace test when both tests obtain different number of cointegrating vectors. Additionally, Mukhtar and Rasheed (2010, p. 47) also suggest the maximum eigenvalue test to be taken into consideration because of its greater reliability in small samples unlike the trace test. The

[19] These technical formalities are available upon request from the author and they are not included in the paper in order to save space.

maximum eigenvalue test[20] suggests either one or two cointegrating vectors for the regressions that are going to be considered in the paper. Unlike the maximum eigenvalue test, the trace test will be neglected because it suggests more than two vectors for some regressions and makes the estimation unfeasible. Therefore, the maximum eigenvalue test is preferred in this paper for determining the number of the cointegrating vectors.

Furthermore, the dependent variable loans to non-loans ratio is defined as logit transformation of the loans to assets. Therefore, the chain rule will be applied in order to assess the effect of the independent variables on the loans to assets evaluated at its' sample mean as suggested by the stress test literature or more concretely IMF, Country Report on Croatia (2007, p. 102) and Vazquez et al (2010, p. 14). The chain rule is presented in the formula 8 given below.

$$\frac{\Delta\, Loans\ to\ assets\ in\ p.p.}{\Delta\, X\ in\ p.p.\ or\ \%} = \{long - run\ coefficient(X) * \frac{\overline{Loans\ to\ assets\ in\ \%} * \left(100 - \overline{Loans\ to\ assets\ in\ \%}\right)}{100}\}/100 \qquad (8)$$

where: $\Delta loans\ to\ assets$ is the estimated long-run effect (change in percentage points (p.p.)) on the loans to assets, *long-run coefficient(X)* is the long-run coefficient in front of the respective independent variable, $\overline{Loans\ to\ assets\ in\ \%}$ is the mean value of the seasonally adjusted loans to assets and ΔX is a change of the independent variable and is assumed ΔX=1[21].

The tables 1, 2 and 3 below contain the estimated long run coefficients in front of the independent variables as well as the ECM term.

[20] The maximum eigenvalue test is considered on 5% or 1% statistical level of significance depending on the number of the cointegrating vectors obtained and the reasonability of the obtained results, or more concretely, if obtained more than two cointegrating vectors then the cointegrating vectors could not be identified by assigning restrictions to the long-run coefficients.

[21] ΔX=1 is expressed in percentage points for variables expressed in % and in % for variables taken as natural logarithm.

Table 1: Estimated regressions based on the specification 5

	Estimated long-run effect in % on loans to non-loans as dependent variable						
Probability for non-rejection of the long-run coefficient restrictions when having two cointegrating vectors			0.14			0.49	
	1	**2**	**3**		**4**	**5**	
	1 cointegrating vector	**1 cointegrating vector**	**2 cointegrating vectors**		**1 cointegrating vector**	**2 cointegrating vectors**	
			Loan Demand	**Loan Supply**		**Loan Demand**	**Loan Supply**
Deposits to assets	7.79***	8.35***					
Capital to assets				-16.36***			
Non-performing loans ratio					-34.49***		-20.73***
Inflation	3.96***	2.95***	8.33***		42.91***	34.53***	4.23***
GDP	0.60				-1.34		
Industrial production		1.73***	6.49***			18.10***	
CBBIR	4.93***	3.52***	11.90***	10.06***	24.92	41.07***	-1.50
Reserve requirement ratio		-7.89***					-43.60***
ECM	-0.09	-0.27***	-0.06***	0.07	-0.007	-0.01***	-0.03
*****, ** and * indicate statistical level of significance at 1%, 5% and 10%**							
	Estimated long-run effect on Loans to assets in percentage points						
$\overline{Loans\ to\ assets} = 50.17\%$	$\frac{\Delta\ Loans\ to\ assets}{\Delta\ X} = \{long - run\ coefficient(X) * \frac{\overline{Loans\ to\ assets} * \left(100 - \overline{Loans\ to\ assets}\right)}{100}\}/100$						
	1	**2**	**3**		**4**	**5**	
			Loan Demand	**Loan Supply**		**Loan Demand**	**Loan Supply**
Deposits to assets	1.95***	2.09***					
Capital to assets				-4.09***			
Non-performing loans ratio					-8.62***		-5.18***
Inflation	0.99***	0.74***	2.08***		10.73***	8.63***	1.06***
GDP	0.15				-0.34		
Industrial production		0.43***	1.62***			4.52***	
CBBIR	1.23***	0.88***	2.97***	2.51***	6.23	10.27***	-0.37
Reserve requirement ratio		-1.97***					-10.90***
*****, ** and * indicate statistical level of significance at 1%, 5% and 10%**							

Source: author's estimations

The estimated results contained in the table 1 suggest the following long-run effects on the loans to assets variable[22]:

- Deposits to assets ratio have positive average effect on the loans to assets from 1.95 p.p. to 2.09 p.p., ceteris paribus. The coefficients are statistically significant.

[22] See the lower part in the table 1. The results are obtained by using the chain rule given in the equation 8 and the estimated long-run coefficients in the higher part of the table 1.

- Capital to assets ratio has negative average effect on the loans to assets of 4.09 p.p., ceteris paribus. The coefficient is statistically significant.
- Non-performing loans ratio has negative average effect on the loans to assets from 5.18 p.p. to 8.62 p.p., ceteris paribus. The coefficients are statistically significant.
- Inflation has positive average effect on the loans to assets from 0.99 p.p. to 10.73 p.p., ceteris paribus. The coefficients are statistically significant.
- GDP coefficients are statistically insignificant.
- Industrial production index has positive average effect on the loans to assets from 0.43 p.p. to 4.52 p.p., ceteris paribus. The coefficients are statistically significant.
- CBBIR has positive average effect on the loans to assets from 0.88 p.p. to 10.27 p.p., ceteris paribus. The coefficients within this interval are statistically significant, the others are not.
- Reserve requirement ratio has negative average effect on the loans to assets from 1.97 p.p. to 10.90 p.p., ceteris paribus. The coefficients are statistically significant.

The results in the table 1 are based on the specification 5 and should represent the Bernanke and Blinder model. The regressions 3 and 5 are estimated with two cointegrating vectors, while the other regressions are estimated with one cointegrating vector. Concerning the regressions 3 and 5, zero restrictions have been assigned to the long-run coefficients of the banking sector variables (not to appear) in the first cointegrating vector and zero restrictions have been assigned to the long-run coefficients of the income variables (not to appear) in the second cointegrating vector. Thus, as suggested by the Bernanke and Blinder equations 2 and 3 given above, the first cointegrating vector represents the loan demand and the second cointegrating vector represents the loan supply.

The results in the table 1 suggest that the estimated long-run coefficients in front of the independent variables are reasonable concerning their sign, but the magnitude is very variable and relatively large for NPL ratio, inflation, industrial production, CBBIR and reserve requirement ratio. The deposits to assets and non-performing loans ratio have expected positive and negative effect, respectively. Peculiar is the negative effect of the capital to assets ratio, most probably suggesting that the Macedonian banking sector restricts the lending in order to decrease the assets (denominator) and thus increase the capital to assets ratio. This might be reasonable due to the underdeveloped capital market in RM and therefore the banks have not been using extensively the primary market to increase the equity base. The inflation positively affects the dependent variable. This is also reasonable having in mind the relatively stable level of the inflation that has been maintained

throughout the considered period, but the effect is with very variable magnitude. The GDP coefficients are unexpectedly with variable signs, but statistically insignificant. The industrial production might be considered as a proxy for the income and its' effect is positive, but with relatively variable magnitude.

Concerning the monetary transmission, the CBBIR variable has positive effect on the loans to assets and it is not in accordance with expectations, nor with the obtained negative coefficient of the linear trend in the left-hand scatter diagram of the figure 5 given in the section 3.2. Although, the positive effect of the CBBIR might be considered as expected in the loan demand of the regressions 3 and 5, as implied by the Bernanke and Blinder definition of loan demand in the equation 3, still this effect is contradictory. Namely, the CBB are monetary instrument that NBRM uses to regulate the liquidity of the banks. Also, companies have not been using the Macedonian stock exchange extensively to fund their activities by substituting the banks' loans with bonds. Thus, when the CBBIR rises, then most of the regular banks' borrowers do not face higher cost on the stock exchange market in order to switch the bonds with the banks' loans. Such effect of the CBBIR in the loan demand of the regressions 3 and 5 might be result of the high liquidity of the banks and the fact that CBBIR is not cost of financing for them (Jovanovic et al, 2015). High banking liquidity contributes the banks not to change the loan interest rates immediately and lend at prevailing rates. Moreover, banking sector recorded strong rates of loan growth backed up by the their favorable balance sheet structure and that is high level of deposits and capital accompanied with declining trend of NPL ratio at the beginning of the period under investigation (2003q3). Additionally, the loan demand was driven by the positive macroeconomic performances of the Macedonian economy up to the period of 2009q1 when the effects of the global economic recession were felt. Most probably, the banks by perceiving previous mentioned factors (their favorable balance sheet structure and macroeconomic performance) within this period, they increased lending rapidly in order to catch up the credit convergence that was lower during the previous years. In addition to this, it can be observed from the results in the table 1 that the effect of the deposits to assets, capital to assets and NPL ratio is higher compared to the effect of the CBBIR. The rationale would be that the favorable structure of the banking sector balance sheet, or more specifically, the rise of the deposit base and improvement of the NPL ratio provided potential for relatively very high rates of loans growth at the expense of the capital to assets ratio. Finally, the reserve requirement ratio has negative effect with relatively large variability in the magnitude.

Table 2: Estimated regressions based on the specification 6

	Estimated long-run effect in % on loans to non-loans as dependent variable						
Probability for non-rejection of the long-run coefficient restrictions when having two cointegrating vectors		0.03**[23]				0.54	
	1	**2**		**3**		**4**	
	1 cointegrating vector	**2 cointegrating vectors**		**1 cointegrating vector**		**2 cointegrating vectors**	
		Loan Demand	**Loan Supply**			**Loan Demand**	**Loan Supply**
Deposits to assets	2.56***						
Capital to assets			-12.92***				
Non-performing loans ratio				-4.07***			-15.29***
Inflation	1.18***	5.16***	0.90**	1.27***		40.95***	2.84**
GDP	2.42***			1.85***			
Industrial production		5.90***				10.15***	
CBBIR	41.60***	10.10***	42.30***	47.03***			
CBBIR²	-2.77***		-2.68***	-3.23***			
Reserve requirement ratio							-22.00***
ECM	-0.15	-0.06**	0.15	-0.05		-0.01**	-0.002
***, ** and * indicate statistical level of significance at 1%, 5% and 10%							

	Estimated long-run effect on Loans to assets in percentage points						
$\overline{Loans\ to\ assets} = 50.17\%$	$\frac{\Delta\ Loans\ to\ assets}{\Delta\ X} = \{long - run\ coefficient(X) * \frac{\overline{Loans\ to\ assets} * (100 - \overline{Loans\ to\ assets})}{100}\}/100$						
	1	**2**		**3**		**4**	
		Loan Demand	**Loan Supply**			**Loan Demand**	**Loan Supply**
Deposits to assets	0.64***						
Capital to assets			-3.23***				
Non-performing loans ratio				-1.02***			-3.82***
Inflation	0.30***	1.29***	0.22**	0.32***		10.24***	0.71**
GDP	0.60***			0.46***			
Industrial production		1.47***				2.54***	
CBBIR	10.40***	2.52***	10.58***	11.76***			
CBBIR²	-0.69***		-0.67***	-0.81***			
Reserve requirement ratio							-5.50***
***, ** and * indicate statistical level of significance at 1%, 5% and 10%							

Source: author's estimations

The estimated results contained in the table 2 suggest the following long-run effects on the loans to assets variable[24]:

[23] The hypothesis for restricting the long-run coefficients is rejected at 5% and 10% statistical level of significance, but it is not rejected at 1% statistical level of significance.

- Deposit to assets ratio has positive average effect on the loans to assets of 0.64 p.p., ceteris paribus. The coefficient is statistically significant.
- Capital to assets ratio has negative average effect on the loans to assets of 3.23 p.p., ceteris paribus. The coefficient is statistically significant.
- Non-performing loans ratio has negative average effect on the loans to assets from 1.02 p.p. to 3.82 p.p., ceteris paribus. The coefficients are statistically significant.
- Inflation has positive average effect on the loans to assets from 0.22 p.p. to 10.24 p.p., ceteris paribus. The coefficients are statistically significant.
- GDP has positive average effect on the loans to assets from 0.46 p.p. to 0.60 p.p., ceteris paribus. The coefficients are statistically significant.
- Industrial production index has positive average effect on the loans to assets from 1.47 p.p. to 2.54 p.p., ceteris paribus. The coefficients are statistically significant.
- The linear and the quadratic terms of CBBIR have the expected positive and negative signs, respectively. The coefficients are statistically significant.
- Reserve requirement ratio has negative average effect on the loans to of 5.50 p.p., ceteris paribus. The coefficient is statistically significant.

The results in the table 2 are based on the specification 6 and should represent the Stiglitz and Weiss model. The estimated long-run coefficients in front of the independent variables are reasonable concerning their sign and the magnitude with exception for the inflation where the magnitude is very variable and relatively large. The regressions 2 and 4 are estimated with two cointegrating vectors, while the other regressions are estimated with one cointegrating vector. Concerning the regressions 2 and 4, similarly as presented in the table 1 for the regressions 3 and 5, the first cointegrating vector represents the loan demand and the second cointegrating vector represents the loan supply. Namely, zero restrictions have been assigned to the long-run coefficients of the banking sector variables (not to appear) and the quadratic term of the CBBIR[25] in the first cointegrating vector and zero restrictions have been assigned to the long-run coefficients of the income variables (not to appear) in the second cointegrating vector.

[24] See the lower part in the table 2. The results are obtained by using the chain rule given in the equation 8 and the estimated long-run coefficients in the higher part of the table 2.

[25] As can be seen from the north-east quadrant of the figure 1 given above, the loan demand is linear downward sloping curve relative to the interest rate and therefore it should not contain the quadratic term of the CBBIR. The quadratic term of the CBBIR should be included in the cointegrating vector that represents the loan supply and it is supposed to provide bending of the loans to assets.

The results in the table 2 indicate that the banking sector variables (deposits to assets, capital to assets and NPL ratio) have similar effect with regards to the sign, as in the table 1. The inflation positively affects the dependent variable. The coefficients in front of the GDP and the industrial production are positive and statistically significant. Similarly as in the table 1, the reserve requirement ratio has negative effect.

Finally, the linear and the quadratic term of the CBBIR have the expected positive and negative effects on the loans to assets, respectively and they are statistically significant. These estimated coefficients are evidence in favor of the Stiglitz and Weiss model. The figures 7, 8 and 9 below provide graphical presentation of the effect of the CBBIR variable and that is the backward bending curve of the loans to assets, having in mind the ceteris paribus principle.

According to the figures 7, 8 and 9 as well as the given calculations, the points of the CBBIR where the loans to assets bends or the levels of the CBBIR that provide maximum loans to assets are: 7.5%, 7.9% and 7.3%, respectively. Similarly as the calculation provided in the indicative analysis, these points are obtained by taking the first derivative of the regressions 1, 2 and 3 in the table 2[26] with respect to CBBIR.

Thus, the banks increase the loans to assets by diminishing rate up to the CBBIR level of 7.3% to 7.9% and above this point the loans to assets decrease. For example, as can be seen from the right-hand part of the figure 7, an increase of the CBBIR[27] by 1 p.p. or from 3.25% to 4.25% has a positive marginal effect on the loans to assets by 5.20 p.p.. Following increase of the CBBIR by 1 p.p. or from 4.25% to 5.25% affects the loans to assets to rise by lower marginal rate of 3.81 p.p.. Furthermore, as the CBBIR rises up to the level of 7.5%, it can be seen that the loans to assets rise by diminishing marginal rate and afterwards it turns into negative. The same conclusion can be derived from the figures 8 and 9 as well.

Within the figures 7, 8 and 9, the results obtained are fitted values for loans to assets with respect to the CBBIR ranging from 3.25 to 10 for the period under investigation. Figures suggest that banks increase the loans up to certain level of the CBBIR (threshold) in line with the contribution in the profitability[28]. Hovewer, above the CBBIR threshold, the

[26] See the estimated coefficients in the lower table.

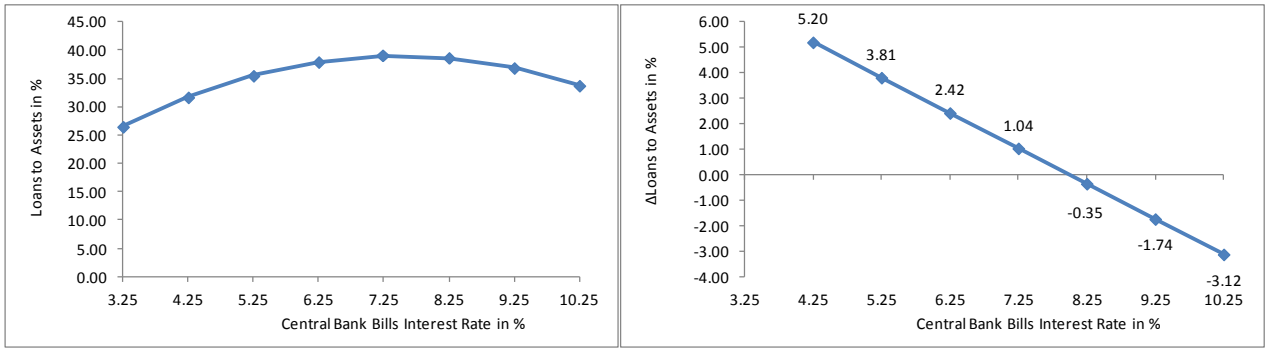
[27] The minimum and the maximum values of the CBBIR variable (3.25% is the minimum and 10% is the maximum) in the period under investigation (2003q3 to 2015q2) are within the interval of 3.25% to 10.25% and therefore the horizontal axes of the figures 7, 8 and 9 are showing this interval.

[28] The effect of the CBBIR on the profitability is contained in the appendix 2.

banks perceive higher risks and decrese lending. However, it is very important to note that these range of threshold of the CBBIR from 7.3% to 7.9% is based on estimations that consider the period from 2003q3 to 2015q2 and does not necessarily mean that it will be constant over time. Most probably, if the estimations were to be redone for extended period, then the results would change.

Hence, the inclusion of the linear and the quadratic term of the CBBIR clearly indicate the contractionary monetary transmission effect on the loans and that is as the key interest rate rises, then the loans to assets rise by diminishing rate or stated differently the Macedonian banking sector reduces newly approved loans up to level of the CBBIR between 7.3% and 7.9%. After this level of the CBBIR is being surpassed, then the banks restructure the assets in favor of the non-loan instruments. This is reasonable transmission effect and it is evidence in favor of the Stglitz and Weiss model implying that the Macedonian banking sector rations the loans when the monetary policy increases the CBBIR. Similar conclusions can be deduced from the figures 8 and 9.

Figure 7: Derivation of backward bending loans to assets and the level of the CBBIR that provides maximum loans to assets based on the regression 1 in the lower part of the table 2

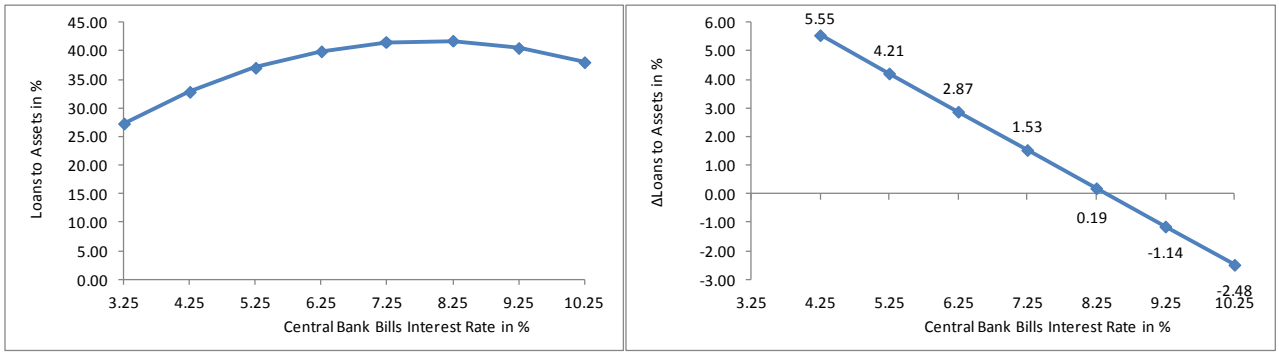


Source: author's estimations

The point of the CBBIR where the loans to assets bends or more concretely the level of the CBBIR that provides maximum loans to assets is 7.5% based on the regression 1[29] in the table 2. The calculation of the CBBIR level of 7.5% is presented in the appendix 1.

Figure 8: Derivation of backward bending loans to assets and the level of the CBBIR that provides maximum loans to assets based on the regression 2 (loan supply) in the lower part of the table 2

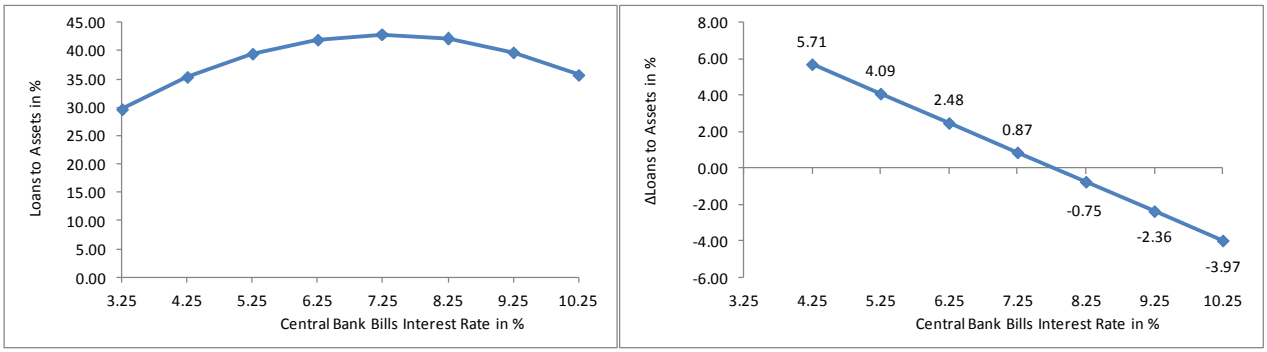
[29] See the estimated coefficients in the lower table.



Source: author's estimations

The point of the CBBIR where the loans to assets bends or more concretely the level of the CBBIR that provides maximum loans to assets is 7.9% based on the regression 2[30] in the table 2. The calculation of the CBBIR level of 7.9% is presented in the appendix 1.

Figure 9: Derivation of backward bending loans to assets and the level of the CBBIR that provides maximum loans to assets based on the regression 3 in the lower part of the table 2



Source: author's estimations

The point of the CBBIR where the loans to assets bends or more concretely the level of the CBBIR that provides maximum loans to assets is 7.3% based on the regression 3[31] in the table 2. The calculation of the CBBIR level of 7.3% is presented in the appendix 1.

Having in mind these estimated coefficients for the CBBIR and the CBBIR^2, it appears that the relationship between the reference interest rate and the loans to assets is non-linear. Therefore, the Macedonian banking sector is aware of the information asymmetry problems (adverse selection and moral hazard) and rations the loans in response to higher

[30] See the estimated coefficients in the lower table.
[31] See the estimated coefficients in the lower table.

CBBIR. Hence, according to the results contained in the table 2, the Stiglitz and Weiss theorem is valid for the Macedonian banking sector.

Table 3: Estimated regressions based on the specification 7

	Estimated long-run effect on loans to non-loans as dependent variable					
	1	**2**	**3**	**4**	**5**	**6**
	1 cointegrating vector	**1 cointegrating vector**	**1 cointegrating vector**	**1 cointegrating vector**	**1 cointegrating vector**	**1 cointegrating vector**
Deposits to assets	4.84***	2.42***		6.11***	4.04***	
Capital to assets		-8.03***	-8.93***	0.38	-2.19	
Non-performing loans ratio			-2.37**			-6.89***
Inflation	2.15***	1.73***	1.79***		2.15***	1.10***
GDP	1.62***					1.17***
Industrial production		0.98***	1.25***	2.27***	1.55***	
MKD loan interest rate - CBBIR	-5.01***	-6.28***	-7.03***	-4.71***	-8.56***	-6.79***
F/X loan interest rate - 1-month EURIBOR	-13.96***	-0.67	-3.69			
Reserve requirement ratio				2.01	11.18***	3.89***
ECM	-0.33***	-0.54***	-0.39***	-0.23***	-0.21***	-0.43***
*****, ** and * indicate statistical level of significance at 1%, 5% and 10%**						

	Estimated long-run effect on Loans to assets in percentage points					
$\overline{Loans\ to\ assets} = 51.92\%$	$\frac{\Delta\ Loans\ to\ assets}{\Delta\ X} = \{long - run\ coefficient(X) * \frac{\overline{Loans\ to\ assets} * (100 - \overline{Loans\ to\ assets})}{100}\}/100$					
	1	**2**	**3**	**4**	**5**	**6**
Deposits to assets	1.21***	0.61***		1.53***	1.01***	
Capital to assets		-2.01***	-2.23***	0.10	-0.55	
Non-performing loans ratio			-0.59**			-1.72***
Inflation	0.54***	0.43***	0.45***		0.54***	0.28***
GDP	0.40***					0.29***
Industrial production		0.25***	0.31***	0.57***	0.39***	
MKD loan interest rate - CBBIR	-1.26***	-1.57***	-1.76***	-1.18***	-2.14***	-1.69***
F/X loan interest rate - 1-month EURIBOR	-3.49***	-0.17	-0.92			
Reserve requirement ratio				0.50	2.79***	0.97***
*****, ** and * indicate statistical level of significance at 1%, 5% and 10%**						

Source: author's estimations

The estimated results contained in the table 3 suggest the following long-run effects on the loans to assets variable[32]:

[32] See the lower part in the table 3. The results are obtained by using the chain rule given in the equation 8 and the estimated long-run coefficients in the higher part of the table 3.

- Deposit to assets ratio has positive average effect on the loans to assets from 0.61 p.p. to 1.53 p.p., ceteris paribus. The coefficients are statistically significant.
- Capital to assets ratio has negative average effect on the loans to assets from 2.01 p.p. to 2.23 p.p., ceteris paribus. The coefficients within this interval are statistically significant, the others are not.
- Non-performing loans ratio has negative average effect on the loans to assets from 0.59 p.p. to 1.72 p.p., ceteris paribus. The coefficients are statistically significant.
- Inflation has positive average effect on the loans to assets from 0.28 p.p. to 0.54 p.p., ceteris paribus. The coefficients are statistically significant.
- GDP has positive average effect on the loans to assets from 0.29 p.p. to 0.40 p.p., ceteris paribus. The coefficients are statistically significant.
- Industrial production index has positive average effect on the loans to assets from 0.25 p.p. to 0.57 p.p., ceteris paribus. The coefficients are statistically significant.
- Domestic risk premium has negative average effect on the loans to assets from 1.18 p.p. to 2.14 p.p., ceteris paribus. The coefficients are statistically significant.
- Foreign risk premium has negative average effect on the loans to assets of 3.49 p.p., ceteris paribus. This coefficient is statistically significant, the others are not.
- Reserve requirement ratio has positive average effect on the loans to of 0.97 p.p. to 2.79 p.p., ceteris paribus. The coefficients within this interval are statistically significant, the remaining coefficient is not.

The results in the table 3 are based on the specification 7 and should indicate which of the two theoretical models considered is valid. The indication would be based on the estimated positive or negative coefficients of the risk premium variables especially of the domestic risk premium variable where the CBBIR is contained. The estimated long-run coefficients in front of all independent variables are reasonable concerning their sign and the magnitude, but the contradiction is the positive effect of the reserve requirement ratio.

The banking sector variables (deposits to assets, capital to assets and NPL ratio) have similar effect with regards to the sign and with smaller magnitude compared to the results in the tables 1 and 2. The inflation positively affects the dependent variable. The coefficients in front of the GDP and the industrial production are positive and statistically significant. Unlike the results in the tables 1 and 2, the reserve requirement ratio has positive effect which is not in accordance with the expectations.

The estimated long-run coefficients in front of the risk premium variables are negative. According to the explanations given in the sections 3.2. and 4.1., this is other

evidence in favor of the Stiglitz and Weiss model. Namely, the risk premium might widen as a result of increase of the MKD/FX loan interest rates relative to the unchanged reference interest rates or considered other way round, decrease of the reference interest rates relative to the unchanged MKD/FX loan interest rates, or decrease of the MKD/FX loan interest rates by smaller proportion compared to the decrease of the reference interest rates. Thus, as the considered risk premiums widen, then loans to assets decrease. This is additional evidence that the Macedonian banking sector is aware of the potential information asymmetry problems that might arise by increasing the loan interest rates. Consequently, the upward movement of the loan interest rates is considered by the banks, as an opportunity for undertaking higher risk instead of creating higher return. Therefore, they ration the loans and put more weigh to the risks compared to the return.

The effect of the domestic risk premium in the table 3 coincides with its equivalent in the right-hand scatter diagram of the figure 5 contained in the above given indicative analysis. The estimated effect of the foreign risk premium in the table 3 is negative as expected, unlike the corresponding positive effect of the lower scatter diagram of the figure 5.

Concerning the results in the tables 1, 2 and 3, the diagnostic tests[33] do not imply problems with auto correlation and homohetasdicity of the residuals at 1% level of statistical significance. The normality assumption of the residuals is valid for most of the regressions, but for some regressions it is rejected on the mentioned statistical level. Also, in all three tables, the ECM terms are mostly with negative signs and statistically significant (the upper tables) and they correct the short-run disequilibrium of the dependent variable towards the long-run equilibrium.

5.2. DISCUSSION ON THE RESULTS REGARDING THE MONETARY TRANSMISSION

Most important results for the monetary transmission are the coefficients in front of the CBBIR variable. All the results for the linear term of the CBBIR contained in the three tables given above, are in compliance between each other. The positive linear term of the CBBIR in the table 1 is present in the tables 2 and 3 as well. However, the point is that the relationship between the CBBIR and the loans to assets is non-linear and thus the appropriate effect of the monetary transmission cannot be implied by linear regression.

[33] Results of the diagnostic tests are available upon request from the author and they are not provided in the paper in order to save space.

Therefore, the negative quadratic term of the CBBIR in the table 2 clearly indicates that Macedonian banking sector grants less new loans implying that the loans are rationed when restrictive signal is provided. Moreover, when the CBBIR rate is combined with the MKD loan interest rate in the table 3, then the negative effect of such combined variable is actually positive considered only for the CBBIR. For example, the coefficient in front of the variable *MKD loan interest rate – CBBIR* in the first regression in the table 3 is negative with magnitude of 1.26 or simply written as -1.26 (*MKD loan interest rate – CBBIR*) or written as *-1.26MKD loan interest rate + 1.26CBBIR*. Therefore, assuming that the CBBIR rises, ceteris paribus, then the banks increase the loans to assets by diminishing marginal rate up to the level of 7.3% to 7.9% as indicated by the results based on the table 2. After this point, the banks decrease or ration the loans to assets and restructure the balance sheets with higher participation of the non-loan assets in order not to deteriorate the quality of the loan portfolio by attracting bad borrowers. Thus, thanks to the quadratic term in the table 2, the monetary transmission to the loans to assets is clearly observable and with reasonable effect in a case of monetary restriction.

Having in mind the non-linear relationship indicated by the table 2 as well as the negative coefficient in front of the domestic risk premium variable in the table 3, it appears that the effect of the monetary transmission is not clear in a case of monetary expansion. Namely, having in mind the less proportionate response of the loan interest rates to the CBBIR as indicated by the NBRM (2015), then the risk premium remains high when the NBRM decreases the CBBIR. Thus, when the NBRM provides monetary expansive signal, then the banks still perceive high risks in the economy and are reluctant to decrease the loan interest rate and increase lending.

From the above said, the inference would be that the Macedonian banking sector is risk averse and it primarily assesses every monetary signal by the risks that are going to be undertaken. In a situation of monetary loosening, it is clear that the transmission has to be supported by higher GDP, stable prices and solid balance sheet structure of the banks that will contain high level of loanable supply funds. In such manner, banks' risk perceptions could be reduced and in contrast to the rationing, the loans would be more available for the borrowers.

The effect of the reserve requirement ratio is negative in the tables 1 and 2. This effect is reasonable, but its' magnitude is very volatile. In contrast, the positive effect in the table 3 is in contrast with the expectations.

5.3. FURTHER EVIDENCE ON STIGLITZ AND WEISS CREDIT RATIONING MODEL

The estimated results in the previous section provide more evidence on the credit rationing model by Stiglitz and Weiss compared to the Bernanke and Blinder model and therefore further econometric estimations will be made in order to confirm that conclusion. As indicated by the south-east quadrant in the figure 1, the profit curve is also backward bending as the interest rate increases or more concretely the profit is maximized at the interest rate that maximizes the loan supply curve in the north-east quadrant. Thus, the further econometric estimations will consider whether the banking sector profitability bends at proximate or same level of the CBBIR as the results and the calculations in the figures 7, 8 and 9 suggest for the loans to assets.

Therefore estimations regarding the banking sector profitability were made and they include quadratic term of the CBBIR. The detailed results are presented in the appendix 2. Basically, as presented in the results of the appendix 2, profitability variables measured by ROA and ROE reach their maximum in relation to the CBBIR level between 5.7% to 7.0%. The CBBIR level that provides maximum profitability is proximate to the one that provides maximum loans to assets and thus the credit rationing conclusion is confirmed.

6. CONCLUSION

Within this research, the monetary transmission from the NBRM to the banks' lending was investigated. Therefore, the traditional bank lending channel explained by the Bernanke and Blinder (1988) and the credit rationing model by Stiglitz and Weiss (1981) were considered, and tested which one of them better fits to the case of the RM.

The bank lending channel in RM operates as indicated by the theory of the credit rationing by Stiglitz and Weiss, based on the indicative analysis and the VECM analysis. The results obtained in this research clearly indicate that the credit monetary transmission operates very clearly when the NBRM tightens the monetary policy by increasing the CBBIR. Namely, as indicated by the quadratic regressions in the table 2 and the figures 7, 8 and 9, the loans to assets rise by diminishing marginal rate, as the CBBIR increases up to level within the interval from 7.3% to 7.9%. Afterwards the lending declines or stated differently the amount of new granted loans decreases as the CBBIR increases. Also, most of the results concerning the reserve requirement ratio suggest appropriate negative effect on the loans to assets (with exception of the results in the table 3).

Additionally, in order to provide further evidence on the Stiglitz and Weiss model, the profitability indicators (ROA and ROE) were tested with quadratic terms of the CBBIR in order to consider whether the reference interest rate has diminishing marginal effect on the profitability. Once again, the estimated results in the tables 4 and 5 and the figures from 10 to 17 provide evidence in favor of the Stiglitz and Weiss theory. Thus, the profitability rises with diminishing marginal rate relative to the CBBIR and reaches its' maximum when the level of the reference interest rate is within the interval from 5.7% to 7.0%. Afterwards, the profitability declines as the CBBIR rises. The results concerning the level of the CBBIR that maximizes the profitability are relatively close to the results in the table 2.

The overall results obtained from the VECM analysis regarding the CBBIR level that maximizes the loans to assets and the profitability are within the interval from 5.7% to 7.9% and coincide with the respective results in the indicative analysis from 5.6% to 7.3%. However, as mentioned above, it is very important to note that these range of threshold of the CBBIR from 7.3% to 7.9% is based on estimations that consider the period from 2003q3 to 2015q2 and does not necessarily mean that it will be constant over time. Most probably, if the estimatios were to be redone for extended period, then the results would change.

Furthermore, according to the results in the table 3, the relationship between the domestic risk premium and the loans to assets is inversely proportionate. Thus, despite the widening of the domestic risk premium as a result of the decrease of the CBBIR, the Macedonian banking sector do not perceives this as an opportunity for higher lending, but as an opportunity for undertaking higher risk by approving loans to risky borrowers. Therefore, the loan interest rates are sticky relative to the CBBIR in order the banks to preserve their profitability. This is also evidence that the Macedonian banking sector rations the lending.

The contribution of this paper is providing evidence about the credit rationing in the Macedonian banking sector. According to the knowledge of the author, this paper is most probably the first one that investigates the credit rationing with non-linear (quadratic) regression function. The non-linear regression function is very simple for use and provides estimation of the threshold levels concerning the reference interest rate level (CBBIR) above which the Macedonian banks ration the lending.

As a recommendation for the future researches for this issue, it is recommendable to consider this issue by employing another time-series analysis technique that would include

dummy variable for capturing the interest rate threshold and confirmation or non-confirmation of the credit rationing model.

Based on the analysis made, it can be concluded that the banks are risk averse and due to that the credit monetary transmission in RM is non-linear as suggested by the credit rationing model. Having in mind this, the banks will not respond appropriately to the monetary expansionary signals as long as they perceive high risks in the economy. Therefore, the measures should be oriented towards reducing banks' risk perceptions and increasing the availability of the loans in order to facilitate the monetary expansionary signals. Favorable macroeconomic conditions have to be maintained and in that manner the loan demand with creditworthy borrowers would expand. Also, further maintenance of the favorable banks' balance sheet structure with higher deposits and lower NPL ratio are necessary preconditions for better transmission. Moreover, providing opportunities for higher capital availability is also necessary, because the estimated negative effect of the capital to assets ratio on the loans to assets suggests that the banks build up the capitalization at the expense of the lending. In that direction, the banks have to be encouraged for financing through shares issuance on the Macedonian stock exchange.

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APPENDIX 1: DERIVATION OF MAXIMUM LOANS TO ASSETS IN RELATION TO THE CBBIR LEVEL

Calculation of the first derivative based on the data for the quadratic trend in the left-hand diagram in the figure 5.

$$y = -0.3586x^2 + 4.0052x + 42.445;$$
$$\frac{\Delta y}{\Delta x} = -2 * (0.3586)x + 4.0052;$$
$$\frac{\Delta y}{\Delta x} = -0.7172x + 4.0052;$$
$$\frac{\Delta y}{\Delta x} = 0;\ 0 = -0.7172x + 4.0052;$$
$$0.7172x = 4.0052;$$
$$x = 5.6\%.$$

Calculation of the first derivative based on the data for the quadratic trend in the left-hand diagram in the figure 6.

$$y = -0.0487x^2 + 0.7122x - 1.2383;$$
$$\frac{\Delta y}{\Delta x} = -2 * (0.0487)x + 0.7122;$$
$$\frac{\Delta y}{\Delta x} = -0.0974x + 0.7122;$$
$$\frac{\Delta y}{\Delta x} = 0; 0 = -0.0974x + 0.7122;$$
$$0.0974x = 0.7122;$$
$$x = 7.3\%.$$

Calculation of the first derivative based on the data for the quadratic trend in the right-hand diagram in the figure 6.

$$y = -0.4159x^2 + 5.6881x - 9.0898;$$
$$\frac{\Delta y}{\Delta x} = -2 * (0.4159)x + 5.6881;$$
$$\frac{\Delta y}{\Delta x} = -0.8318x + 5.6881;$$
$$\frac{\Delta y}{\Delta x} = 0; 0 = -0.8318x + 5.6881;$$
$$0.8318x = 5.6881;$$
$$x = 6.8\%.$$

Calculation of the first derivative based on the data in the table 2 concerning the regression 1.

$$Loans\ to\ assets = -0.69CBBIR^2 + 10.40CBBIR;$$
$$\frac{\Delta Loans\ to\ assets}{\Delta CBBIR} = -2 * (0.69)CBBIR + 10.40;$$
$$\frac{\Delta Loans\ to\ assets}{\Delta CBBIR} = -1.38CBBIR + 10.40;$$
$$\frac{\Delta Loans\ to\ assets}{\Delta CBBIR} = 0;\ 0 = -1.38CBBIR + 10.40;$$
$$1.38CBBIR = 10.40;$$
$$CBBIR = 7.5\%$$

Calculation of the first derivative based on the data in the table 2 concerning the regression 2.

$$Loans\ to\ assets = -0.67CBBIR^2 + 10.58CBBIR;$$
$$\frac{\Delta Loans\ to\ assets}{\Delta CBBIR} = -2 * (0.67)CBBIR + 10.58;$$
$$\frac{\Delta Loans\ to\ assets}{\Delta CBBIR} = -1.34CBBIR + 10.58;$$
$$\frac{\Delta Loans\ to\ assets}{\Delta CBBIR} = 0;\ 0 = -1.34CBBIR + 10.58;$$
$$1.34CBBIR = 10.58;$$
$$CBBIR = 7.9\%$$

Calculation of the first derivative based on the data in the table 2 concerning the regression 3.

$$Loans\ to\ assets = -\ 0.81CBBIR^2 + 11.76CBBIR;$$
$$\frac{\Delta Loans\ to\ assets}{\Delta CBBIR} = -2 * (0.81)CBBIR + 11.76;$$
$$\frac{\Delta Loans\ to\ assets}{\Delta CBBIR} = -1.62CBBIR + 11.76;$$
$$\frac{\Delta Loans\ to\ assets}{\Delta CBBIR} = 0;\ 0 = -1.62CBBIR + 11.76;$$
$$1.62CBBIR = 11.76;$$
$$CBBIR = 7.3\%$$

APPENDIX 2: FURTHER EVIDENCE ON STIGLITZ AND WEISS CREDIT RATIONING MODEL

The estimated results in the previous section provide more evidence on the credit rationing model by Stiglitz and Weiss compared to the Bernanke and Blinder model and therefore further econometric estimations will be made in order to confirm that conclusion. As indicated by the south-east quadrant in the figure 1, the profit curve is also backward bending as the interest rate increases or more concretely the profit is maximized at the interest rate that maximizes the loan supply curve in the north-east quadrant. Thus, the further econometric estimations will consider whether the banking sector profitability bends at proximate or same level of the CBBIR as the results and the calculations in the figures 7, 8 and 9 suggest for the loans to assets.

Similarly as in the section 5.1., the VECM technique will be utilized once again and following variables will be included:

Profitability variables

- Return on assets (ROA) as dependent variable expressed in % and
- Return on equity (ROE) as dependent variable expressed in %.

Banking sector variables:

- Deposits to assets as independent variable,
- Loans to assets ratio as independent variable,
- Non-performing loans ratio as independent variable and
- Cost to income ratio as independent variable in %.

Macroeconomic variables:

- Real GDP at 2005 prices in millions of denars as independent variable, taken as natural logarithm and
- Inflation rate in % as independent variable, calculated as year on year growth of the consumer price index (CPI).

Central bank variable:

- Nominal CBBIR in % as independent variable and

- Nominal 1-month EURIBOR[34] as independent variable.

The dataset encompasses the period from 2004q4 to 2016q1. The different period taken for estimation in this section allows for further robustness check of the credit rationing hypothesis.

Within the previous section, the monetary statistics data were used for the banking sector variables and now the data regarding these variables are taken from banking supervision and regulation indicators[35] published by the NBRM. The reason for taking different source concerning the banking sector variables is to check additionally the robustness of the credit rationing hypothesis. The data for the nominal CBBIR and the macroeconomic variables are kept from the same data source as in the previous section. Also, all the series are seasonally adjusted by using the additive Census X12 option in EViews 8, with the exception only made for the CBBIR and the 1-month EURIBOR.

Thus, the following econometric specifications 8 and 9 are formed[36]:

$$ROA_t = f\begin{pmatrix} deposits\ to\ assets_t, loans\ to\ assets_t, \\ non-performing\ loans\ ratio_t, cost\ to\ income\ ratio_t, GDP_t, \\ inflation_t, CBBIR_t, CBBIR_t^2 \end{pmatrix} \quad (8)$$

$$ROE_t = f\begin{pmatrix} deposits\ to\ assets_t, loans\ to\ assets_t, \\ non-performing\ loans\ ratio_t, cost\ to\ income\ ratio_t, GDP_t, \\ inflation_t, CBBIR_t, CBBIR_t^2 \end{pmatrix} \quad (9)$$

Once again, key variables are $CBBIR_t$ and $CBBIR^2_t$ and the expected sign of the coefficient in front of the linear term should be positive while the expected sign of the coefficient in front of the quadratic term should be negative similarly to the quadratic trend obtained in the figure 6. If the estimated coefficients of both the linear and quadratic CBBIR are as expected, then the indications provided in the above given indicative analysis that Macedonian banks ration the loans will be confirmed.

All variables have been checked for the unit root test and they are integrated of the first order - I(1) [37]. The VECM procedure has been applied once again with same technical

[34] Nominal 1-month EURIBOR variable is taken as exogenous variable in the econometric testing while all other independent variables are taken as endogenous variables.
[35] The basic difference between the monetary statistics data and banking supervision and regulation data is the different treatment and inclusion of separate items within aggregate items.
[36] The 1-month EURIBOR is not contained here because it is taken as an exogenous variable.
[37] Results of the Augmented Dickey-Fuller test and Phillips-Perron test are available upon request from the author and they are not presented in order to save space.

details[38] as in the section 5.1 i.e order of VAR 2 and the number of cointegrating vectors is determined by considering the maximum eigenvalue test[39]. The results are given in the tables 4 and 5.

Table 4: Estimated regressions based on the specification 8

	Estimated long-run effect in p.p. on ROA as dependent variable				
	1	**2**	**3**	**4**	**5**
	1 cointegrating vector	**1 cointegrating vector**	**1 cointegrating vector**	**1 cointegrating vector**	**1 cointegrating vector**
Deposits to assets	0.31***	-0.002			
Loans to assets	0.11**	0.31***	0.13***		0.26***
Non-performing loans ratio	0.58***	1.08***	0.54***	0.89***	1.04***
Cost to income ratio	-0.003				0.07**
GDP				0.20***	
Inflation			-0.15***		-0.32***
CBBIR	0.03	3.00***	1.75***	4.56***	2.15***
CBBIR^2	-0.01	-0.25***	-0.14***	-0.33***	-0.18***
ECM	-0.39***	-0.08	-0.30***	-0.14*	-0.15***
*****, ** and * indicate statistical level of significance at 1%, 5% and 10%**					

Source: author's estimations

The estimated results contained in the table 4 suggest the following long-run effects on the ROA:

- Deposit to assets ratio has positive average effect on the ROA of 0.31 p.p., ceteris paribus. This coefficient is statistically significant, the other one is not.
- Loan to assets ratio has positive average effect on the ROA from 0.11 p.p. to 0.31 p.p., ceteris paribus. The coefficients are statistically significant.
- Non-performing loans ratio has positive average effect on the ROA from 0.54 p.p. to 1.08 p.p., ceteris paribus. The coefficients are statistically significant.
- Cost to income ratio has positive average effect on the ROA of 0.07 p.p., ceteris paribus. This coefficient is statistically significant, the other one is not.
- GDP has positive average effect on the ROA of 0.20 p.p., ceteris paribus. The coefficient is statistically significant.
- Inflation has negative average effect on the ROA from 0.15 p.p. to 0.32 p.p., ceteris paribus. The coefficients are statistically significant.

[38] All technical details regarding the VECM analysis are available upon request from the author and they are not presented in order to save space.

[39] The maximum eigenvalue test is considered at 1% statistical level of significance.

- The linear and the quadratic term of CBBIR have the expected positive and negative signs, respectively. The coefficients are statistically significant, except for the regression 1.

The results in the table 4 are based on the specification 8. The long-run coefficients in front of the deposits to assets ratio and loans to assets ratio are positive and expected. Also, the estimations indicate positive effects of the NPL ratio and cost to income ratio, which might be considered as unexpected. Perhaps, the positive effect of the NPL ratio on the ROA is attributed by the accounting rules concerning the treatment of the foreclosed assets valid up to June 2012. Namely, the foreclosure practice up to the mentioned period allowed for registering an income in the profit and loss account when the collateral was foreclosed and registered in the balance sheet, although there was no real collection of money (NBRM, 2013). The NBRM amended the regulation properly regarding this issue in order the banks to show realistic value of their profit. Furthermore, the positive effect of the cost to income ratio might be reasonable because costs for employees are included within this ratio and they might be very important for increasing productivity and the profit. The long-run coefficient in front of the GDP is positive and statistically significant. The inflation negatively affects the dependent variable.

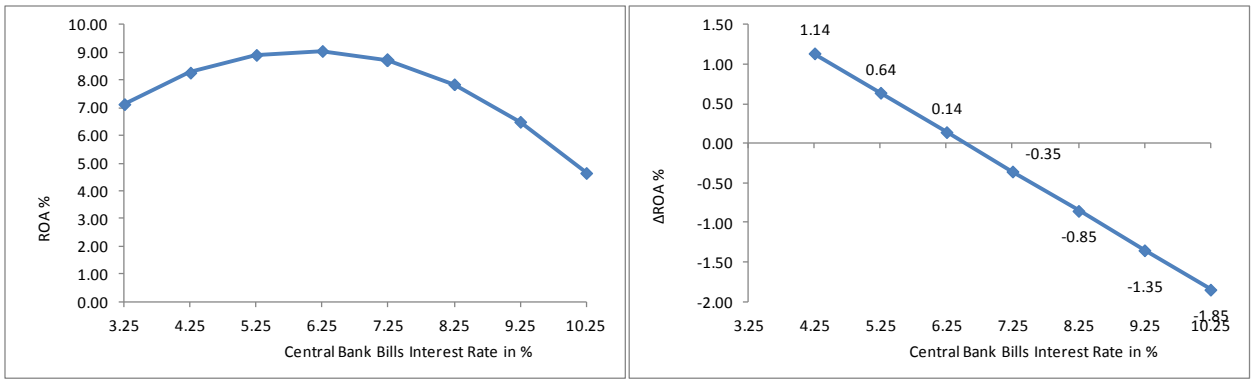
Finally, the linear and the quadratic term of the CBBIR have the expected positive and negative effects on the ROA, respectively and they are statistically significant (except for the regression 1). Again, these estimated coefficients are evidence in favor of the Stiglitz and Weiss model implying the south-east quadrant of the figure 1 presented above. The figures 10, 11, 12 and 13 below provide graphical presentation of the effect of the CBBIR variable and imply the backward bending curve of the ROA, having in mind the ceteris paribus principle.

According to the figures 10, 11, 12 and 13 as well as the given calculations, the points of the CBBIR where the ROA bends, or specificaly the levels of the CBBIR that provide maximum profitability are: 6.0%, 6.3%, 6.9% and 6.0%, respectively. Also, these levels of the CBBIR are relatively close to their counterparts based on the table 2 and presented in the figures 7, 8 and 9. Once again, these points are obtained by taking the first derivative of the regressions 2 to 5 in the table 4[40] with respect to CBBIR. Thus, the banks increase the

[40] The results of the CBBIR and $CBBIR^2$ in the regression 1 are not taken into consideration because they are not statistically significant.

ROA with diminishing rate up to the CBBIR level of 6.0% to 6.9% and above this point they register decline of the profit.

Figure 10: Derivation of backward bending ROA and the level of the CBBIR that provides maximum ROA based on the regression 2 in the table 4

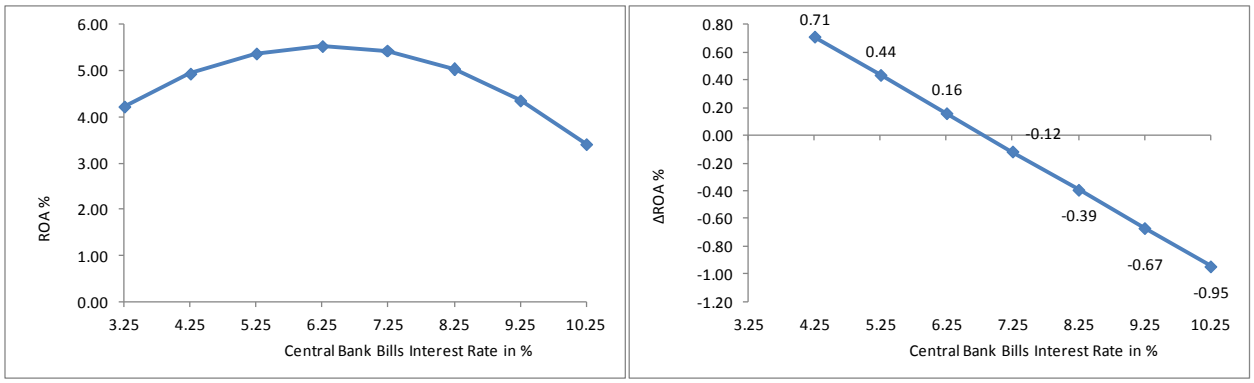


Source: author's estimations

The point of the CBBIR where the ROA bends or more concretely the level of the CBBIR that provides maximum ROA is 6.0% based on the regression 2 in the table 4.

$$ROA = -0.25CBBIR^2 + 3.00CBBIR;$$
$$\frac{\Delta ROA}{\Delta CBBIR} = -2 * (0.25)CBBIR + 3.00;$$
$$\frac{\Delta ROA}{\Delta CBBIR} = -0.50CBBIR + 3.00;$$
$$\frac{\Delta ROA}{\Delta CBBIR} = 0;\ 0 = -0.50CBBIR + 3.00;$$
$$0.50CBBIR = 3.00;$$
$$CBBIR = 6.0\%$$

Figure 11: Derivation of backward bending ROA and the level of the CBBIR that provides maximum ROA based on the regression 3 in the table 4

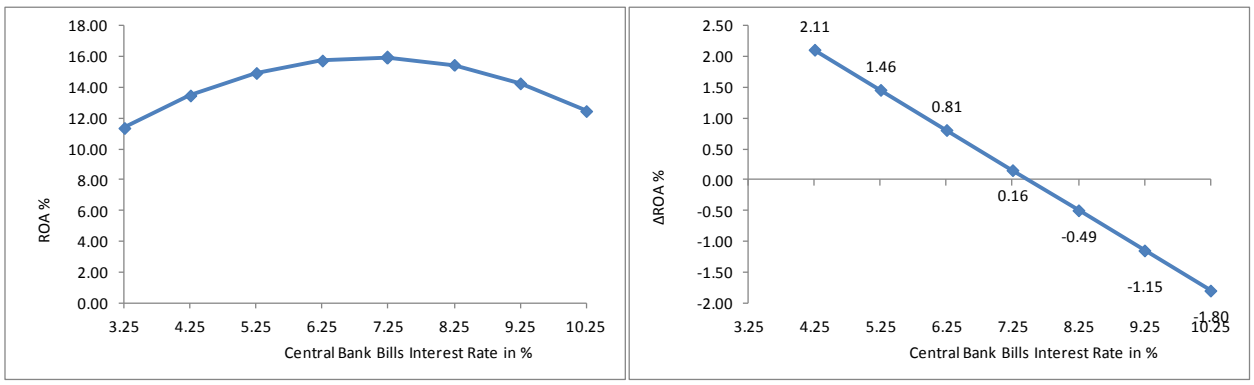


Source: author's estimations

The point of the CBBIR where the ROA bends or more concretely the level of the CBBIR that provides maximum ROA is 6.3% based on the regression 3 in the table 4.

$$ROA = -0.14CBBIR^2 + 1.75CBBIR;$$
$$\frac{\Delta ROA}{\Delta CBBIR} = -2 * (0.14)CBBIR + 1.75;$$
$$\frac{\Delta ROA}{\Delta CBBIR} = -0.28CBBIR + 1.75;$$
$$\frac{\Delta ROA}{\Delta CBBIR} = 0;\ 0 = -0.28CBBIR + 1.75;$$
$$0.28CBBIR = 1.75;$$
$$CBBIR = 6.3\%$$

Figure 12: Derivation of backward bending ROA and the level of the CBBIR that provides maximum ROA based on the regression 4 in the table 4

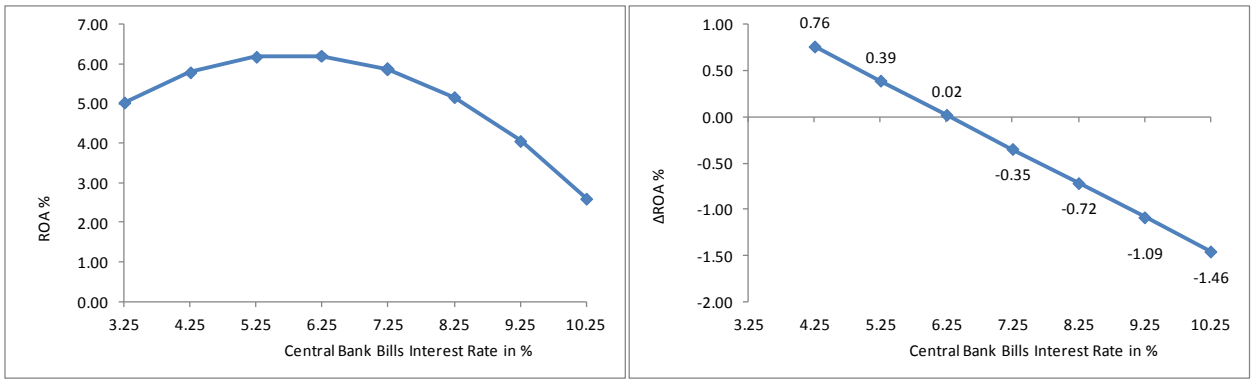


Source: author's estimations

The point of the CBBIR where the ROA bends or more concretely the level of the CBBIR that provides maximum ROA is 6.9% based on the regression 4 in the table 4.

$$ROA = -0.33CBBIR^2 + 4.56CBBIR;$$
$$\frac{\Delta ROA}{\Delta CBBIR} = -2 * (0.33)CBBIR + 4.56;$$
$$\frac{\Delta ROA}{\Delta CBBIR} = -0.66CBBIR + 4.56;$$
$$\frac{\Delta ROA}{\Delta CBBIR} = 0;\ 0 = -0.66CBBIR + 4.56;$$
$$0.66CBBIR = 4.56;$$
$$CBBIR = 6.9\%$$

Figure 13: Derivation of backward bending ROA and the level of the CBBIR that provides maximum ROA based on the regression 5 in the table 4



Source: author's estimations

The point of the CBBIR where the ROA bends or more concretely the level of the CBBIR that provides maximum ROA is 6.0% based on the regression 5 in the table 4.

$$ROA = -0.18CBBIR^2 + 2.15CBBIR;$$
$$\frac{\Delta ROA}{\Delta CBBIR} = -2 * (0.18)CBBIR + 2.15;$$
$$\frac{\Delta ROA}{\Delta CBBIR} = -0.36CBBIR + 2.15;$$
$$\frac{\Delta ROA}{\Delta CBBIR} = 0;\ 0 = -0.36CBBIR + 2.15;$$
$$0.36CBBIR = 2.15;$$
$$CBBIR = 6.0\%$$

Table 5: Estimated regressions based on the specification 9

	Estimated long-run effect in p.p. on ROE as dependent variable			
	1	**2**	**3**	**4**
	1 cointegrating vector	**1 cointegrating vector**	**1 cointegrating vector**	**1 cointegrating vector**
Deposits to assets	-0.08			
Loans to assets	2.68***	1.34***	2.58***	
Non-performing loans ratio	8.24***	4.35***	8.78***	7.01***
Cost to income ratio			0.67***	
GDP				1.76***
Inflation		-1.18***	-2.75***	
CBBIR	21.92***	12.51***	16.26***	38.21***
CBBIR^2	-1.83***	-1.00***	-1.43***	-2.72***
ECM	-0.09	-0.31***	-0.15***	-0.12
*****, ** and * indicate statistical level of significance at 1%, 5% and 10%**				

Source: author's estimations

The estimated results contained in the table 5 suggest the following long-run effects on the ROE:

- Deposit to assets ratio has statistically insignificant effect.
- Loan to assets ratio has positive average effect on the ROE from 1.34 p.p. to 2.68 p.p., ceteris paribus. The coefficients are statistically significant.
- Non-performing loans ratio has positive average effect on the ROE from 4.35 p.p. to 8.78 p.p., ceteris paribus. The coefficients are statistically significant.
- Cost to income ratio has positive average effect on the ROE of 0.67 p.p., ceteris paribus. This coefficient is statistically significant.

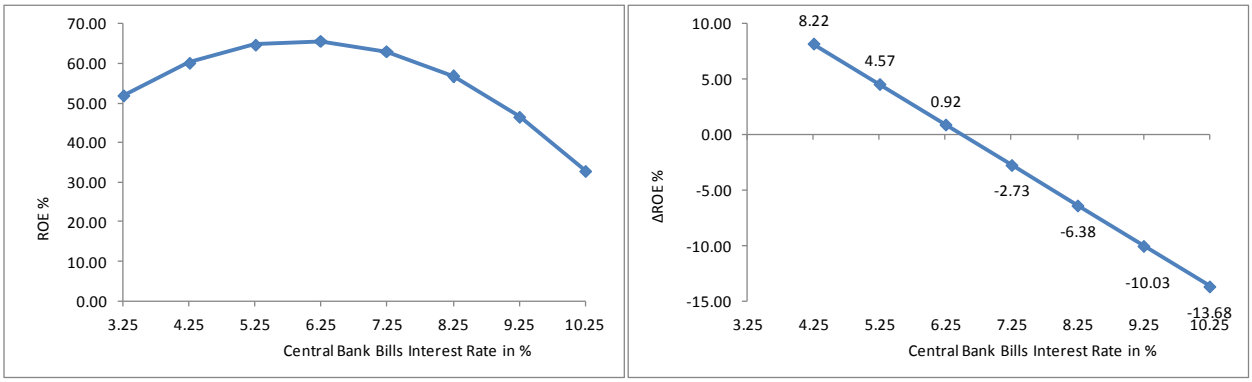
- GDP has positive average effect on the ROE of 1.76 p.p., ceteris paribus. The coefficient is statistically significant.
- Inflation has negative average effect on the ROE from 1.18 p.p. to 2.75 p.p., ceteris paribus. The coefficients are statistically significant.
- The linear and the quadratic terms of CBBIR have the expected positive and negative signs, respectively. The coefficients are statistically significant.

The results in the table 5 are based on the specification 9. Concerning the signs of the long-run coefficients, the results are in compliance with their equivalents in the table 4, but their magnitude is very variable.

Also, the linear and the quadratic term of the CBBIR have the expected positive and negative effects on the ROE, respectively and they are statistically significant. Thus, the Stiglitz and Weiss model is confirmed once again. The figures 14, 15, 16 and 17 below provide graphical presentation of the effect of the CBBIR variable, specificaly the backward bending curve of the ROE, having in mind the ceteris paribus principle.

According to the figures 14, 15, 16 and 17 as well as the given calculations, the points of the CBBIR where the ROE bends or more concretely the levels of the CBBIR that provide maximum profitability are: 6.0%, 6.3%, 5.7% and 7.0%, respectively. Also, these levels of the CBBIR are relatively close to their counterparts based on the table 2 and presented in the figures 7, 8 and 9. Thus, the banks increase the ROE with diminishing rate up to the CBBIR level of 5.7% to 7.0% and above this point they register decline of the profit.

Figure 14: Derivation of backward bending ROE and the level of the CBBIR that provides maximum ROE based on the regression 1 in the table 5

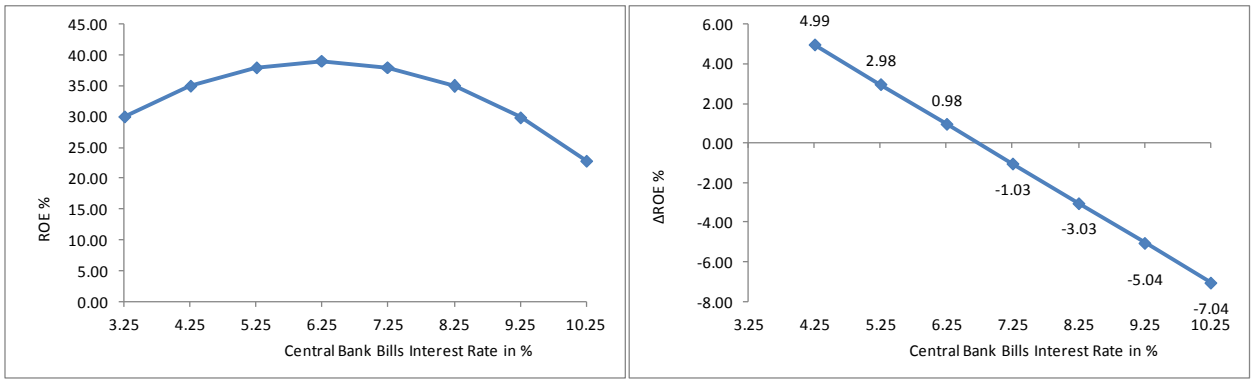


Source: author's estimations

The point of the CBBIR where the ROE bends or more concretely the level of the CBBIR that provides maximum ROE is 6.0% based on the regression 1 in the table 5.

$$ROE = -1.83CBBIR^2 + 21.92CBBIR;$$
$$\frac{\Delta ROE}{\Delta CBBIR} = -2 * (1.83)CBBIR + 21.92;$$
$$\frac{\Delta ROE}{\Delta CBBIR} = -3.66CBBIR + 21.92;$$
$$\frac{\Delta ROE}{\Delta CBBIR} = 0;\ 0 = -3.66CBBIR + 21.92;$$
$$3.66CBBIR = 21.92;$$
$$CBBIR = 6.0\%$$

Figure 15: Derivation of backward bending ROE and the level of the CBBIR that provides maximum ROE based on the regression 2 in the table 5

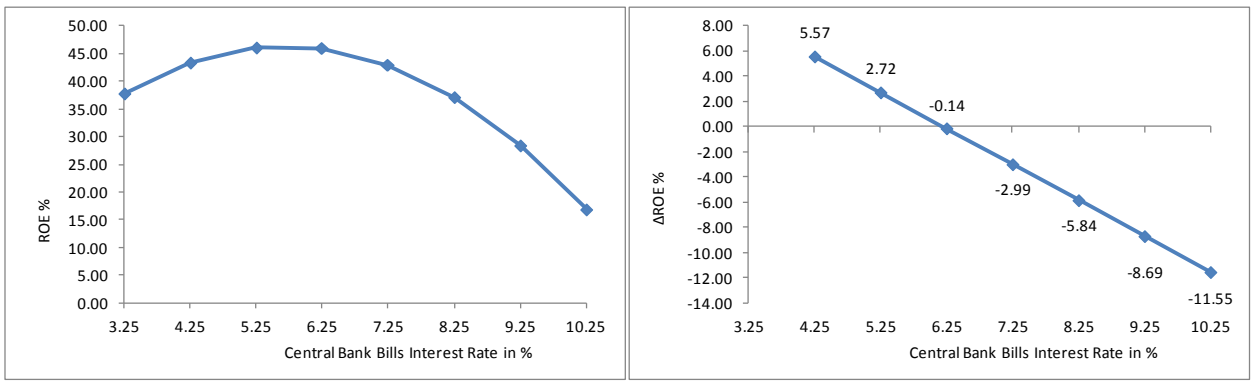


Source: author's estimations

The point of the CBBIR where the ROE bends or more concretely the level of the CBBIR that provides maximum ROE is 6.3% based on the regression 2 in the table 5.

$$ROE = -1.00CBBIR^2 + 12.51CBBIR;$$
$$\frac{\Delta ROE}{\Delta CBBIR} = -2 * (1.00)CBBIR + 12.51;$$
$$\frac{\Delta ROE}{\Delta CBBIR} = -2.00CBBIR + 12.51;$$
$$\frac{\Delta ROE}{\Delta CBBIR} = 0;\ 0 = -2.00CBBIR + 12.51;$$
$$2.00CBBIR = 12.51;$$
$$CBBIR = 6.3\%$$

Figure 16: Derivation of backward bending ROE and the level of the CBBIR that provides maximum ROE based on the regression 3 in the table 5

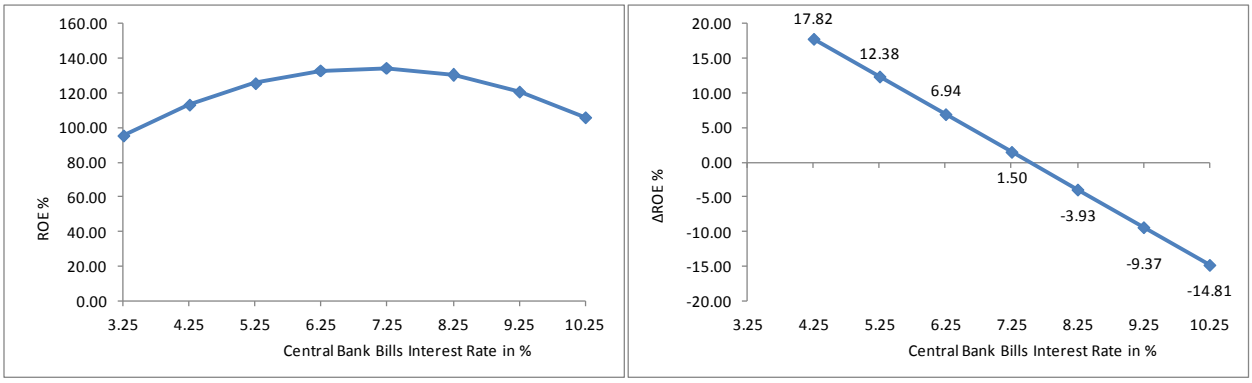


Source: author's estimations

The point of the CBBIR where the ROE bends or more concretely the level of the CBBIR that provides maximum ROE is 5.7% based on the regression 3 in the table 5.

$$ROE = -1.43CBBIR^2 + 16.26CBBIR;$$
$$\frac{\Delta ROE}{\Delta CBBIR} = -2 * (1.43)CBBIR + 16.26;$$
$$\frac{\Delta ROE}{\Delta CBBIR} = -2.86CBBIR + 16.26;$$
$$\frac{\Delta ROE}{\Delta CBBIR} = 0;\ 0 = -2.86CBBIR + 16.26;$$
$$2.86CBBIR = 16.26;$$
$$CBBIR = 5.7\%$$

Figure 17: Derivation of backward bending ROE and the level of the CBBIR that provides maximum ROE based on the regression 4 in the table 5



Source: author's estimations

The point of the CBBIR where the ROE bends or more concretely the level of the CBBIR that provides maximum ROE is 7.0% based on the regression 4 in the table 5.

$$ROE = -2.72CBBIR^2 + 38.21CBBIR;$$
$$\frac{\Delta ROE}{\Delta CBBIR} = -2 * (2.72)CBBIR + 38.21;$$
$$\frac{\Delta ROE}{\Delta CBBIR} = -5.44CBBIR + 38.21;$$
$$\frac{\Delta ROE}{\Delta CBBIR} = 0;\ 0 = -5.44CBBIR + 38.21;$$
$$5.44CBBIR = 38.21;$$
$$CBBIR = 7.0\%$$

Concerning the results in the tables 4 and 5, the diagnostic tests[41] do not imply problems with the auto correlation of the residuals at 1% level of statistical significance. The normality assumption of the residuals is not valid for all regressions and the homescedasticity assumption is valid for 4 out of all 9 regressions in the mentioned tables. Also, in the tables 4 and 5, all ECM terms are with negative signs and most of them are statistically significant indicating that the short-run disequilibrium of the dependent variable is corrected towards the long-run equilibrium.

[41] Results of the diagnostic tests are available upon request from the author and they are not provided in the paper in order to save space.

Thus, from the results given above, it appears that the relationship between the reference interest rate and the profitability is non-linear as well and the Stiglitz and Weiss model has been indicated once again. Therefore, as the CBBIR increases, then the Macedonian banking sector rations the loans in order to preserve the profitability.