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The new currency boards and discretion: empirical evidence from Bulgaria

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Abstract

In recent years, a number of countries have introduced currency boards (CBs). Gaining in swing and popularity, this *new* generation CB preserves, to varying degrees, the Central Bank's ability to function as the lender of last resort (LOLR) and to intervene in case of systemic risk. Recently, Central Bank flexibility has been preserved in different forms in Hong Kong, Argentina, Estonia, Lithuania and Bulgaria. Macro- and microeconomic implications of such departures from orthodox CBs have not been thoroughly studied yet. Theoretically, the introduction of this second-generation CB provides an opportunity for conducting discretionary monetary policy (though certainly not in its typical form). Some major, ensuing questions require answers. What are the new channels of monetary policy? Does an orthodox self-regulating (automatic) mechanism work with second-generation CBs? How are monetary disequilibria in the economy adjusted? We define an automatic mechanism as "the presence of a positive cointegration relationship between the overall balance of payments (BOPs) and the reserve money, and the absence of discretionary variables in the model." The theoretical hypothesis is checked empirically based on Bulgarian data.

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1. Introduction

Experience with stabilization programs has shown that money supply concerns are first and foremost institutional. Consequently, a number of countries have recently introduced currency boards (hereafter referred to as CBs) and constrained their Central Bank functions,

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reducing them to note issuing and banking supervision. Recent studies suggest that countries with a CB have been quite successful in bringing down inflation. For instance, Ghosh et al. (2000) conclude that CBs have been instituted to gain credibility following periods of high inflation and, in this regard, they have been remarkably successful. Countries with a CB experienced lower inflation and higher growth compared to both floating regimes and simple pegs. The lack of discretionary powers of a CB is considered to be crucial in this respect. [1]

An orthodox CB (we would rather call it *first-generation* CB), typical of the colonial system, completely excludes monetary policy (Schuler, 1992; Schwartz, 1993). It entails flexibility in the real economy and liberalization of balance of payments (BOPs). CB automation is backed by a simple and clear rule which determines the relationship between BOPs, reserve money (money supply) and interest rate dynamics (Hanke and Schuler, 1994; Williamson, 1995). A CB possibly mandated for discretionary intervention is de facto ruled out.

The new, *second-generation* CBs, gaining swing and popularity, preserve to varying degrees the Central Bank ability to function as the lender of last resort (LOLR) and to intervene in case of systemic risk. Central Bank flexibility was preserved in different forms in Hong Kong, Argentina, Estonia, Lithuania and Bulgaria (Tsang, 1999; Caprio et al., 1996; Bennett, 1993, 1994; Camard, 1996; Miller, 1999). Macro- and microeconomic implications of such departures from orthodox CBs have not been thoroughly studied yet. However, the introduction of these second-generation CBs (often called quasi CBs) certainly provides an opportunity for conducting discretionary monetary policy (though certainly not in its typical form). [2] Moreover, these new developments allow us to argue that there is room for discretion within the framework of modern CB rules.

Major new questions have, thus, arisen. What are the new channels of monetary policy? How can an automatic mechanism be defined? Does it work with second-generation CBs? How are monetary disequilibria adjusted? How can the automatic mechanism be checked? The resulting theoretical hypotheses presented in the paper are empirically tested based on Bulgarian data.

With the introduction of a CB arrangement on 1 July 1997, Bulgaria's Central Bank underwent the most profound institutional change since its establishment in 1879. This radical step came in response to the severe banking and currency crisis of late-1996 and early-1997, culminating in a hyperinflation in early-1997 (43% in January and 240% in February), a drastic depletion of foreign currency reserves (to a critical level of USD 440

[1] Schuler (1999) argues: "bitter experience has taught many countries that chasing after short-term "flexibility" in monetary policy reduces the prospects for long-term growth. There are times when you must accept losses in the short term to make greater gains later. Hong Kong has one of the world's best long-term records of economic growth. The currency board system has contributed to it, by enabling Hong Kong to avoid the currency disasters that have beset its neighbors. If central banking were to be worthwhile for Hong Kong, monetary policy with a domestic CB would have to be better than the policy Hong Kong imports from the US Federal Reserve System. It is unlikely that Hong Kong would succeed where so many others have failed. The answer is rather to make the currency board system more orthodox so that the Hong Kong dollar becomes truly as good as the US dollar, and enjoys the same level of credibility."

[2] A short review of the critiques against currency boards as a stabilization tool is presented in Roubini (1998). A comprehensive discussion on the advantages and disadvantages of the currency board as a monetary regime is made in Leviatan (1992).

million), the closure of 14 commercial banks (comprising 25% of the consolidated bank balance sheet) and a full disruption of the functions of the national currency (OECD, 1999).

The present study is based on the first 4 years of the Bulgarian experience under a CB arrangement. This operation in Bulgaria enables us to draw theoretical and empirical conclusions some of which are confirmed by the operation of this monetary regime in other countries (Nenovsky et al., 2001).

This paper is organized as follows. Section 2 presents two major channels of monetary policy. The first is inherited from former discretionary Central Bank policy. The second, however, is specific to the channels of monetary discretion under a CB arrangement. Next, we focus on the specific design of the Bulgarian CB and discuss hypotheses about major monetary discretion channels. Section 3 deals with departures from the automatic CB mechanism and with the possibilities for conducting monetary policy in Bulgaria. Section 4 presents a theoretical model of the relationship between balance of payments (hereafter referred to as BOPs), reserve money and government deposits, and an econometric test based on cointegration analysis. Finally, conclusions are drawn and some policy implications for the Bulgarian CB are suggested.

2. The main channels of discretionary monetary policy under the currency board

In contrast to the first-generation CBs, the possibility of conducting discretionary monetary policy is preserved with the new CBs. [3] We classify the discretionary monetary policies into two types, one classical and one new, both conducted within the framework of the new CB regime. The first type consists of functions inherited from the classical Central Bank and the second derives from the specific design of the modern CBs.

2.1. Traditional channels

While orthodox CBs had historically preceded the independent Central Bank in colonial countries, the new generation CBs followed just the opposite course of development. They emerged chronologically after those Central Bank associated with discretionary monetary policies. The pursuit of these latter policies especially reinforced the preservation of certain classical Central Bank tools and created a kind of path dependence.

In most countries, *minimum required reserves* were preserved to varying degrees. Whereas in Bulgaria and Estonia the minimum required reserves are set in the standard way, the so-called liquidity requirements determine the reserves in Argentina where commercial banks are required to hold a portion of their reserves in high-liquid US securities (Banco Central de la Republica Argentina, 2000). This mechanism leaves room for Central Bank to manipulate of reserve money and money supply through changes in the level of minimum required reserves and through the reporting methodology to be used by commercial banks. Though, despite the existing opportunities, these tools are used quite sparingly. In the rare cases when they are used, it has been mainly in response to bank crises triggered by external shocks rather than as discretion on money supply. The Argentine experience during

[3] By monetary policy, we mean a deliberate intervention into money supply dynamics.

Table 1
Issue Department balance sheet

Assets	Liabilities
Cash and nostro accounts in foreign currency	Currency in circulation
Monetary gold	Bank deposits and current accounts
Foreign securities	Government deposits and accounts, Banking department deposit
Banking Department balance sheet	
Nonmonetary gold and other precious metals	Borrowings from IMF
Investment in securities	Liabilities to other IFIs
Loans and advances to banks	Capital
Claims on government	Reserves
Bulgarian's IMF quota and holdings in other international financial institutions	Retained profit
Deposit with Issue Department	

the Mexican crisis is indicative of the role minimum required reserves could play under a CB arrangement (Caprio et al., 1996). Contrary to others countries, Estonia has recurrently used this instrument. Its use for more than 10 times since the launch of CB in 1991 comes close to the CB discretion through money supply regulation. [4]

In Bulgaria, the level of the minimum required reserves had been set at 11% of the commercial bank deposit base upon CB introduction and was not modified till June 2000, despite the country's exposure to adverse external shocks related to the Russian financial crisis and to the war in Kosovo. In April 1998, the methodology of reporting minimum required reserves was modified to provide for greater commercial bank autonomy and flexibility in liquidity management. Since July 2000, Bulgarian National Bank (BNB) has reduced minimum reserves requirements from 11 to 8%. The reduction decision was consistent with the strategic long-run Central Bank policy of a gradual reduction of reserve requirements to the 2% euro-area level. The decision also aimed to offset the shock generated by the ministry of finance policy of centralizing government money transactions through establishing a single fiscal account with the Central Bank.

The next function that was preserved under the second-generation CBs is the LOLR (for a historical survey of LOLR under different monetary regimes see Bordo, 1989). LOLR is performed within the framework of the CB monetary rules, i.e. up to the level of CB excess reserves (see Table 1). Under orthodox CBs, the net worth of reserves is used to serve only as a guarantee against asset value volatility. Thus, the retention of LOLR function reflects a widely held view that, in some instances, it may not be possible to solve the individual banks' liquidity problems by simply organizing private sector support (Bagehot, 1866; Diamond and Dybvig, 1983; Freixas et al., 1999). Moreover, liquidity shortages may be experienced by the banking system as a whole, in which case a private sector solution—

[4] The other peculiarity of the Estonian CB is the presence of certificates of deposit (CDs) issued by the Central Bank (since March 1993). Although it is argued that CDs encourage the development of an interbank market (serving as collateral) when in small volumes, they represent a departure from CB principles in strictu sensu (Aima, 1998). In Lithuania, besides reserve requirements and LOLR functions, repo operations with treasury bills and auctions for time deposits were introduced in the summer of 1997.

which redistributes the currently available liquidity in the market from institutions with surpluses to those with deficits could not help. When liquidity problems are not caused by the underlying insolvency problems, Central Bank will usually consider stepping in to provide liquidity support.

2.2. New channels

The emergence of new monetary discretion channels under the new generation CBs is determined by a choice of liabilities that need be backed by reserve currency and the degree of this backing. With first-generation CBs they are backed at least 100% and the assets backing CB liabilities must be issued by nonresidents. A departure from this principle under the current version of CBs generates possibilities for the pursuit of discretionary monetary policy. The Argentine model of a quasi CB is indicative of the possibility of conducting monetary policy through establishing a certain floor (not less than 66.6%) for liability backing with international assets issued by nonresidents. Within the remainder, the Banco Central de la Republica Argentina may hold securities issued by the Argentine government.

The inclusion of *government fiscal reserves* in the liability side of a CB (i.e. covering them with international reserves) is the major channel of monetary policy transmission in the Bulgarian and Lithuanian models of the CB. Consequently, government revenue and expenditure policies directly impact the reserve money and, hence, the money supply. Moreover, privatization revenues, which constitute a major part of foreign direct investment inflows, go directly into government deposits with the CB. This mechanism creates a kind of automatic sterilization of foreign direct investment inflows as long as the CB is obliged, by law, to invest its reserves in securities issued by nonresidents (whenever those privatization revenues are not used to finance government expenditures). In other words, the government may be conducting, intentionally or not, monetary discretion. Also, this mechanism destroys the automatic link between BOPs dynamics and reserve money dynamics. In these circumstances, money market disequilibria do not disappear with interest rate adjustments as they do under an orthodox CB but, rather, require management of government reserves at the Central Bank balance sheet. Hence, the government is able to use discretion by integrating fiscal and monetary policies into a *syncretic* whole (Nenovsky and Hristov, 1998).

It is a well known fact in all countries that Treasury departments' activities affect the deposits held with Central Bank and, therefore, the liquidity situation. Extensive research has been conducted to explore the treasury activities' impact on liquidity conditions and on Central Bank monetary policies (Griffiths and Winters, 1995; Hamilton, 1997; Almuina, 1999; among others). The main difference under CBs is that, since CBs do not conduct any kind of monetary policy operations, treasury activities create asymmetric liquidity shocks, which could not be offset in practice by the Central Bank.[5] For instance, Petrov (2000) concludes that treasury operations are the most significant source of shocks on Bulgarian interbank interest rates.

From our point of view, the major argument in favor of an inclusion of government reserves in the liability side of CB balance is that the free movement of capital and a high

[5] Asymmetric liquidity shocks means that when the Ministry of Finance withdraws liquidity, interbank interest rate variance increases but the opposite dependence is not in force.

capital mobility cause large capital flow volatility, which reflects directly on reserve money and interest rates as they are automatically linked to the BOPs. In these circumstances, government fiscal policy working through fiscal reserve dynamics in the balance sheet of the Central Bank may offset shocks and help smooth reserve money and interest rate fluctuations. Moreover, it is argued that for countries with relatively high external debt (like Bulgaria with 78% of GDP) and large annual service obligations, the inclusion of government reserves in the liabilities side and their backing with international reserves help enhance CB credibility. Concurrently, such a design reduces reserve money volatility as large payments on external debt are accommodated by government reserves (Miller, 1999). It, thus, seems theoretically possible to design fiscal policy operations to stabilize interest rates in the presence of exogenous shocks like a change of direction in capital flows. In the case of the Bulgarian CB, there is no such intentionally designed operation to smooth out interest rate movements that create additional uncertainty.

In Section 3, we focus on the new channels of discretion to highlight how the structure of CB liabilities reflects on the operation of the automatic mechanism between the BOPs and the reserve money. We examine this relationship on the basis of the Bulgarian design of CB.

2.3. The structure of the balance sheet of the Bulgarian currency board

The Bulgarian National Bank is divided into two departments–an Issue Department and a Banking Department. [6] The balance sheet of the Issue Department which, in practice, plays the role of a CB, includes international assets that serve as cover for its liabilities. The latter are comprised of items typical of an orthodox CB: banknotes and coins on the one hand and, on the other, items typical of second-generation CBs such as commercial bank reserves, government fiscal reserves and net worth expressed by the deposit of the Banking Department. The item recording the net worth of the CB also exists in the orthodox variant but, in the new board's case, it only plays the role of a buffer which absorbs shocks triggered by asset operations. Beyond the buffer role and expressed through the Banking Department deposit, this net worth provides an opportunity for performing the LOLR role (within the size of the deposits) in case of systemic banking crisis. The BNB may extend loans in levs to banks through the Banking Department in the event of a *liquidity risk affecting the stability of the banking system*; these loans are extended only to solvent banks experiencing acute needs of liquidity that cannot be provided from other sources. Such loans are extended only against a collateral of liquid assets and the repayment term is not supposed to exceed 3 months. BNB's regulation N6 defines *liquidity risk* as a situation in which the total amount of ordered but unpaid payment documents in the Banking Integrated System for Electronic Transfer (BISERA) exceeds 15% of their total amount for each of the last 2 days. Furthermore, liquidity risk for the banking system arises if an individual bank delays or announces that it is going

[6] This follows the model of the Bank of England, likewise divided into Issue Department and Banking Department. Bank of Estonia also has a similar structure. Unlike the BNB and the Bank of Estonia, the Issue Department of the Bank of England does not hold foreign exchange as a backing for the note issue, but rather for domestic securities.

to delay the settlement of the payment documents submitted to it for more than 3 days and if the bank has at least an eight percent share of all interbank payments for each of the last five business days prior to filing a request for a loan with the BNB (BNB, 1999).

The Banking Department deposit provides the link between the Issue Department and the Banking Department and also reflects the relationship between the Government and the CB. The relationship between the government and the International Monetary Fund (IMF) passes through the Central Bank balance sheet. Tranches received in the balance sheet of the Banking Department are recorded as Borrowings from the IMF under liabilities and as Banking Department deposit with the Issue Department under assets. Within 90 days of reception, the IMF tranches are transferred to the government account whereby the Banking Department deposit decreases and the government deposit increases by the same amount. In the balance sheet of the Banking Department, this transaction is recorded by crediting the deposit at the Issue Department and debiting it from "the CB lending to the government" item. When the Government does not borrow from the IMF, it stays within the limits of the Banking Department deposit, thus, providing larger funds for the Central Bank LOLR function.

3. The automatic mechanism and its deviations—theory and measurement

Since there is no precise definition of the CB automatic mechanism in the literature, we define an automatic mechanism as a procedure where, for a specific period of time, the dynamics of reserve money follows the dynamics of the BOPs and any deviation from that parallel and synchronous dynamics is relatively rapidly and automatically corrected to restore the functioning of the mechanism. In econometric terms, this means that a cointegration relationship should exist between the two series.

A major methodological and terminological clarification need be made at this point. We could speak of an automatic mechanism proper if and only if there is a relationship between the BOPs and the reserve money *without any discretionary* (*policy*) *variable* in the model. If there exists a relationship between the BOPs and the reserve money, and discretionary (policy) variables are included in the model (in the short or long-run dynamics), we cannot speak of a pure operation of the automatic mechanism but rather of an adjustment through discretion (or a combined adjustment through automation and discretion).

Miller was the first who clearly detected some significant deviations from automation in the operation of the Bulgarian CB's mechanism (Miller, 1999). He noted that the BOPs deficit does not cause automatic contraction in reserve money (see Fig. 1). In our opinion, this deviation from orthodox principles is mainly due to the specific design of the Bulgarian CB, described in Section 2.

3.1. Monetary discretion through government deposit

The orthodox CB precludes monetary policy and represents a specific form of monetary constitution. As the asset side of the balance sheet of the Issue Department does not include domestic assets, reserve money dynamics depends only on changes in foreign currency reserves, which derive from the BOPs position. As is well known from experience with

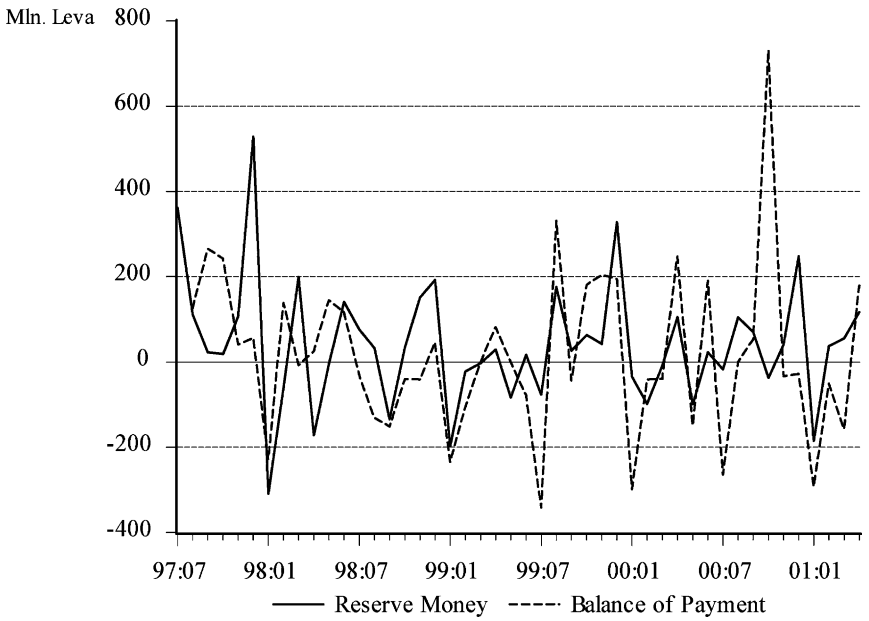

Fig. 1. Changes in reserve money and BOPs.

stabilization programs based on fixed exchange rates, the responsibility for macroeconomic management rests entirely with fiscal policy.[7]

The design of the Bulgarian CB entails, whether intentionally or not, the possibility that the government conduct monetary policy through its deposits in the liability side of Issue department. It can definitely be argued that there exists a specific transmission mechanism through which fiscal policy directly affects the reserve money[8] and only indirectly the interest rates. In the latter case, we can detect a liquidity effect under the CB (see empirical study of the liquidity effect in Nenovsky et al. (2001)).

An illustration of a simplified CB (Issue Department) balance sheet is presented as follows.

Assets	Liabilities
F	*C*
	R
	G
	B

[7] Moras (1998) constructed a CB model in which fiscal dynamics and an "adverse tax shock" affect the credibility of the exchange rate fix. In this model, fiscal policy has an indirect effect on the CB.

[8] We concentrate our analysis of the currency board automatic mechanism on the relationship between the balance of payments and the reserve money. The relationship between the balance of payments and the broad money supply is not investigated. This latter relationship heavily depends on the degree of financial development, currency substitution and unofficial dollarization. A simplified empirical test of the relationship between the balance of payments dynamics and the broad money supply is presented in Nenovsky et al. (2001).

where F is the Issue Department foreign currency reserves, C the banknotes and coins in circulation, R the required reserves and excess reserves of commercial banks, G the government deposit, B is the Banking Department deposit (net worth of the CB).

Let H be reserve money, then

$$H \equiv C + R \equiv F - G - B \tag{1}$$

The government deposit shows the government's budget revenues and expenditures and the lending to Government. Let T be tax income, E the government operating and investment expenditures, P receipts from privatization, dBn the net value of securities financing and dI is the value of tranches from IMF. Then the government deposit is equal to: [9]

$$G = T - E + (-P - \mathrm{dBn} - \mathrm{dI}) \tag{2}$$

Thus, money supply assumes the classical form:

$$M^{\mathrm{s}} = mH = m[F - (T - E - P - \mathrm{dBn} - \mathrm{dI}) - B] \tag{3}$$

where m is the money multiplier ($m > 0$). Or

$$M^{\mathrm{s}} = mH = m[F - T + E + P + \mathrm{dBn} + \mathrm{dI} - B] \tag{4}$$

Partial derivatives showing the money supply's ceteris paribus response to increases in foreign exchange reserves, tax income, Fund tranches, government spending and the Banking Department residual are as follows:

$$\frac{\partial M^{\mathrm{s}}}{\partial F} > 0, \quad \frac{\partial M^{\mathrm{s}}}{\partial T} < 0, \quad \frac{\partial M^{\mathrm{s}}}{\partial E} > 0, \quad \frac{\partial M^{\mathrm{s}}}{\partial P} \gtreqless 0, \quad \frac{\partial M^{\mathrm{s}}}{\partial |\mathrm{dBn}|} \gtreqless 0,$$
$$\frac{\partial M^{\mathrm{s}}}{\partial |\mathrm{dI}|} \gtreqless 0, \quad \frac{\partial M^{\mathrm{s}}}{\partial B} < 0 \tag{5}$$

Hence, it is evident that the revenue and expenditure dynamics directly affects the reserve money and only indirectly the money supply. It becomes clear that a decrease in tax revenues causes an automatic monetary expansion and vice versa. However, a tax revenue increase results in monetary contraction. With an increase in government expenditures, the reserve money expands and vice versa. Restrictive spending policies lead to money supply contraction. The likelihood of the partial derivative with respect to privatization revenues to be of either sign derives from the fact that privatization is comprised of two financial components: finance by domestic funds and finance by foreign capital. In the former case, a contraction of reserve money and an increase in fiscal reserves occur, resulting in a negative partial derivative. In the latter case, the privatization through foreign capital financing reflects on the financial account of the BOPs and could result in a money supply increase.In general, government deposit dynamics synthesizes not only fiscal policy but monetary policy as

[9] We put a minus sign before government budget deficit financing on the assumption that the government budget position is approximated by the fiscal reserves in the liabilities side of the CB balance sheet. In this sense, for the budget to stay balanced $T - E = P + \mathrm{dBn} + \mathrm{dI}$, i.e. $T - E - P - \mathrm{dBn} - \mathrm{dI} = 0$.

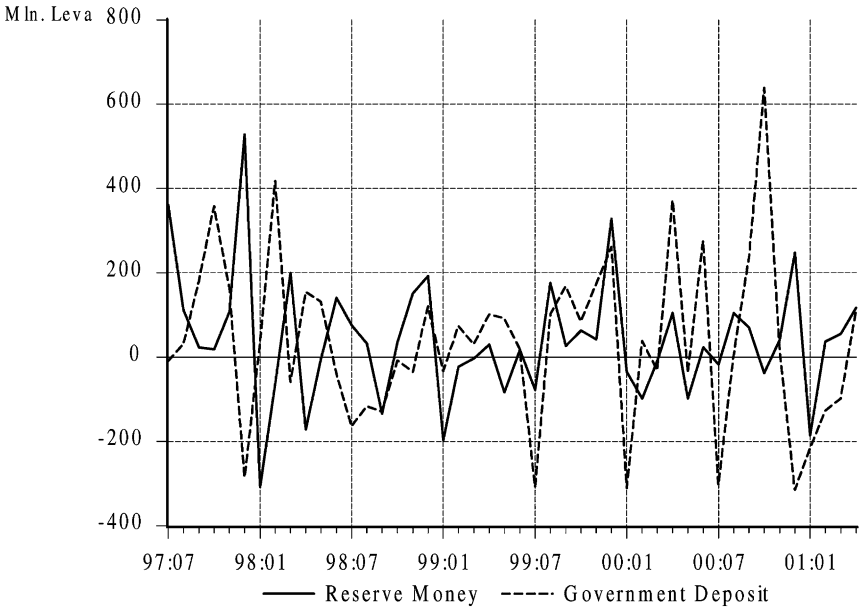

Fig. 2. Changes in reserve money and fiscal reserves.

well. [10] In a sense, it may be concluded that both policies are incorporated into a *syncretic one* (see Fig. 2). This sincretic policy may be of a particularly strong discretionary nature, in essence supplanting former Central Bank tools.

As we have seen, the specific design of the Bulgarian CB provides an opportunity for conducting discretionary monetary policy. Our next step will be to find an answer to the question 'under what conditions this policy could be stabilizing'.

3.2. Does the government deposit contribute to stabilization?

The CB automatic mechanism works best when reserve money volatility follows BOPs volatility. Stabilization is interpreted as a low variance in the reserve money supply. This latter is measured by the Central Bank balance sheet identity. We note that defining reserve money through the balance sheet places a focus on its supply. We raise the question: 'under what circumstances, the government deposit G in the CB liabilities is stabilizing?' To this end, we compare the reserve money variance with and without government deposit.

[10] A money supply model may also be presented as: $M^s = mH = m(F(G) - G - B(G))$, where net foreign assets and the Banking Department deposit are also functions of the government deposit. Then the derivative takes the following form:

$$\frac{\partial M^s}{\partial G} = \left[\left(\frac{\partial F}{\partial G}\right) - 1 - \left(\frac{\partial B}{\partial G}\right)\right] m < 0.$$

The overall impact of G on money supply will depend on joint F and B responses to changes in G.

Actually we compare two Issue Department balance sheets, one with and the other without government deposit. In the latter case, government fiscal reserves are added to both sides of the balance sheet as the amount deposited in the liabilities side becomes part of CB assets and is placed as part of foreign currency reserves.

Issue Department balance sheet without government deposit.

Assets	Liabilities
F	*C*
	R
	B

Issue Department balance sheet with government deposit.

Assets	Liabilities
F	*C*
G	*R*
	G
	B

To have a stabilizing presence of *G* in the balance sheet, the variance of changes of reserve money in the first balance sheet should be higher than that in the second balance sheet. We express the reserve money variances in the two cases as

$$\text{var}(\Delta F) = \text{var}(\Delta H + \Delta B) \tag{6}$$

$$\text{var}(\Delta F + \Delta G) = \text{var}(\Delta H + \Delta B + \Delta G) \tag{7}$$

Eq. (6) shows the position of the orthodox CB when the variance of the foreign currency reserve changes is equal to the variance of the sum of reserve money changes and of the changes in excess over the reserve money, which is the Banking Department deposit in the Bulgarian case. We add the government deposit to both sides in Eq. (7). Next, we combine (6) and (7) to obtain the variance of the reserve money changes ΔH.

From Eq. (6) we have

$$\text{var}(\Delta F) = \text{var}(\Delta H) + \text{var}(\Delta B) + 2\text{cov}(\Delta H,\ \Delta B)$$

Hence,

$$\text{var}(\Delta H) = \text{var}(\Delta F) - \text{var}(\Delta B) - 2\text{cov}(\Delta H,\ \Delta B) \tag{8}$$

From Eq. (7) we have

$$\begin{aligned}&\text{var}(\Delta F) + \text{var}(\Delta G) + 2\text{Cov}(\Delta F,\ \Delta G)\\ &\quad = \text{var}(\Delta H) + \text{var}(\Delta B) + \text{var}(\Delta G) + 2\text{cov}(\Delta H,\ \Delta B) + 2\text{cov}(\Delta H,\ \Delta G)\\ &\qquad + 2\text{cov}(\Delta G,\ \Delta B)\end{aligned}$$

Hence,

$$\begin{aligned}\mathrm{var}(\Delta H) = {} & \mathrm{var}(\Delta F) + \mathrm{var}(\Delta G) + 2\mathrm{cov}(\Delta F,\ \Delta G) - \mathrm{var}(\Delta B) - \mathrm{var}(\Delta G) \\ & - 2\mathrm{cov}(\Delta H,\ \Delta B) - 2\mathrm{cov}(\Delta H,\ \Delta G) - 2\mathrm{cov}(\Delta G,\ \Delta B) \end{aligned} \tag{9}$$

The condition for stabilization is for var(ΔH) in Eq. (9) to be smaller than var(ΔH) in Eq. (8). After manipulations, we obtain

$$2\mathrm{cov}(\Delta F,\ \Delta G) - 2\mathrm{cov}(\Delta H,\ \Delta G) - 2\mathrm{cov}(\Delta B,\ \Delta G) < 0 \tag{10}$$

Thus, (10) may be presented as

$$\rho_{\Delta F\,\Delta G}\sigma_{\Delta F}\sigma_{\Delta G} - \rho_{\Delta H\,\Delta G}\sigma_{\Delta H}\sigma_{\Delta G} - \rho_{\Delta B\,\Delta G}\sigma_{\Delta B}\sigma_{\Delta G} < 0$$

where $\rho_{\Delta F\,\Delta G}$, $\rho_{\Delta H\,\Delta G}$, $\rho_{\Delta B\,\Delta G}$ are the coefficients of correlation between changes in foreign currency reserves and the government deposit, in reserve money and the government deposit, and in Banking Department deposit and the government deposit, respectively and $\sigma_{\Delta G}, \sigma_{\Delta H}, \sigma_{\Delta B}$ are the mean square deviations of the changes in the government deposit, the reserve money and the Banking Department deposit, respectively.

Therefore, we can express the condition for stabilization in terms of the correlation between changes in reserve money and the government deposit $\rho_{\Delta H\,\Delta G}$:

$$\rho_{\Delta H\,\Delta G} > \frac{\rho_{\Delta F\,\Delta G}\sigma_{\Delta F} - \rho_{\Delta B\,\Delta G}\sigma_{\Delta B}}{\sigma_{\Delta H}} \tag{11}$$

As the correlation between changes in the CB assets and the government deposit ($\rho_{\Delta F\,\Delta G}$) is positive, the correlation between changes in the Banking Department deposit and the government deposit ($\rho_{\Delta B\,\Delta G}$) negative, and the mean square deviations of CB assets, Banking Department deposit and reserve money changes are positive, then the term on the right-hand side of inequality (11) is positive. Therefore, the correlation between changes in reserve money and changes in government deposit should be positive or

$$0 < \rho_{\Delta H\,\Delta G} \leq 1 \tag{12}$$

Inequality (12) imposes a strict condition on the behavior of the deposit and reserve money changes: they must always move in the same direction. If their one-way dynamics is broken, it may be argued that the government deposit has a destabilizing effect on reserve money supply. During the period under consideration, these correlations have had the following values: $\rho_{\Delta F\,\Delta G} = 0.70$, $\rho_{\Delta B\,\Delta G} = -0.1$ and $\rho_{\Delta H\,\Delta G} = -0.1$. These results allow us to conclude that, since the introduction of the CB, the government deposit has played a rather destabilizing role.

4. The model and the discussion of results

4.1. Background model

The theoretical model is aimed at testing two hypotheses. The first is whether the automatic link between the BOPs dynamics and the reserve money dynamics typical of orthodox

CBs remains in force under the second-generation CBs. The second is to find out how the inclusion of fiscal reserves in the liabilities of the quasi CB affects the reserve money dynamics and the money market adjustment process. [11]

With the first-generation (orthodox) CBs, the reserve money dynamics is determined entirely by the BOPs dynamics. If there is no possibility of changing either the level of reserve money backing by international reserves or the level of commercial bank minimum required reserves (if any), then there are no factors causing deviations from the long-run relationship between the BOPs and the reserve money. This, in turn, means that for a long-run cointegration relationship between the BOPs and the reserve money to persist (i.e. to be cointegrated with cointegration vector CI (1, 1)), the reserve money and the BOPs series should both be nonstationary.

The factors that can cause deviations from the long-run relationship between the BOPs and reserve money are the retention of the LOLR function, a change in minimum required reserves and, also, the methodology of reporting these reserves under a CB. Moreover, the inclusion of government fiscal reserves in the liabilities of the CB is another major source of deviation. A final factor is the presence of those capital inflows which are not reflected in the financial account of the BOPs and not induced by market forces. This could be an IMF financing or another sort of official financing, i.e. an inflow induced mainly by political concerns rather than by market decisions. Since official financing (by IMF or World Bank) flows to the government, this effect is captured by the fiscal reserve account within the Central Bank.

The theoretical model of cointegration between the BOPs and reserve money is applied to the Bulgarian case. During the period under consideration, the BNB did not perform its LOLR function and only once changed the level of commercial bank minimum required reserves (in July 2000). Thus, the main source determining the deviation of reserve money dynamics from BOPs dynamics is government fiscal reserves which destroy the long-run relationship between the two.

Econometric cointegration and error correction methodology are widely used in studies exploring long-run equilibrium among variables. (Campbell and Perron, 1991; Enders, 1995). A principal feature of cointegrated variables is that their time paths are influenced by the extent of any deviation from long-run equilibrium. After all, if the system is to return to the long-run equilibrium, the movements of at least some of the variables must respond to the magnitude of the disequilibrium. According to our definition of the CB automatic mechanism, the existence of cointegration between the BOPs and reserve money is proof of a smooth functioning of this mechanism. The absence of cointegration, however, is a signal of malfunctioning automatic mechanism and the presence of discretion. The policy variable used to exercise discretion is the government fiscal account with the CB. The cointegration test for the BOPs and reserve money is conducted by including the government fiscal account as an exogenous policy variable. Consequently, the existence of cointegration is interpreted as a signal for discretion.

[11] There is one more issue concerning the effectiveness of a currency board's operation. It is the question as to what extent the interest rate performs its transmission mechanism function for the money market's adjustment to various external and internal shocks. We do not explore that issue as Petrov (2000) has studied the Bulgarian case.

The first stage of this methodology is the unit root test for the following variables:

$h_t = \log(H_t)$: logarithm of reserve money;
$\text{bop}_t = \log(\text{BOP}_t)$: logarithm of the overall BOPs (accumulated);
$g_t = \log(G_t)$: logarithm of government deposit.

The second stage involves measuring the long-run relationship between reserve money and foreign currency reserves as determined by the BOPs dynamics, the deviations from long-run equilibrium and the speed of adjustment. The cointegration relationship (i.e. the long-run relationship) between the BOPs and reserve money is shown as folows:

$$h_t = \alpha_0 + \alpha_1 \text{bop}_t + \varepsilon_t$$

where ε_t is the stationary disturbance term.

The mechanism of error correction (i.e. the short-run adjustment dynamics) is as follows:

$$\Delta h_t = A(L)\,\Delta h_{t-1} + B(L)\,\Delta \text{bop}_{t-1} + C(L)\,\Delta g_{t-1} + \delta(h_{t-1} - \alpha_1 \text{bop}_{t-1} - \alpha_0) + \beta_0 + \upsilon_t$$

$A(L)$, $B(L)$ and $C(L)$ are the lag polynomials and δ is the correction coefficient for restoring the long-run equilibrium. In accordance with our definition of the CB automatic mechanism, we introduce the government deposits into the model as an exogenous variable. Under a well-functioning automatic CB mechanism, the coefficient for the BOPs must be $\alpha_1 = 1$, i.e. an increase (a decrease) in reserve money must be equal to an increase (a decrease) in foreign currency reserves.

4.2. Statistical data and the econometric testing of the model

The present study covers the period following the introduction of the CB in Bulgaria. Monthly data from BNB monetary statistics for the period July 1997–April 2001 are used. The variables included in the analysis are the reserve money (H), fiscal reserves (G) and the overall BOPs. Also included are two dummy variables that capture the changes in reserve requirements d1 (July 2000) and the financial account liberalization d2 (January 2000), respectively. All series are transformed into logarithms. The first two variables are taken from Issue Department monthly balance sheets. Reserve money is calculated as a sum total of banknotes and coins in circulation and commercial bank reserves, recorded in the Issue Department balance sheet. As monthly data on the BOPs capture flows, we transformed this data into stock using June 1997 as a starting point. In order to capture the effects of the reserve requirement reduction in July 2000 and of the financial account liberalization in January 2000, we created two dummies and used them as exogenous variables.

Since cointegration analysis [12] is applicable only to nonstationary time series with levels, we apply the unit root test to the variables used (h, bop, g). We apply the ADF test. The results obtained are displayed in Table 1.

[12] We used the Eviews 4 software for econometric testing.

Table 2
Unit root test

Variables	Augmented Dickey–Fuller test (ADF)		McKinnon critical values (ADF)[a] (%)			Order of integration and lags	
	Levels	First differences	1	5	10	Integration	Lags
h	−2.15	−5.35	−3.59	−2.93	−2.60	*I*(1)	2
bop	−2.63	−4.63	−3.59	−2.93	−2.60	*I*(1)	2
g	−2.46	−4.88	−3.59	−2.93	−2.60	*I*(1)	2

[a] Critical values refer to the case with constant without trend.

The variables *h*, bop and *g* are *I*(1). This enables us to apply the Johansen test for cointegration between the BOPs (bop) and reserve money (*h*).

Drawing on the understanding that government fiscal reserves in the balance sheet of the quasi CB constitute the only source for deviations between reserve money and BOPs movements, we conduct two tests for cointegration. In the first test, by including the BOPs and the reserve money variables, we search for a long-run relationship between the two and, hence, for the presence of a pure automatic mechanism. If this latter is rejected, we conduct a second cointegration test by including government fiscal reserves as an exogenous variable. In this case, we search for a long-run relationship between the BOPs and the reserve money in the presence of discretion as exercised by the ministry of finance. Last step is to quantify the speed of adjustment of the long-run relationship between the BOPs and the reserve money variables in order to detect the short-run deviations from equilibrium in the presence of discretion.

The results obtained are summarized in Table 2.

The results from the two models may be summarized as follows. First, there is no cointegration between the BOPs and the reserve money. This result confirms our hypothesis of a broken link between the two and, thus, the absence of a pure automatic mechanism under second-generation CBs. The source of this deviation is explained by the fact that the deficit in the BOPs is neither entirely financed by a change in the reserve money of the CB, nor by credits from the IMF and other international financial institutions. At the same time, capital inflows entered in the BOPs capital account do not directly affect reserve money as the overwhelming amount of this capital consists of receipts from privatization deals accumulating in the government deposit (fiscal reserves).

Second, there is cointegration between the BOPs and the reserve money when government fiscal reserves with CB are included as an exogenous variable. We interpret this result as proof of the existence of an automatic mechanism provided there is discretion exercised by the Ministry of Finance.

The vector error correction (VEC) model shows a statistically significant error correction term. The coefficient that represents the speed of adjustment is relatively high (−1.03). The government fiscal reserve account, a proxy of the degree of discretion in our model, is statistically significant and the dummy variables capturing the reduction of commercial banks reserve requirements and financial account liberalization are insignificant. This result confirms our hypothesis that government fiscal reserves play a key balancing role for the operation of the Bulgarian CB (Table 3).

Table 3
Cointegration and VEC

	Model 1 (without *g*)	Model 2 (with *g* in the VEC)
Variables[a]	Dependent variable *h*	Dependent variable *h*
Cointegration equation (long-run relationship)		
Intercept	No cointegration	0.12
Trend		0.01 (5.7)
bop		0.12 (2.6)
VEC (short-run relationship)		
Error correction term		−1.03 (−5.31)
d(h(−1))		0.23 (1.49)
d(bop(−1))		−0.09 (−2.11)
d(g(−1))		0.32 (3.02)
d1		−0.05 (−1.14)
d2		−0.01 (−0.31)
Intercept		−0.89 (−3.01)
R^2		0.68
R^2 adjusted		0.51
Log likelihood		72.83
F-statistics		5.75

[a] Values shown in the parentheses represent *t*-values.

5. Summary

The proposed theoretical model and the empirical analysis of the operation of the Bulgarian CB suggest the following theoretical conclusions.

1. The Bulgarian Central Bank is a hybrid of an orthodox Central Bank and a classical Central Bank. It combines a lack of flexibility typical of first-generation Central Bank with elements of Central Bank flexibility. Criticisms of CB inflexibility cannot be leveled against the Bulgarian version of CB as options for conducting monetary policy exist. The LOLR function is preserved. Moreover, new channels of affecting reserve money supply through the specific design of the CB balance sheet have been created. These options provide room for a rapid response to banking and currency crises.
2. The automatic adjustment mechanism of the orthodox CB does not work, for reserve money supply dynamics does not follow BOPs dynamics. Nevertheless, there exists a long-run cointegration relation between the two variables if we include government fiscal reserves as an outside variable in the VEC. The short-run equilibrium is made possible through budget flows (expenditures, revenues, privatization receipts, securities floating and tranches from the IMF and other IFIs). Hence, we can speak of an "adjustment mechanism through discretion—conscious or unconscious". However, this type of adjustment cannot be called a pure automatic mechanism.
3. The presence of government fiscal reserves in the form of deposit in the liabilities on the Issue Department balance sheet not only provides an opportunity for a discretionary manipulation of reserve money supply but also, as already noted, produces a destabilizing rather than stabilizing effect. For this deposit's presence to have a stabilizing impact on

reserve money, its correlation with reserve money need be positive, a condition that cannot always be fulfilled.

4. The efficiency of the hybrid form of the CB in Bulgaria could be subject of discussion. Despite significant flexibilities under the second-generation CBs, we consider that the possibility of monetary discretion and the break of the automatic mechanism are not desirables.

There are several possible options for change in the Bulgarian CB. The *first* is to go back to a first-generation CB and to restore the classical automatic adjustment mechanism. This requires shifting the government deposit from the Issue Department balance sheet to one of the several options available: commercial banks, a separate institution, a combination of these two options or placing government money with Banking Department balance sheet. This measure should be accompanied by an elimination of minimum required reserves or by shifting to liquidity requirements as in Argentina. The *second alternative* is to move closer to a discretionary Central Bank by active and deliberate management of the government deposit with a view to affecting reserve money supply (i.e. reserve money will be targeted in a manner similar to a classical Central Bank) upon assessment of money demand. The *third alternative* is to transfer government deposits to a separate fiscal agency with transparent operation rules. This agency would invest government funds in high grade foreign assets and would not affect domestic interest rates. Concurrently, these funds would provide room for manoeuvre for the government in the presence of adverse external shocks.

These options should be carefully considered. However, in our opinion, the first, i.e. the restoration of the orthodox CB, appears to be the most appropriate in the case of Bulgaria.

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