

The compensation thesis and its application to central bank balance sheets: an empirical analysis of the balance sheet components of the Macedonian central bank

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*Abstract*

*This paper is on the compensation thesis, also known as the “Banque the France” view, which is an extension of demand-led endogenous money in an open economy. In the world of endogenous money any excess liquidity gets automatically destroyed, which in an open economy would mean that the external position of countries has no influence on money creation. The changes in the other components of the central bank balance sheet offset the changes in foreign reserves, not only as a deliberate action of the central bank, but also endogenously, at the initiative of private agents. The paper gives a theoretical overview of the post-Keynesian interpretation, a short literature review and an empirical analysis on the balance sheet of the Macedonian central bank (NBRM), by using Autoregressive Distributed Lags (ARDL) bound testing approach for cointegration. A long-term relationship was found between the foreign reserves and the central bank bonds. No other long-term relationship was found between the foreign reserves and the other central bank balance sheet components. The results led to the conclusion that the neutralization of the inflows or outflows of foreign reserves in Macedonia happens mainly through movements of central bank bonds, which means that this balance sheet component is the main component of the sterilization process in the long-run in the case of Macedonia. The results support the compensation thesis – the endogenous sterilization of foreign reserves in countries with fixed exchange rate regime.*

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## *Introduction*

The compensation thesis, also known as the “Banque the France” view, is an extension of demand-led endogenous money in an open economy. According to the post-Keynesian theory of endogenous money, the money creation is driven by the demand for credit and is outside of the control of the central bank. Money is created in the system by commercial banks giving credit according to the demand for it, based on the creditworthiness of the borrower. However, high powered money is still demanded by the general public and following the horizontalist approach, the central bank has to accommodate the demand. That turns the causality between loans and deposits on its head - banks do give away credits first and they later look for deposits. Thus, the central bank can only have a control of the interest rate for which it provides central bank money.

If money is created according to the demand of the agents in the economy, the agents have no use of the excess liquidity and they try to get rid of it by repaying their existing debt. In a world of endogenous money any excess liquidity is automatically destroyed - the same holds not only in a closed, but also in an open economy. The mechanisms that allow for automatic adjustments to external imbalances of the countries do not hold in a post-Keynesian interpretation. By introducing endogenous money and rejecting that assets denominated in different currencies are perfect substitutes, the extension of the validity of this concept is introduced even in an open economy. Therefore, the external position of the countries has no influence on money creation. The changes in the other components of the central bank balance sheet offset the changes in foreign reserves.

The post-Keynesian interpretation builds on the ideas of an endogenous sterilization process, which were presented already in the 1940s following the work of Nurkse (1944), the beginning of the 1960s, by the work of the French economist Le Bourva (1992) and at the beginning of the 1970s by Berger (1972a, 1972b). In the last two decades the most important contribution was made by Lavoie (2001, 2014), who added on his earlier work on endogenous money, the reflux mechanism (1999) and interest rate parities (Lavoie, 2000, 2002-3), thus putting together a horizontalist approach to endogenous credit and money in an open economy.. Seranno and Summa (2015) also endorse the concept. A recent empirical contribution was made by Lavoie and Wang (2012). This paper is largely inspired by this work.

The first part of this text gives a theoretical overview of the post-Keynesian views on the topic and a short literature review on the compensation thesis. The second part consists of an empirical analysis of the components of the balance sheet of the Macedonian central bank (NBRM hereafter), in order to look for empirical evidence of the validity of the compensation thesis in the case of Macedonia. The last part concludes.

## *Theoretical overview and a review of literature*

The theoretical foundations of the compensation thesis are to be found in the demand-led endogeneity of money and the rejection of the validity of the interest rate parities. Those two concepts, together with the functioning of the reflux mechanism allow for the compensation thesis to happen, in the case of fixed exchange rate regime.

According to the post-Keynesian theory, the money supply is endogenous and driven by demand for credit. In this sense, the central bank has no control over the money supply. The money supply is not a result of an exogenously determined monetary base that gets multiplied – the money creation is out of the control of the central bank and it is in the hands of the commercial banks, which allow credit according to the demand for it, under the condition that the borrowers are creditworthy - therefore being only a demand-led phenomenon. The causality between loans and deposits goes opposite the mainstream story – banks do not wait for deposits from their clients so they allow more credit, but they give credit and then have deposits created on the liability side. When banks are in need of banknotes, because their withdrawal is demanded by the borrowers, the commercial banks either pull on their overdrafts from the central bank, which is a sole provider of banknotes, or sell those that are already on its balance sheet - mostly government securities - in order to obtain the central bank money. Since the central bank has no control over money creation, the only thing that can be under its control is the interest rate for which the banks obtain high powered money from the central bank. Following the horizontalist view, the central bank has to accommodate the demand for banknotes and reserves from the commercial banks, since if it does not do so, the functioning of the economic activities would be seriously impeded. This means that the central bank provides central bank money at whatever quantity demanded, but for an interest rate that the central bank actually could set – therefore the interest rate is a matter of policy choice.

The reflux principle is an important mechanism, which allows for the functioning of the compensation thesis and is of great importance in understanding endogenous money. As Lavoie (2014, p.462) explains, “the compensation approach can be considered as an extension of the reflux to the open economy”. According to the reflux principle, in the case of an excess liquidity in the system, the agents would use this excess in circulation to pay back their already existing debt, by running a process opposite of demand-led money creation – that is money destruction. In an endogenous money world, the agents have no interest in holding any excess that it is not demanded, therefore they get rid of it. The origin of the reflux mechanism goes back to the 19th century Banking school, according to which banknotes were always issued by the central bank in order to satisfy commercial needs, in which printing too much money has no reason to occur. Therefore, if too many banknotes were created, the holders would bring them back to the issuer,

hence the excess would disappear (Lavoie, 2014, p.184).

The reflux mechanism was supported by authors including Kaldor and Trevithick (1987), Le Bourva (1992) and Lavoie (1999). In his two articles in the early 1960s, Le Bourva apart from expressing the basis of demand-led endogenous money so early in the literature (rejection of the money multiplier, reverse causation from loans to deposits, money tied to production and not on exchange) also recognized the reflux mechanism: “given that the banks exist only insofar as entrepreneurs are indebted to them, the quantity of money in an economy can always be reduced by repaying loans without borrowing anew; in other words, only desired money can exist” (Le Bourva, 1992, p.451-2). In support of this mechanism, Lavoie (2001, p.1) writes: “the reflux principle applies first and foremost to firms, which are systematically in debt vis-à-vis the banks or other financial institutions, but also it applies to households and to the banking institutions themselves”. Its application to the balance sheets to the central banks in the case of the open economy, allows for the functioning of the compensation thesis.

The post-Keynesian criticism of the interest rate parities is focused on the unsound theoretical grounds of the interest rate parities and on the lack of empirical evidence. Concerning the purchasing power parity, the post-Keynesians reject its validity in a short and medium run, because of the lack of empirical evidence. According to the purchasing power parity, the differential in the price levels are determinants to the changes in the exchange rate, while it might be argued that the causality goes the opposite way (Lavoie, 2001). Following Coulbois and Prissert (1974), Lavoie (2000; 2002-3; 2014) and Smithin (2002-3) and Moosa (2004) give their support for the validity of the so-called “cambist” approach, according to which the covered interest parity always holds, but not as a result of the free capital flows and the correct expectations, but because the differential between the forward rate compared to the spot exchange rates is set exactly by calculating the interest rate differentials on the currency markets, being a mark-up on their costs. In order for the banks to cover themselves, whenever the agents sell the domestic currency forward, the banks would sell spot, thus offsetting the initial transactions. As a result, the only transactions influencing the exchange rates are the transactions with an uncovered position, since according to the post-Keynesian view of exchange rate determination, the short term capital flows are the forces that determine the changes in the interest rate. However, the post-Keynesians reject the validity of the uncovered interest rate parity. The actions of the arbitrageurs which are supposed to even out the differentials, according to the mainstream story, does not work in real life, since they do not consider the assets denominated in different currencies as perfect substitutes. The fact that the different assets are denominated in different currencies with exchange rates that might possibly change, in an uncertain future, from the standpoint of the asset holders diversifying their portfolios, does not make the assets, even the risk-free assets, perfect substitutes. Therefore, the uncovered interest parity

not being valid, the equalization of the real interest does not need to happen, thus allowing for a country to have and for the central bank to set exogenously interest rates different from those in the rest of the world, even in an open economy. To sum up, in the post-Keynesian interpretation, although the perfect mobility of capital is assumed, in terms of free movement of capital across countries, the assumption of perfect asset substitutability is rejected. Following Lavoie (2000; 2002-3) and Smithin (2002-3), in the case of perfect asset mobility and imperfect asset substitutability, there would not be an unlimited inflow of capital for any interest rate differential.

Serrano and Summa (2015) accept the perfect capital mobility assumption, but not perfect asset substitutability for reasons close to the previous post-Keynesian literature, expressing views in line with the compensation thesis. However, the authors support the proposition by Smithin (2002-3), according to which the differential between the interest rates in the uncovered interest parity might be attributed to some sort of currency premium, which might depend on the accumulated net foreign debt. Therefore, they assume a sort of foreign credit rationing, meaning that after a certain interest rate level, because of the rising current-account deficits with the rising output – therefore accumulating foreign debt, the country will not be able to attract more foreign currency.

Following these theoretical foundations, in a post-Keynesian interpretation of an open economy, a central bank is able to set the interest rate at a level of its policy choice, which does not depend on the interest rate level abroad. In a fixed exchange rate regime, movements in the foreign reserves that are a result of the external position of the country, would not have effect on money creation. There is no mechanism which would go from foreign reserves to money supply and influence the level of the interest rate, so there could be some sort of automatic external adjustment. Any excess liquidity which is a result of an increase in foreign reserves, following the reflux principle, gets destroyed by agents in the economy trying to get rid of it. This could be done either through obtaining government securities or central bank bonds, either through repaying their existing debt or through moving government deposits from between commercial banks and the central banks in order to offset the changes.

These actions would neutralize the effect of the initial change in the foreign reserves through the balance sheet of the central bank. In contrast to the mainstream open economy analysis (following the logic of the Mundell-Fleming model), sterilization of the movements in the foreign reserves is either not possible, or it can be done only by the central bank selling or buying government securities as a deliberate action. This approach suggests a central bank balance sheet consisting only of the foreign reserves and government deposits on the asset side and monetary base on the liability side. However, in reality the central bank balance sheets are way more complicated and include additional entries than those already mentioned, as elaborated in Lavoie (2001). Therefore, the balance sheet composition consistent with the compensation thesis would include

also overdrafts to the commercial banks on the asset side, and government deposits and central bank bonds on the liability side (Lavoie, 2001, 2014; Lavoie and Wang, 2012). Thus, the neutralization of the movements in foreign reserves can be done not only as a deliberate policy action of sterilization at the initiative of the central bank, but also endogenously, as at the initiative of the private agents in the economy through the other components of the central bank balance sheet, both on the asset and the liability side. An example from the literature in support of the endogenous sterilization process is the work of Nurkse (1944), in which the neutralization of the international assets is presented as being “designed and undesigned” (ibid., p.68). Nurkse states that whenever there is a opposite movements of the domestic assets compared to the international reserves “it may well be due to the bank’s inaction rather than its action” (ibid., p.70).

By analyzing the movements of international and domestic assets and their direction, Nurkse (1944) found that the movements of the foreign reserves to be mostly followed by opposite movements in the domestic credit, during the period from 1922 until 1938, in 26 countries taken into consideration. His findings contradict the logic of the rules of the game of the inflows of gold and foreign exchange leading to an increase in domestic assets, thus questioning its validity. Similarly, in a world of endogenous money and an interest level set by the central bank independently from the interest rate in the rest of the world, there should be no mechanism that goes from changes in foreign reserves, to changes in money supply and finally, changes in interest rates. An increase in foreign reserves should not lead to an increase in money supply (through the monetary base). Thus, in order to empirically prove the validity of the compensation thesis, the expected outcome would be not to find a long-term relationship between the foreign reserves and the monetary base. This result would mean that in a fixed exchange rate regime, the external position of the country has no influence on money creation. In the very short run, increase in foreign assets does increase bank reserves in the process of the exchange of the foreign currency. An absence of a long-term relationship on the other side implies that the inflow of foreign reserves does not influence money creation. However, it is important to mention that in the case of an increase in foreign reserves, there is a possibility of the monetary base increasing at the same time, but for different reasons, such as increased economic activity for example, which would lead to an increased demand for bank reserves. Thus, the monetary base increasing at the same time should not be considered as the result which ultimately rejects the validity of the compensation mechanism.

The movements in the foreign reserves can be sterilized by movements in the other components of the central bank balance sheet, here included the central bank bonds, government deposits, claims on the private sector and government securities. In the case of excess reserves, following the reflux principle, these reserves could be used by the private agents or commercial banks to obtain central bank bonds and government

securities. Reducing their existing overdrafts is a possibility, thus affecting the claims on the private sector component. Moving government deposits is one of the possible ways of offsetting changes in the foreign reserves.

The literature which attempts to give an empirical support of this theoretical concept is not extensive. An empirical analysis on the compensation principle was made by Lavoie and Wang (2012), which examines the compensation thesis in the case of China. They run a cointegration analysis on the balance sheet components of People's bank of China – foreign reserves, claims on the domestic sector, central bank bonds and government deposits, using IMF monthly data from December 1997 until November 2007. Lavoie and Wang (2012) find that if foreign reserves tend to increase by 1 percent, the claims on the domestic economy would decrease by 0.5 percent and the central bank bonds would tend to increase by 11.7 percent, while no long-term relationship was found between the foreign reserves and the monetary base. From their analysis it seems that the central bank bonds have the biggest role in the sterilization process during the analyzed period. Lavoie and Wang (2012) also look for a long-run relationship between the foreign reserves and the consumer price index (CPI) and they do not find one – there is no empirical evidence of the foreign reserves increasing the money supply that would lead to inflation.

### *Empirical analysis of the balance sheet of the Macedonian central bank*

The previous text dealt with the theoretical overview of the compensation thesis and the review of the existing literature. The following part gives an empirical analysis of the balance sheet of the Macedonian central bank (NBRM) and examines the validity of the compensation thesis in the case of Macedonia.

The National Bank of the Republic of Macedonia (NBRM) was established shortly after the country's independence. The national currency – the Macedonian denar (MKD) was introduced in April 1992. Before 1995, the central bank targeted the monetary aggregates. From that year on, the central bank conducts exchange rate targeting – first the exchange rate set against the German mark (DM) and later to the euro (EUR), since its introduction until today.

The NBRM officialy has price stability as an ultimate goal of the monetary policy. According to the Article 3 of the Law on NBRM of 2002, “The National bank shall support the economic policy of the country and the financial stability of the country without jeopardizing the realization of the main objective and adhering to the principles of the market economy”<sup>1</sup> In order to accomplish that goal, the central bank does not

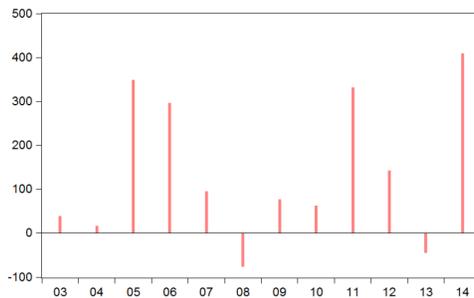
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<sup>1</sup>Law on the National Bank of the Republic of Macedonia, “Official Gazette of the Republic of Macedonia”, no. 3/02

target inflation, but it targets the exchange rate of the Macedonian denar against the euro, therefore the exchange rate being the intermediate target.

The NBRM says that it manages the level of the interest rates and the liquidity in the system, by using the monetary policy instruments, such as open market operations, reserve requirements, deposit facility and the overnight facility and the intraday credit. In the official statements of the Macedonian central bank, the main instrument for managing the liquidity of the system are the short-term securities issued by the NBRM with a very short maturity - the central bank bills.<sup>2</sup>

Before beginning with the analysis of the balance sheet of the Macedonian central bank, it is important to determine the balance of payments position in the years taken into consideration. Figure 1 shows data on the changes in the official international reserves, taken from the balance of payments. The changes in the foreign reserves in the period from 2003 until 2014 have been mostly positive - the country in this period has been accumulating foreign reserves.<sup>3</sup>



*Figure 1:* Changes in official international reserves, BOP data, in millions of EUR

The following analysis would use the data on the balance sheet of the NBRM, using NBRM as a source. However, the data presented is not in its original form, the simplified version of the central bank balance sheet components has been made in particular for the needs of this analysis. The dataset covers the period from January 2003 until April 2015, the period during which the exchange rate of the Macedonian denar was being held fixed to the euro. Balance sheet data of the NBRM is also available from 1996 until 2003 – for the consistency of this analysis, this time period has been excluded from this analysis, since the exchange rate was being held against the German mark and because of a methodological change in the balance sheet at the beginning of 2003. Therefore, the dataset contains 148 observations for each of the series. The balance sheet representation after its simplification is given in Table 1. Since the following part

<sup>2</sup>NBRM, Monetary policy implementation

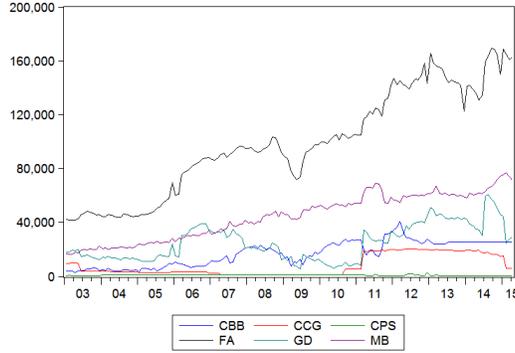
<sup>3</sup>NBRM, Statistics, Balance of payments

of this text will examine empirically the movements of the components of the balance sheet of the NBRM from the period between January 2003 and April 2015, here the balance sheet composition for exactly those two months is presented, as a good example of the balance sheet composition that supports the representation consistent with the compensation thesis, based on Lavoie and Wang (2012) and Lavoie (2014).

	January 2003	April 2015
ASSETS (in millions of MKD)	54238	170181
Foreign assets	42250	163021
Claims on the central government	9473	6058
Claims on banks and other financial institutions	504	80
Other assets	2011	1022
LIABILITIES (in millions of MKD)	54238	170181
Monetary base	16591	71372
Central bank bonds	4016	25470
Central government deposits	17976	29492
Foreign liabilities	4738	29492
Capital accounts and other items	11259	20459
Source:NBRM, Monetary statistics		

*Table 1:* Balance sheet of the Macedonian central bank (NBRM)

Following the balance sheet representation given the part dedicated to the theoretical overview, it can be concluded that the balance sheet of the Macedonian central bank (NBRM) has a composition really close to the representation consistent with the compensation thesis. The asset side of the balance sheet does not consist only of foreign reserves and government securities, it includes the components “claims on the banks and other financial institutions” as well, which represents the advances that the central banks give to the private sector. The asset side also contains an additional entry which consists of all the other asset entries in the balance sheet. The liability side also includes all the components consistent with the representation by Lavoie (2001). The monetary base consists of the currency in circulation plus reserves – the liabilities to the banks and the other financial institutions. The central bank bonds components comprises the securities issued by the NBRM which serve the purpose of maintaining the level of the liquidity in the system. The central bank balance sheet also contains government deposits on the liabilities side. The foreign liabilities component includes the liabilities to non-residents, as an example, credits from the IMF. The last component includes the own funds and the other unclassified liabilities. Figure 2 gives a graphical representation of the balance sheet components.



cbb – central bank bonds; ; ccg – claims on the central government; cps – claims on the private sector (banks and other fin.instit.) fa – foreign reserves; gd – government deposits; mb – monetary base

Figure 2: The components of the balance sheet of the NBRM (in millions of MKD)

A distinction between asset-based and an overdraft economy can be made depending on the asset side components of the central bank balance sheet – if the central banks allows for advances to the commercial banks, the country can be considered of the overdraft type. Otherwise, if the balance sheet of the central bank does not include claims on the private sector, the country can be considered to be an asset-based economy. In the case of Macedonia, this distinction seems not easy to make. Even though the Macedonian central bank (NBRM) gives advances to the commercial banks the size of the claims on the banks and the other financial institutions is at a very low level compared to the other components of the balance sheet of the NBRM. Thus, even though the Macedonian central bank allows for advances to the commercial banks, given that their size is negligible, it can be concluded that the economy is more of an asset-based, than of an overdraft type.

The five series that were included in the econometric analysis are foreign reserves, monetary base, claims on the domestic sector (consisting of claims on the central government and claims on the banks and other financial institutions), central bank bonds and government deposits. According to the compensation thesis, any increase in foreign reserves – a result of a surplus in the balance of payments of the country, will lead to movements in the other components of the balance sheet of the central bank, but they would not affect the monetary base. An increase in the foreign reserves would lead to a decrease in the components on the asset side – the claims on the central government, but also an increase in the central bank bonds and the government deposits – the components on the liabilities side of the balance sheet of the central bank. Thus, the results of the econometric analysis would be consistent with the compensation thesis, if they show that there is a long-run relationship between the foreign reserves, claims on the central government, central bank bonds and government deposits.

fa (foreign reserves) ↑
mb (monetary base) –
cds (claims on the domestic sector) ↓
cbb (central bank bonds) ↑
gd (government deposits) ↑

Table 2: Expected movements in the balance sheet components, when foreign reserves increase

In order to determine if the variables are stationary or not, a standard augmented Dickey-Fuller test was conducted. The ADF test was conducted on all the variables, while the lag length was determined automatically by the statistical software – according to the Akaike Information Criterion (AIC). The results of the augmented Dickey-Fuller test are given in the Table 3.

	Lag length	Test statistics	Critical value (95%)	p-value
Foreign reserves (FA)	12	-3.239753	-3.443450	0.0812
Monetary base (MB)	0	-3.512889	-3.440681	0.0417
Claims on dom.sector (CDS)	0	-1.032953	-1.943107	0.2706
Central bank bonds (CBB)	9	-2.826644	-3.442712	0.1904
Government deposits (GD)	0	-2.205115	-2.881123	0.2054

Table 3: Augmented Dickey-Fuller test

The results suggest that the null hypothesis of the variables having a unit root cannot be rejected in all the cases, except for the one of the monetary base. The absolute value of the test statistic of the ADF test for the monetary base is lower than the absolute value of the critical value – the null hypothesis has to be rejected. That means that the foreign reserves, claims on the central government, central bank bonds and the government deposits are non-stationary, except from the monetary base – which is  $I(0)$ . Therefore, in this analysis a regular cointegration testing cannot be implemented - the standard cointegration analysis would be possible if all the variables are non-stationary. In this situation, an analysis of the long-run relationship between the variables of different orders –  $I(0)$  and  $I(1)$ , can be done with the Autoregressive Distributed Lags (ARDL) bound testing approach for cointegration, put forward by Pesaran et al. (2001).

ARDL models include both current and lagged values for the explanatory variables but also include lagged values of the dependent variable. One of the advantages of the ARDL methodology over the regular cointegration is that it can be used with both stationary and non-stationary variables. However, none of the variables should be second-order integrated –  $I(2)$ . In order to determine the order of integration, the first difference was calculated and tested for unit root – the null hypothesis was rejected for

all the cases – the variables are all integrated of first order. Apart from determining if there exists the long-run relationship between the variable, the ARDL approach also gives not only the long-run parameters, but accounts also for the short-run.

Therefore, in constructing the ARDL, the first step to be to determine the causality and the variables taken into consideration. According to the compensation thesis, changes in the foreign reserves (which are the result of the balance of payments position of the country in the given period) should not be followed by changes in the monetary base (in the long-run), but they should be followed by changes in the other components of the balance sheet.

Since the effect goes from the foreign assets to the other components, there is a need to construct as many ARDL models as there are components on which the effect of the changes of the foreign reserves would be analyzed. Thus, in all of these models, the foreign reserves would be the explanatory variable, on the right side on the equation. Since the other components are monetary base, claims on the domestic sector, central bank bonds and government deposits, this empirical analysis would include four ARDL models.

After determining the dependent and explanatory variables in the model, the next step is to determine the number of lags for each variable of each model. The lag selection has been done automatically by the statistical software used<sup>4</sup>, with the maximum number of lags set by 6 and following the Akaike Information Criterion. The lag structure for the given set of dependent and explanatory variables is given in Table 4.

Dependent variable	Explanatory variable	ARDL lag structure*
mb	fa	ARDL (1,1)
cbb	fa	ARDL (5,1)
cds	fa	ARDL (6,1)
gd	fa	ARDL (1,1)

\* The number of lags being determined by AIC

*Table 4:* Lag structure of the ARDL models

The ARDL bound testing approach requires constructing an “unrestricted error-correction model”, which means that the error correction term from the regular ECM would be replaced by the lagged levels of the dependent and the explanatory variables, which means that in this case the coefficients of the lagged levels are not restricted. The unrestricted, or the conditional ECM is given in the following equation:

$$\Delta y_t = \beta_0 + \sum_{i=1}^p \delta_i \Delta y_{t-i} + \sum_{j=0}^q \gamma_j \Delta x_{t-j} + \mu_0 y_{t-1} + \mu_1 x_{t-1}$$

<sup>4</sup>For all the analyses, the statistical software EViews 8 was used.

The unrestricted ECM is used to determine if there exists a long-run relationship between the variables or not. In case there is, the long-run coefficients between the variables can be calculated from the unrestricted ECM. By introducing the variables into this equation and having in mind the previously determined lag structure, the following models were created:

*Model 1*

$$\Delta mb_t = \beta_0 + \delta_1 \Delta mb_{t-1} + \gamma_1 \Delta fa_{t-1} + \mu_0 mb_{t-1} + \mu_1 fa_{t-1}$$

*Model 2*

$$\Delta cbb_t = \beta_0 + \sum_{i=1}^5 \delta_i \Delta cbb_{t-i} + \gamma_1 \Delta fa_{t-1} + \mu_0 cbb_{t-1} + \mu_1 fa_{t-1}$$

*Model 3*

$$\Delta cds_t = \beta_0 + \sum_{i=1}^6 \delta_i \Delta cds_{t-i} + \gamma_1 \Delta fa_{t-1} + \mu_0 cds_{t-1} + \mu_1 fa_{t-1}$$

*Model 4*

$$\Delta gd_t = \beta_0 + \delta_1 \Delta gd_{t-1} + \gamma_1 \Delta fa_{t-1} + \mu_0 gd_{t-1} + \mu_1 fa_{t-1}$$

In order to determine if there is a long-run relationship between the variables in each model, it should be conducted an F-test on the coefficients from the unrestricted ECM. Thus, the null hypothesis would be that there is no cointegration between the variables in each of the models. There would be no cointegration if the long run coefficient from the unrestricted ECM would be zero.

The results of the test for each of the models are to be compared to the critical values by Pesaran et al. (2001). They give a lower and an upper bound, to which the F-statistic should be compared in order to determine if there is cointegration between the variables. If the F-statistic is greater than the upper value, the null hypothesis is rejected - there is a long-term relationship between the variables. If the value is lower than the lower bound, it can be concluded that there is no cointegration between the variables. A value which is between the bounds can not lead to conclusive results. The results of the test for each of the four models is given in Table 5.

The results show that there is a cointegration for only one of the models - the Model 2, since the F-statistic is higher than the upper bound. This is the model which includes the central bank bonds and the foreign reserves - it can be concluded that there is a long-run relationship between the two variables. Given the F-stat and the p-value, it can be concluded that it is a strong relationship, since it is significant even at a 1% level.

	F-stat	p-value	Critical values *	
			lower	upper
Model 1	1.321594	0.27	4.94	5.73
Model 2	9.106896	0.0002	4.94	5.73
Model 3	1.252812	0.2891	4.94	5.73
Model 4	2.844573	0.0615	4.94	5.73

\* Critical values: intercept and no trend, 95%, k=1 (Pesaran et al. 2001)

*Table 5:* ARDL bound testing for cointegration

However, the null hypothesis cannot be rejected in the case of Model 1, Model 3 and Model 4. The F-stats for each of the models are lower than the lower bound of the critical values by Pesaran et al. (2001). The result of having no cointegration in Model 1 is great news - that means that in the long-run, the monetary base is not determined by the foreign reserves - the money supply in a fixed exchange regime is not determined endogenously from the supply of foreign reserves, which depends on the country's external position. This finding supports the demand-led endogeneity of money.

The results for Model 3 and Model 4 lead to the conclusion that the claims on the domestic government and the government deposits, do not play a significant role in the sterilization of the foreign reserves in the long run. The result of a no-cointegration relationship in the case for Model 3 can be said that it contradicts the most widely accepted method of sterilization in the mainstream analysis of an open economy. Since the claims on the domestic sector in the case of Macedonia consist mostly of claims on the central government, the non-existence of the long-run relationship would contradict the view of sterilization only as buying or selling government securities. This empirical analysis shows no long-run relationship between the foreign reserves and the government deposits on the balance sheet of the central bank.

The logical next step would be to estimate the long-run and short-run coefficients of the only model showing cointegration between the variables.<sup>5</sup> The long run coefficients can be calculated from the restricted ECM. Since in the long-run, the first differences are taken as zero, in the case of Model 2, the long run coefficient between the two would be

$$-(\mu_1/\mu_0) = -(0.041289/ - 0.201731) = 0.20467$$

This result shows that 1 percent increase in the foreign reserves would lead to approximately 0.2 percent increase in central bank bonds. This result is consistent with

<sup>5</sup>The unrestricted ECM and the regular ECM for Model 2 can be found in the Appendix

the compensation thesis - the changes in the foreign reserves are followed by changes in the same direction of the central bank bonds.

The short-run coefficient can be drawn from the regular ECM - the coefficient for the error-correction term is -0.202080, significant even on a one percent level. Therefore, it can be concluded that 20 percent of any disequilibrium between cbb and fa is corrected in a period of one month.

## *Conclusion*

The idea of an empirical analysis of the movements in the central bank balance sheet components comes from the not so extensive literature on the topic and it was inspired by the empirical study of Lavoie and Wang (2012) on the case of China. It was also fueled by the interest in the Macedonian case and the functioning of the NBRM. The case of Macedonia seemed like a suitable choice, since the national currency had its exchange rate fixed to the euro and since the balance sheet of the NBRM proved to be very close to the representation consistent with the compensation thesis.

The results of the econometric analysis seem to give support for the compensation principle. The non-existence of a long-run relationship between the foreign reserves and the monetary base contradicts the logic of the automatic adjustment mechanism, which goes from foreign reserves to money supply to interest rates. This result seems to confirm the demand-led nature of endogenous money, even in an open economy. This result does not show that there is no connection between the foreign reserves and the monetary base whatsoever - on a very short term, increases in foreign reserves lead to an increase in the bank reserves at the central bank as the agents transfer the foreign currency in deposits in the domestic currency and the central bank exchanges them for bank reserves at the central bank. However, these excess reserves get destroyed in the short-run, through the functioning of the reflux mechanism. Therefore, in the long-run in an endogenous money world, there should not be any relationship between these two variables.

The results on the relationship between the government deposits and the claims on the central government can still be considered as favorable to the compensation thesis. The offsetting of the foreign reserves does not need to happen through long-run movements in all of the components. There is a possibility of a neutralization of the foreign reserves by these components at a very low level or not on a regular basis. However, the absence of this relationship cannot be ignored. Since this analysis dealt only with data, without putting an emphasis on the actual conduct of the monetary policy and its operations, the conclusions drawn would stop here, while at the same time pointing out the need for taking a more in-depth monetary policy perspective in

order to explain the role, or an absence of one and the reasons for it, in the neutralization of the foreign inflows or outflows.

The only long-term relationship in the models that was tested is the one between the foreign reserves and the central bank bonds. At an F-statistic at a really high level compared to the higher bound of the critical value and at the level significant even at a one percent level, the cointegration relationship seems to be very strong. This result is actually consistent with what the Macedonian central bank actually claims to do. According to the official statements of the NBRM, the central bank bonds, called “blagajnicki zapisi” are the main instrument of the monetary policy and an instrument of managing liquidity in the system.<sup>6</sup> Therefore, it can be concluded that the central bank bonds are actually the component of the balance sheet of the NBRM which compensates for the movements in the foreign reserves.

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<sup>6</sup>NBRM, Monetary policy implementation

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## Appendix

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-621.5045	534.7084	-1.162324	0.2472
D(CBB(-1))	0.147351	0.083735	1.759724	0.0808
D(CBB(-2))	0.019416	0.084395	0.230060	0.8184
D(CBB(-3))	0.109694	0.083547	1.312965	0.1915
D(CBB(-4))	0.233769	0.082117	2.846771	0.0051
D(CBB(-5))	0.186600	0.084681	2.203560	0.0293
D(FA(-1))	-0.014168	0.031836	-0.445034	0.6570
CBB(-1)	-0.201731	0.047471	-4.249574	0.0000
FA(-1)	0.041289	0.011129	3.710003	0.0003
R-squared	0.162809	Mean dependent var		148.3752
Adjusted R-squared	0.11245	S.D. dependent var		2178.632
S.E. of regression	2052.485	Akaike info crterion		18.15277
Sum squared resid	5.60E+08	Schwartz criterion		18.34011
Log likelihood	-1279.847	Hannan-Quinn criterion		18.22890
F-statistic	3.233073	Durbin Watson criterion		1.967422
Prob (F-statistic)	0.002157			

Table A1: Unrestricted ECM, Model 2

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	69.12999	175.4743	0.393961	0.6942
D(CBB(-1))	0.148146	0.083400	1.776326	0.0779
D(CBB(-2))	0.020087	0.084072	0.238929	0.8115
D(CBB(-3))	0.109969	0.083254	1.320892	0.1888
D(CBB(-4))	0.233817	0.081835	2.857191	0.0050
D(CBB(-5))	0.186586	0.084390	2.210999	0.0287
D(FA(-1))	-0.014957	0.031605	-0.473264	0.6368
Z(-1)	-0.202080	0.047292	-4.273053	0.000
R-squared	0.612304	Mean dependent var		148.3752
Adjusted R-squared	0.118544	S.D. dependent var		2178.632
S.E. of regression	2045.428	Akaike info crterion		18.13929
Sum squared resid	5.61E+08	Schwartz criterion		18.30582
Log likelihood	-1279.890	Hannan-Quinn criterion		18.20696
F-statistic	3.708951	Durbin Watson criterion		1.967207
Prob (F-statistic)	0.001066			

Table A2: ECM, Model 2