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Sterilization Activities and Lender of Last Resort in Recent Currency Board-Like Countries

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Abstract

This paper empirically analyses discretionary monetary activities in recent currency board-like countries. In contrast to the previous research, it shows that none of the recent currency board-like countries, except for Argentina, was excessively overusing sterilization activities, when these activities were more precisely defined. In this respect, other currency board arrangements can be considered either as orthodox or unorthodox and differ from the majority of the central banking countries that were investigated. Furthermore, the function of lender of last resort was significantly limited in CEE currency board-like countries as compared to the other monetary arrangements; on the other hand the monetary authorities in Hong Kong and Argentina were comparably active lenders of last resort to the banking sector.

Introduction

Many studies that have focused on recent currency board systems indicate two separate views on the way these systems should operate. The first view, mainly advocated by Hanke and Schuler, tells that recent currency boards should comply with so called orthodox rules. This is a set of rules which limits the activities of monetary authorities within a currency board. More precisely, orthodoxy implies that monetary authority obeys these rules: supplies notes and coins only; keeps fixed exchange rate with an anchor currency; keeps foreign reserves of 100% of the monetary base; ensures full convertibility; does not act as lender of last resort; and obeys rule-bound monetary policy, just to mention the most important (Hanke et al, 1993). This set of rules defines an orthodox currency board, which according to its proponents cannot create inflation and finance government deficit. Consequently, orthodox currency boards entail credibility of domestic currency and promote stability of the whole economy (Hanke, 2002a).

However, the followers of the second view claim that it is necessary to allow slight deviations from the orthodox rules, especially regarding the rule-bound monetary policy and the lender of last resort (Ho, 2002; Nenovsky and Hristov, 2001; Siaudinis, 2003). They argue that monetary rigidity implied by the orthodox rules burdens banks and increases the possibility of liquidity crunch and systemic crises in the banking sector. Hence some monetary discretion[1] within a currency board arrangement is necessary in order to promote stability of the financial system. Actually most of the recent currency boards that existed in the past ten years including: Hong Kong (from 1983), Argentina (from 1991 to 2001), Estonia (from 1992), Lithuania (from 1994), Bulgaria (from 1997) and Bosnia and Herzegovina (from 1997) had formal legal provisions, which allowed non orthodox exceptions (Ho, 2002). Therefore, it is quite common in the literature to define these countries as "unorthodox" or "currency board-like" systems.

[1] Monetary discretion implies the opposite to rule bound monetary policy (Hanke et al, 1993) rather than central bank initiated discretion, which treats standing facilities and overnight loans as non discretionary tools (initiated by counterparties) (Ho, 2002).

The clash between the two views did not become acute until the Argentinean crisis of 2001. Many economists were quick to blame currency board arrangement as one of the causes of the crisis[2]. This accusation forced Hanke and Schuler, as the most devoted currency board proponents, to take an active defending stance (Hanke 2003, Schuler 2003b). One of their most articulated counterarguments is that Argentinean monetary arrangement was not really a currency board because it allowed so much monetary discretion that it could not be distinguished from central banking countries (Hanke, 2002b; Schuler, 2003a). Accordingly, it was not a currency board which failed but rather a system which they extensively opposed by promoting orthodoxy rules. Furthermore, Hanke (2002b) investigates actual sterilization behavior of recent currency board-like systems and claims that all the other countries, except for Bosnia, in practice performed very much like central banking countries. It is this claim that we investigate in the present paper.

In addition, most of the literature on Lender of Last Resort states that LOLR is very limited in currency board arrangements (Fischer, 1999; He, 2000), as follows straightforwardly from the definition of an orthodox currency board. However, Ho (2002) shows that many recent currency board-like arrangements were authorized to act as lenders of last resort. Taking into account Hanke's argument about excessive discretionary policy in those countries, it is all the more important to check empirically whether lender of last resort is actually limited in recent currency board-like arrangements (CBAs) as it is assessed in theoretical literature.

Given these two aims, the paper is organized in two chapters. The first investigates sterilization activities in recent currency board-like countries and some central banking countries. It shows that Hanke's (2002b) results are misleading, and proposes an alternative way of analyzing sterilization. The second chapter compares lender of last resort activities in recent CBAs with those in other monetary regimes. The last section concludes and suggests lines of future research.

[2] According to Hanke (2002c)

1. Sterilization Activities in Recent Currency Board-Like Countries

According to Hanke (2002c), many so called "anointed" economists assign the problems of Argentina to the currency board arrangement and its lack of discretion. However, Hanke (2002c) and Schuler (2003a) argue that the convertibility system of Argentina was far from being a rule-bound currency board arrangement, since it allowed considerable discretion, including lender of last resort activity. Further, Hanke (2002b) shows that many other recent currency board-like countries deviated significantly from orthodox principles and engaged in sterilization activities throughout their existence. However, we will show that discretionary sterilization was very limited in the majority of CBAs.

1.1 Evaluating Sterilization: the Problem of Misinterpretation

According to the proponents of orthodox rules, currency boards should have only domestic notes and coins on their liabilities side, and these should be fully covered by foreign reserves on the asset side (Hanke et al, 1993). In reality the liabilities of recent CBAs also include reserves of commercial banks, foreign liabilities and other domestic liabilities, whereas the asset side consists of domestic assets as well. This is not a crucial distinction and does not in itself imply discretion as long as net domestic assets are held constant and net foreign reserves change one to one with monetary base[3]. Such behavior ensures full coverage of the monetary base and implies that the monetary authority is not involved in regulating money supply. It merely exchanges domestic currency for the anchor currency as is prescribed by orthodox rules. On the other hand, when the monetary authority tries to influence the money supply, it sterilizes the amount of base money which it sells (buys) for foreign exchange by buying (selling) domestic assets through open market operations.

Based on these considerations, Fane (in Schuler, 2003a) and Hanke (2002b) calculate sterilization ratios, which show to what degree coun-

[3] If not stated different: net domestic assets equal domestic assets minus domestic liabilities; net foreign reserves equal to the foreign assets minus foreign liabilities; monetary base equals currency in circulation plus reserves of banks.

tries are engaged in discretionary monetary policy. Hanke (2002b) uses monetary authorities' balance sheet data on six CBAs and calculates the quarterly changes of net foreign assets and net domestic assets normalized by the monetary base of the previous quarter. According to the balance sheet identity, the sum of these two ratios is simply the percentage change in base money. Hence, under orthodox currency boards the ratio (from now on called the sterilization ratio) of changes in net domestic assets to the changes in net foreign assets should be equal to zero, so that all domestic money creation is the result of increased net foreign assets only. If the central bank uses perfect discretion and sterilizes completely then this ratio would equal —1, leaving the monetary base unchanged for all changes in international reserves. Ratios between —1 and 0 show moderate sterilization, while positive values reveal amplified monetary policy where domestic money increases by more than changes in net foreign assets. Hanke (2002b) gives sterilization ratios for 6 CBAs and concludes that all of them, except for Bosnia, engaged in sterilization activities.

In addition to a simple graphical investigation of the sterilization ratios, Hanke (2002b) employs econometric analysis by regressing changes in net domestic assets on changes in net foreign assets. The coefficient of the regressor is another way of representing the sterilization ratio as it shows the average tendency to offset a one percentage point increase in net foreign assets by changes in net domestic assets. Hanke's results show that CBAs in Bulgaria, Lithuania and Hong Kong were heavily involved in sterilization, with respective coefficients of —0.76, —0.73 and —0.73. This means that in these countries around 75% of the increase in net foreign reserves was offset by decreases in net domestic assets, leaving only 25% for the increase in the monetary base. The other two countries, Estonia and Argentina sterilized around 50% of variations in net foreign assets (only Bosnia and Herzegovina did not engage in significant sterilization), so that five of the CBAs cannot be considered true currency board s, because of the extent of monetary discretion they excercised.

Even though the results are unarguably numerically correct, their interpretation is dubious. Thus, while the central bank of Lithuania has embedded in its legal framework some powers of monetary discretion such as repos, deposit auctions, open market operations, liquidity and overnight

loans[4], according to its annual reports discretionary monetary policy has not been used since the middle of 2000[5]. The Estonian central bank, throughout its existence as a currency board, has used only two types of discretionary tool: standing deposit facilities and certificates of deposits, which have lost their significance since 2000[6]. Hence, Hanke's results indicating significant sterilization in these two countries seem to contradict information we have on the operational activities of some of the monetary authorities concerned.

In the case of Lithuania, the explanation of this contradiction lies in the structure of liabilities in the balance sheet of the Lithuanian central bank. More thorough investigation reveals that the "central government deposits" item on the balance sheet is one of the most volatile parts of domestic liabilities. Moreover, this item is not completely domestic, as on average during the currency board period 85% of these accounts were foreign currency deposits[7]. As a result, in Lithuania an inflow of foreign currency (e.g. a loan from the world bank) into the account of the central government with the Central Bank naturally increases net foreign assets, but it also automatically increases net domestic liabilities (increasing net domestic assets) when the government converts the foreign exchange into domestic currency (with the aim of subsequently spending it within the domestic economy). Accordingly, this purely mechanical action generates a value of — 1 in the sterilization coefficient for the transaction concerned, without any involvement of discretionary monetary policy.

Therefore, the level of sterilization calculated by Hanke (2002b) has to be interpreted with great caution. After the net foreign assets are redefined to be equal to the foreign assets minus foreign liabilities minus foreign currency deposits of the central government, the sterilization coefficient for Lithuania was recalculated using more detailed data from the central bank. After these modifications the Hanke's (2002b) method gives

[4] The Guidelines for the Application of Monetary Policy Instruments of the Bank of Lithuania (1997); available at: **http://www.lb.lt/eng/about/policy.html** (last accessed 2004-06-06).

[5] Annual reports of Lithuanian CB 2001 and 2003 available at: **http://www.lb.lt/eng/publications/index.html** (last accessed 2004-06-06).

[6] Evolution of Eesti Pank monetary policy operational framework and Monetary Policy Operational Framework Reform 2000 both available at the website of Central Bank of Estonia; available at: **http://www.bankofestonia.info/pub/en/majandus/rahasysteem/yldalused/** (last accessed 2004-06-06).

[7] Balance sheet of CB of Lithuania; source: CB of Lithuania; available at: **http://www.lb.lt/eng/statistic/index.html** (last accessed 2004-06-06)

a sterilization coefficient for Lithuania equal to —0.097, which is far lower than in the original calculation that shows on average more than 90% of reserve money increases accompanying foreign reserve increases.

1.2 Re-estimation of Sterilization Activities

The previous example shows how currency boards can be identified as discretionary by using sterilization coefficients, even though their real actions do not excessively deviate from orthodoxy. Thus, the sterilization coefficients have to be recalculated for the other CBAs in order to reveal their degree of monetary policy discretion more precisely. But first it is useful to understand the mechanics of sterilization:

$$\Delta nFA + \Delta nDA = \Delta M0 + \Delta Gov\$ + \Delta GovX \quad \text{eq. (1)}$$

Here delta stands for changes, nFA and nDA are net foreign assets and net domestic assets excluding central government deposits (Gov), M0 is reserve money, $ is foreign currency and X is domestic currency indicator. Transferring Gov to the liabilities side as a positive item (instead of it being a negative item on the assets side) improves the transparency of the central bank balance sheet for our purposes. The variable which shows the degree of sterilization is ΔnDA because it reflects the direction and the extent of intervention of CB into the open markets (buying and selling domestic securities, extending loans and accepting deposits). It was shown at the end of previous sub-chapter that changes in foreign currency government deposits affect net foreign assets directly and leave no effect on monetary base; consequently it has to be excluded from the net domestic assets to avoid misinterpretation of sterilization. The same can be said about domestic currency government deposits: even though it affects the monetary base directly it is hardly possible that government displays its funds at the will of CB whenever the monetary neutralization is needed[8].

[8] When government tax receipts increase and are deposited with the central bank two things happen. First, the domestic liabilities of the central bank increase, and therefore its net domestic assets fall. Second, the monetary liabilities of the central bank — the monetary base — fall. Conversely, when government spends these tax receipts, net domestic assets increase together with monetary base, making it appear that the government is engaged in discretionary monetary policy (though not one associated with changes in reserves).

The argument about no discretion would not hold when the transfer of the whole government account is considered from or to the CB (Hanke and Sekerke, 2003).

As a result, the coefficient of sterilization should be calculated excluding government deposits from domestic liabilities (with a negative sign) and adding them (with a positive sign) to reserve money. Of course, according to orthodox principles the monetary authority should refrain from holding government deposits and their existence in the balance sheets of recent currency boards is a clear deviation from those principles; however when it comes to the evaluation of discretionary powers their changes do not conceal any discretion as it is understood in the central banking systems.

Further, the analysis of sterilization using the most recent data from IFS for six unorthodox currency board countries and other 21 central bank arrangements in similar regions is done for two cases. In the first case government deposits are included in domestic liabilities, while in the second case they are excluded from domestic liabilities. Simple estimation of ΔnDA on ΔnFA as in Hanke (2002b) shows that there is significant autocorrelation in the residuals. According to Greene (2002) this might imply incorrect model specification and therefore the estimates of the regression would be biased. Consequently, there are additionally included lagged dependant (ΔnDA) and explanatory (ΔnFA) variables (up to lag — 10) in the simple regression in order to explain some missing dynamics. The issue of autocorrelation is thoroughly assessed in this analysis because the model with lagged dependent variables and autocorrelation produces unreliable estimates of coefficients (Greene, 2002). The final model specification for each country was chosen in such a way that the lowest number of significant explanatory variables is used in order to minimize autocorrelation in the residuals (see tables 1a and 2a for more details in appendix).

The coefficient of interest is the contemporaneous value of changes in net foreign assets. This shows by how much changes in net foreign assets are immediately offset through sterilization by changes in net domestic assets. Therefore, it represents a monetary authority's instantaneous response to the pressure on the monetary base and reflects how active it is on average to intervene immediately in the markets. Apparently, the estimation in the first case is essentially the same as in Hanke (2002b) (with the exception that it additionally deals with dynamics); on the other hand, the second case tries to clean sterilization coefficients of government deposit "noise" in the way described in the begin-

ning of this section. Recall that the coefficient of — 1 in the first two equations indicates full sterilization, and 0 indicates no sterilization. The results of the analysis for the recent currency boards alone are presented in Table 1 below.

Table 1. Sterilization analysis of recent unorthodox currency boards

Country	Period	Sterilization coefficient (1) [i]	P value [iii]	Sterilization coefficient (2) [ii]	P value
Recent Currency Board-like Systems					
Argentina	1991:05 2001:12	-0.77	0.000	-0.51	0.000
Bulgaria	1997:08 2004:01	-0.78	0.000	-0.18	0.047
Estonia	1992:11 2004:02	-0.12	0.009	-0.11	0.013
Hong Kong	1997:04 2004:02	-0.88	0.000	-0.08	0.507
Lithuania	1994:05 2003:12	-0.78	0.000	-0.01	0.305
Bosnia and Herzegovina	1997:12 2004:02	-0.02	0.090	-0.02	0.254

Data source: International Financial Statistics (IFS).

[i] Sterilization coefficient calculated not excluding government deposits.

[ii] Sterilization coefficient calculated excluding government deposits.

[iii] P-value indicates probability value of significance test.

First of all, we can observe from the table that the sterilization coefficients calculated in the two cases differ to a great extent for the majority of the recent currency board countries. The deviations of the coefficient calculated under the case 1 from the values that were estimated in the original work of Hanke (2002b) can be justified by an extended (or different) period of observation, utilizing other sources of information[9] and using a dynamic model. According to the sterilization coefficients, which are estimated when government deposits are not excluded from domestic liabilities, four unorthodox currency boards were heavily involved in sterili-

[9] In the original work (Hanke, 2002b) it is mentioned that next to IFS data the balance sheets of the monetary authorities were used.

zation (only excepting Bosnia and Estonia), and this is more or less the same result as in the original work.

However, as has been shown, coefficients which do not take government deposits into account are a better guide to the discretionary powers of the monetary authorities. And indeed, the picture changes substantially when we look at these coefficients, with Lithuania joining Bosnia, with a sterilization coefficient that is both economically and statistically insignificantly different from zero. The sharpest fall is observed for Hong Kong, although its coefficient does not fall as low as Bosnian or Lithuanian. The coefficients for Argentina and Bulgaria also become substantially lower. Nevertheless in the case of Argentina, it still indicates significant levels of discretion, which are not consistent with the definition of a currency board. The Bosnian and Estonian indicators do not change, but remain low because of the minor weight of government accounts in the balance sheets of the monetary authorities in those countries.

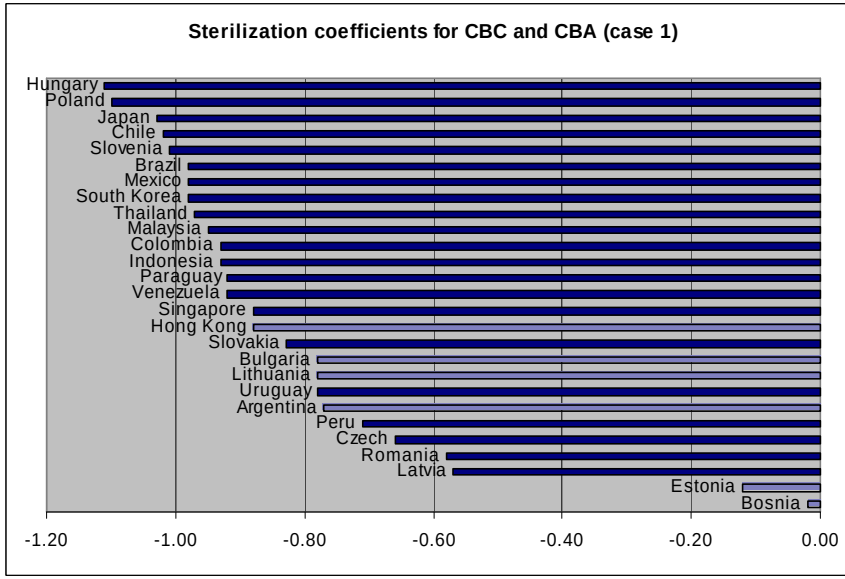
It is possible to rank currency board-like countries according to their involvement in discretionary activities based on our more precise estimates of sterilization coefficients. Bosnia and Lithuania are close adherents of orthodox currency board principles. Hong Kong on average has a somewhat higher, but statistically insignificant, proclivity to sterilization. Bulgaria and Estonia on average sterilized significantly and quite a lot on average (between one tenth and one fifth of non-government inflows). Nevertheless, their sterilization was much lower than in the case of Argentina, which on average offset more than a half of the changes in net foreign assets by the changes in non-government net domestic assets. These indicators of discretion have to be compared with those of other countries in order to asses how restricted discretionary monetary policy has been in recent currency board-like countries.

1.3 Comparison with Alternative Monetary Arrangements

We applied the same analysis as above to 21 central banking countries (CBCs) which were chosen from the same regions as our currency board-like countries (CBAs): Asia, Latin America and

Central and Eastern Europe[10]. Using case 1 coefficients we find, not surprisingly that CBAs sterilize as much as many central banking countries (Graph 1).

Graph 1.

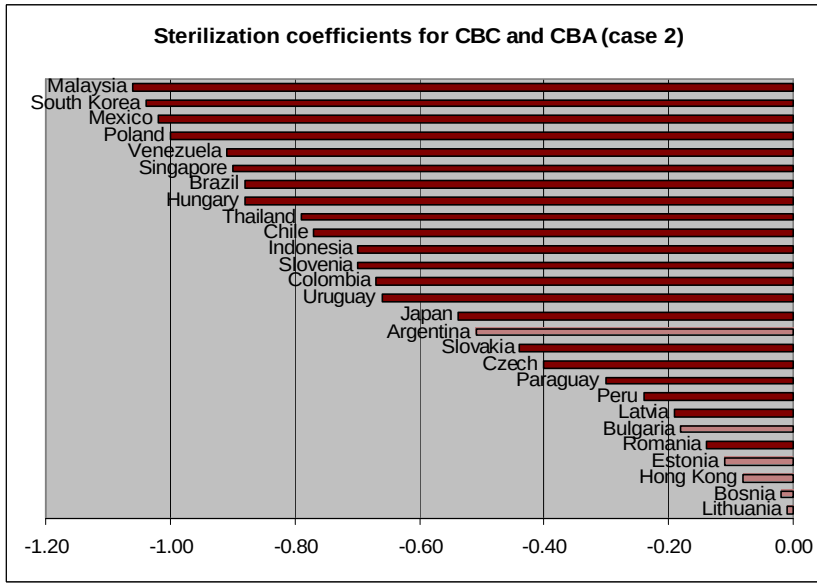


Source: IFS

However, as it was argued before the coefficients under the case 1 can be misleading, while the coefficients under the case 2 reflect sterilization activities more precisely. Graph 2 below depicts sterilization coefficients re-estimated with government deposits excluded from net domestic assets and reveals a more reliable picture of sterilization activities across the countries than the previous graph.

[10] See table 1a and 2a in appendix to find more details on the estimation. For the time being it is worth to mention that all the sterilization coefficients for CBC are statistically significant (95%) and in most of the cases the coefficients under the case 1 are higher than those under the case 2.

Graph 2.



Source: IFS

According to the re-estimated coefficients, all the CBAs except for Argentina are at the lower end of monetary sterilizers in the whole range of countries. Only Latvia and Romania are comparable to Bulgaria, Estonia and Hong Kong. Sometimes Latvia is mistakenly perceived as a currency board arrangement[11] and its low sterilization proclivity should not come as a surprise. Nevertheless, to set the things clear the actual behavior of sterilization, which offsets nearly one fifth of changes in net foreign assets by the changes in the non-governmental net domestic assets, is compatible not with an orthodox currency board, but rather with unorthodox ones. On the other hand, the low

[11] This misperception is mentioned by K. Schuler in his "Introduction to Currency Boards" on the website about currency boards: **http://users.erols.com/kurrency** (last accessed 2004-05-10). The misunderstanding stems from the fact that Latvia has a "tight" peg with the SDR and holds foreign reserves close to 100%. However, Latvia has made no legal commitment to these policies.

Romanian level of sterilization cannot easily be explained[12] and the quite surprising fact that the central bank of Romania is a moderate sterilizer has to be taken as a reflection of the very clean nature of Romania's float.

In contrast, Argentina was an active sterilizer even in comparison with alternative monetary arrangements. Even though it is not as active as the majority of Latin American countries like Mexico, Venezuela, Brazil and Chile, under the "convertibility" system it sterilized more than CBCs such as Peru, Paraguay or the Czech Republic. Consequently, Argentina not only did not conform to the standards of an orthodox currency board, it did not even fit the behavior of the unorthodox currency boards, and was similar to many CBCs, and this coincides with what Hanke (2003) and Schuler (2003b) claim.

1.4 Structural Breaks in Sterilization Behavior in CBAs

It is interesting to find out if there were any structural changes in the sterilization activities in currency board-like systems during the periods analyzed above. First, graphical investigation of the behavior of changes in nFA and nDA served as the indicator of a structural break. The break point for each country was chosen according to the date when the relationship between the two variables changed substantially. Second, the Chow test for structural breaks using these dates was carried out for each CBA in the sterilization regression, with government deposits excluded from net domestic assets.

The results of the structural break tests are presented in table 3a in the appendix. At the chosen level of significance of 95% it turns out that all six CBAs had structural breaks. Consequently, it is important to check whether these countries actually engaged in more (or less) sterilization within the periods partitioned by the structural breaks. In order to do this, the time period was split in two, and the same regression was run on

[12] Domestic currency deprecation boosts foreign assets in domestic terms, and because of this the change in net foreign assets increases. Consequently, the sterilization coefficient being a proxy for an average ratio between changes in nDA and nFA might get smaller because of depreciation. However, the estimation with nFA adjusted for deprecation does not lead to different results in case of Romania and in majority of many other countries.

these separate samples. The sterilization coefficients from the respective equations are presented in table 2 below.

Table 2. Sterilization coefficients for CBA before and after break point

Country	Break point	Sterilization coefficient before the break	P-value	Sterilization coefficient after the break	P-value
Argentina	1996:01	-0.62	0.000	- 0.18 (till 1999:01)	0.084
Argentina	1999:01	- 0.18 (from 1996:01)	0.084	-0.55	0.000
Bosnia	1999:04	-0.06	0.468	-0.02	0.089
Lithuania	1997:01	-0.08	0.344	0.00	0.593
Estonia	1997:01	-0.44	0.000	-0.02	0.355
Bulgaria	2000:06	0.03	0.459	-0.24	0.029
Hong Kong	1999:10	0.09	0.695	-0.26	0.019

Source: IFS

Firstly, as it can be noted from the table Argentina has two break points. These structural breaks can be explained by the real facts from Argentinean economy: the first break was preceded by Tequila crisis while the second one indicates the beginning of the problems which ended in collapse of Argentinean economy in 2001. Not surprisingly the sterilization coefficient between these two turbulent periods is much lower than during the two periods off economic stress. This implies that Argentina was using sterilization proactively when it perceived a need for monetary intervention. Nevertheless, even during the calm period Argentina did not refrain from sterilization completely and had a similar coefficient to the other moderate sterilizers among the CBAs, yet lower than in the majority of the CBCs.

Bosnia, Lithuania and Estonia follow a similar pattern in sterilization before and after the structural break. At the beginning of their currency board-like arrangements these countries tended to have higher discretionary monetary policy. In the case of Bosnia and Lithuania this higher

discretion was still much lower than in any of the CBCs earlier investigated. However, in the case of Estonia the deviation from orthodox principles is really acute till 1997, because it allowed as much monetary discretion as moderate sterilizers among the CBCs earlier investigated (eg. Slovakia and the Czech Republic). Nevertheless, all of these countries after the structural break follow a pattern of behavior which is fully consistent with orthodox currency board principles. This indicates that CBAs have been strengthened over time rather than softened, which is in conflict with the claim of Roubini (1998) who says that CBAs are only useful in the short run when stabilizing very high inflation and dealing with low fiscal discipline or with other kinds of intense economic instability, while in the longer run they are doomed to collapse or to be phased out.

Finally, the coefficients before and after the structural breaks for Bulgaria and Hong Kong reveal the very peculiar behavior of monetary discretion in these countries. For both, the coefficients before the break are slightly positive though statistically insignificant. However, after the break the coefficients show that these countries sterilized around one quarter of changes in their net foreign assets. Even though this value of the coefficient is at the lower end of the coefficients for the CBCs it is in no way compatible with orthodox rules, thus these countries can at best be considered to be unorthodox currency boards. The forced use of sterilization cannot explain the change in coefficients because both countries experienced more turbulent conditions before the break (the Asian crisis affected Hong Kong in 1997-98 and war and sanctions against Serbia affected Bulgaria before the break in its behavior). This implies that the change in sterilization probably indicates a general policy shift to greater monetary discretion. These countries should be observed in order to notice any further divergence from currency board principles.

To summarize, this chapter uncovered some important findings. First, it was shown that the sterilization coefficient can overstate the extent of discretionary monetary policy, when it includes government deposits in the structure of domestic liabilities. Second, better defined sterilization coefficients indicate that in contrast to the original study of Hanke (2002b) two countries: Bosnia and Herzegovina and Lithuania were not found to use sterilization activities throughout the period investigated. These countries follow the principles of the orthodox currency board quite closely. Third, Hong Kong, Estonia and Bulgaria also did not stray far from these

principles over the whole period. However, the trend among these countries diverges. For the last seven years Estonia has been very reticent sterilizer. In contrast, Hong Kong and Bulgaria on the other hand, have shown substantial deviation from negligible sterilization for the last 4 years. Nonetheless according to the sterilization activities these countries can still be called unorthodox currency board countries, because they sterilize much less than most of the CBCs. Finally, Argentina was an obvious exception in the group of recent currency board-like countries and has tended to lie half way between orthodox currency boards and fully sterilizing central banks. Thus, Hanke's (2002b) conclusion that Argentina cannot be considered as a currency board remains valid.

2 Lender of Last Resort in Recent Currency Board-Like Countries

In the previous chapter it was shown that 5 out of 6 recent currency board-like countries have actually used discretionary sterilization activities in a restricted manner as compared to central banking systems. Monetary discretion is usually understood as an active stance to affect money supply and financial markets through the variety of instruments such as open market operations, reserve requirement changes, deposit auctions, provision of loans, etc. The function of lender of last resort (LOLR) is one of these activities. Consequently, the results of the previous chapter to some extent should reflect also the proclivity of the monetary authorities to support the banking sector with liquidity. One might expect that the LOLR function would be negligible in all recent currency board-like countries with the exception of Argentina. This chapter will show that such a supposition is true, with the exception of Argentina (as expected) and Hong Kong.

2.1 The Legal Framework for LOLR in Currency Board Countries

The function of Lender of Last Resort can be defined as a "discretionary provision of liquidity to a financial institution (or the market as a whole) by the central bank in reaction to an adverse shock which causes an abnormal increase in demand for liquidity and which can not be met from an alternative source" (Freixas et al, 1999). The primary goal of this function is to ensure financial stability and to avoid a liquidity crunch in the otherwise solvent system. Some authors (Goodhart, 1995; Fischer, 1999) distinguish between lending to the whole market and individual institutions as the markets might not function effectively due to uncertainties and asymmetric information in the event of panic and consequently otherwise solvent banks can not access liquidity support and fail[13]. As a result

[13] Freixas et al (2003) give an example of a failure of a quarter of small and medium sized banks in the UK in the beginning of 1990's. These banks could not borrow the liquidity they needed from the inter-bank market, when after the announcement of closure of BCCI the deposits were withdrawn from these banks and were settled down within larger ones.

Goodhart (1999) argues that the term LOLR should be referred only to the central bank's liquidity assistance to individual banks.

In the vast majority of the theoretical literature it is held that orthodox currency boards lack a lender of last resort (Hanke et al, 1993; Santiprabhob, 1997; Ghosh et al, 1998; Gale and Vives, 2001; and He, 2000). However, the views on the possibility of using this function under recent currency board-like system diverge a lot. One group of researchers state that under currency board arrangements there is scope for the lender of last resort up to the extent of excess foreign reserves. That is to say, as long as the monetary liabilities of the central bank are fully covered by foreign reserves, there is no threat to the credibility of the currency board arrangement and excess reserves can be used for LOLR (He, 2000). Other authors argue that currency boards should not extend loans to the banks and propose alternative solutions to solve liquidity problems in the banking system (Schuler, 1992; Schuler, 2003a; Hanke et al, 1993)[14]. Their arguments are based on the idea that foreign reserves should always lie in the range between 100% and 110% of monetary liabilities, preventing monetary authorities from inflationary expansion and ensuring credibility of the currency board.

Despite these theoretical considerations, Bosnia and Herzegovina is the only recent currency board-like system that legally forbids its monetary authority from extending credit to any institutions by creating money[15]. Estonia does not have an explicitly stated lender of last resort function in its central bank legislation (Ho, 2002). However, Ilmar Lepik (1999) has stated that the Estonian central bank has acted as a lender of last resort up to the level of excess foreign reserves. The recent Law on the Lithuanian Central Bank[16] also does not mention a function of lender of last resort; however, article 27 of this Law enables the Central Bank of Lithuania to extend credit to banking institutions against "acceptable" collateral. Moreover, the Guidelines for Monetary Policy Instruments define

[14] They indicate that effective inter-bank markets, deposit insurance, foreign bank participation and guaranteed credit lines from foreign banks could reduce the need of LOLR in CBAs.

[15] Article 1 of the Law on the Central Bank of Bosnia and Herzegovina.

[16] The analysis is based on relevant legislation system before Baltic countries entered EU in May 2004.

more precisely the abilities of the CB to support commercial banks with liquidity and overnight loans.

The Bulgarian CB is allowed to extend credit to the banks in the case of a liquidity shortage that might adversely affect the stability of the banking system[17]. Only solvent banks can be supported and loans must be fully secured by acceptable collateral with a maturity of no longer than three months. The Hong Kong Monetary Authority (HKMA) issued a "Policy Statement on the Role of HKMA as Lender of Last Resort" in 1999. According to this the HKMA can provide three types of liquidity assistance: overnight, short term and long term/capital support. Similarly to the Bulgarian CB, the HKMA is ready to provide collateralized support up to the level of excess reserves in the case of a risk of systemic instability. Finally, Argentina also had legal provisions to act as a lender of last resort throughout the period of "convertibility". Schuler (2003a) states Argentina's CB was allowed to help banks to overcome short-term liquidity problems by extending loans of up to 30 days maturity, while during the Tequila crisis this term was prolonged. As in other countries, the loans also required the provision of acceptable collateral from the borrowing institution.

From this review it becomes obvious that all the recent currency board arrangements, except for Bosnia, had at least the option to act as LOLR. However, it is more interesting to investigate to what extent those countries actually used this right, and whether they differed in its use from central bank countries.

2.2 Average Levels of Central Bank Lending to the Banks across Different Monetary Regimes

In the analysis below the view of Goodhart (1999) will be adopted, which considers LOLR to be primarily associated with lending to individual institutions, rather than to the market as a whole. LOLR usually takes the form of three instruments (He, 2000):

- Discounts of eligible paper;
- Advances with or without collateral;
- Repos of the bank's assets which are acceptable to the central bank.

[17] Article 33 of the Law on Bulgarian National Bank.

The discount window in the USA functions as a facility at the Federal Reserve for banks to borrow money at a discount rate and against the collateral of acceptable assets[18]. An advance is also a loan to the bank, granted at its request and secured by collateral. Repos are agreements by which a security is sold with the seller (the commercial bank) agreeing to repurchase it at a pre-specified date and price. In effect it is simply a collateralized loan, with the security sold being the collateral[19]. Therefore, all these forms of LOLR are actually quite similar, and on the balance sheet of the central bank they should appear in the item of central bank claims on the banking system. This type of data is available from IFS resources and in the half yearly balance sheet of Exchange Fund of the HKMA. Of course, not all central bank credit to the banks is associated with LOLR, but whenever such credit is extended in domestic currency,[20] it increases the monetary base and changes the net domestic assets position of the central bank. Hence, even though other types of loans do not serve the purpose of LOLR, they still indicate discretionary monetary policy and should be included in the ongoing discussion.

Four recent currency board-like countries will be included in the analysis (data on Hong Kong is of different periodicity and this country will be analyzed separately, while Bosnia does not lend to the banks at all). Another ten developing countries from Central and Eastern Europe (CEE) (seven countries), Latin America (two countries) and Asia (one country)[21] are analyzed for comparison. Monthly data is available for the period from 1990 until 2004. However, due to availability, comparability and applicability, the sample periods used are different across the countries. Moreover, the level of credit provided to the banking institutions by the central bank in each country is normalized by the contemporaneous monetary base level in order to achieve comparability of the variables.

The most straightforward analysis of LOLR across these countries is a simple comparison of the means of monetary authorities' lending to the

[18] As defined in Compassweb investment glossary (**http://broker.compassweb.com/ilCpCz.htm**).

[19] As defined in Invest Words glossary (**http://www.investorwords.com/4266/reverse_repo.html**).

[20] Loans in foreign currency affect money supply and also are incompatible with orthodox principles.

[21] See table 1b in appendix for more details.

banking institutions (as a ratio to reserve money). The representation of this information is provided in graph 2b in the appendix. It turns out that Argentina's central bank is an exceptional case, not only in the group of recent currency board-like countries but also in the group of central banking countries, which one would expect to exhibit much more discretion than CBAs. The same type of data for Hong Kong is not provided by IFS, however the HKMA web page has half yearly information on placements with banks and other financial institutions for the period from 1996 till 2004. This item is similar to the one provided by IFS and it can be assumed that it is comparable. The mean of HKMA lending to the banking institutions (0.47), which is calculated on this half yearly data as a ratio to the monetary base, is lower than the Argentinean indicator but well above that for the majority of CBCs examined. However, some problems with this interpretation of the data that affect our assessment of all of the CBAs are discussed below.

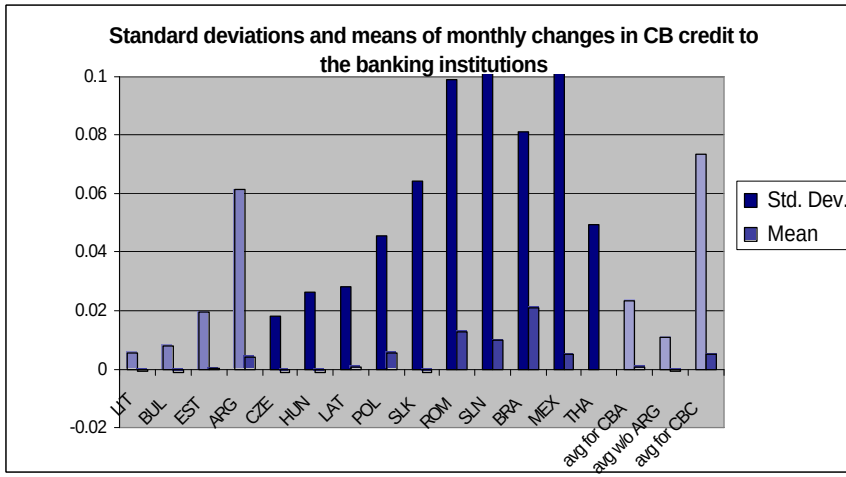
2.3 Variability of Central Bank Lending to Commercial Banks across Different Monetary Regimes

It is worth noting that simple analysis of the average characteristics can be misleading in several ways. First of all, the amount of credit provided by central banks to the banking system can be stable over time, indicating that no new loans are extended to the system. As was stated by Hanke (2002b) an orthodox currency board should not hold domestic assets on its balance sheet or if it holds any they have to remain constant. Clearly, a stable amount of credit extended to the banks does not indicate discretionary policy; consequently it could be the case that currency board-like systems with high but constant aggregate levels of lending actually do not deviate significantly from orthodox rules. On the contrary, if a currency board system on average has very low, but at the same time very volatile levels of credit to the banking sector, then this fact would reveal much more discretion than in the previous case. Moreover, as far as currency boards established in 1990's are concerned, all of them succeeded an unstable economic environment and some of their loans to commercial banks were inherited from the previous monetary systems (Schuler, 2003a; Hanke, 2002a). Therefore, currency board-like systems

at least in the first years of their existence cannot be blamed of deviating from orthodoxy merely because of high credit left over from older times. Finally, the levels of central bank lending can have statistical breaks for some countries, as was indeed the case in Argentina when in 1996 net rather than gross claims on the banking sector started to be reported (Schuler, 2003a). Accordingly, it is more appropriate[22] to use the change in credit to the banking system as the key indicator in a comparative analysis of LOLR in CBAs, rather than taking volumes.

Consequently, we take monthly changes in the level of credit to banking institutions and divide them by the previous month's stock of reserve money. The reason we choose monthly differences is that LOLR support is mostly short term and in order to reflect this, changes of the shortest available duration are used. Graph 3 below depicts the standard deviations and the means of the new variable for different countries.

Graph 3[23]



Data source: IFS

[22] In this case the data is still comparable before and after the break as changes in either gross or net credit represent discretionary policy through the loan extension.

[23] One period outlier (1996:12) was excluded from the analysis for Argentina due to analytical break mentioned above. No other outliers were identified for remaining countries.

First of all, it is apparent that all currency board-like arrangements, except for Argentina, had much lower volatility than central banking countries. The only country from the latter group which is quite similar to the subgroup of moderate CBA lenders is the Czech Republic. In contrast, Argentina had much more volatile lending to the banks than five countries in the CBC group, though its standard deviation was still lower than simple average of CBC standard deviations (especially lower than those of Latin American CBCs). Moreover, even within the subgroup of moderately active CBAs there are clear patterns: Lithuania and Bulgaria on average were ready to support the banking system by half as much (taken as a ratio of the reserve money) as Estonia. The monetary authorities of Romania, Slovenia and Brazil on average significantly increased their stock of credit to the banking system during the period covered, while Bulgaria and Hungary slightly decreased it. This suggests a greater degree of LOLR in the former countries than in the latter. Furthermore, Argentina has a higher mean of credit growth to the banks than Estonia, so it has an even higher proclivity to extend loans to the banks than is represented by the two countries' standard deviations. However, the differences in interpretation are not substantial because of quite low values of the means of monthly changes in credit to the banking system.

The average of standard deviations within CBAs is more than 3 times lower than the average of the CBCs. Statistical analysis of variance equality between the two groups also indicates that the variability of credit to banks is significantly different in the two groups of countries (see table 3b in the appendix). The null hypothesis of variance equality is rejected by all the tests provided in the standard package with a significance level as high as 99%. Therefore, there is a strong basis for claiming that that the LOLR function is significantly limited in CBAs as compared to CBCs. Once again, however, Argentina turns out to be exceptional within the CBA group.

As it was mentioned before, only half yearly data is available for Hong Kong. Standard deviations are usually larger calculated on the data of this periodicity, and for this reason are not comparable with monthly data. In order to make the comparison possible the standard deviations for the half yearly changes in lending to banking institutions were recalculated for all the countries earlier investigated in this chapter. These half yearly standard deviations are presented in graph 4b in the appendix. The order of

countries according to the magnitudes of standard deviations changes slightly; however, the clusters of countries with a similar variability of lending activities remain the same. For example, Lithuania, Bulgaria and Estonia have the lowest half yearly standard deviations together with the Czech Republic, Latvia and Hungary. More importantly, the data for Hong Kong reveals that this country had a similar proclivity to extend loans to the banking system as Argentina. And even though its standard deviation was slightly lower than the simple average for all the CBCs, there were only 4 out of 10 CBC which utilized more discretion through lending to banks than did Hong Kong. Therefore there is no evidence that this country was close in its behavior to the moderate providers of LOLR like the three Central European CBAs. This type of behavior can be justified by the fact that Hong Kong is one of the banking centers in Asia and stability of the banking system is vital for the country. Nevertheless, active assistance to the banks is an obvious violation of orthodox principles.

To what extent is an average change of credit to banks relative to the monetary base of 2% (in Estonia) or less than 1% (Bulgaria and Lithuania) a significant deviation from orthodoxy? One way to see this is by dividing the standard deviation of changes in credit to banks by the standard deviation of changes in net domestic assets (excluding government deposits). Under the assumption that the means of both series are equal zero[24], this ratio will show what share the lending to banks had in general discretionary activities. Under orthodox rules changes in net domestic assets should be zero, so the standard deviation of those changes shows the average proclivity of the monetary authority to engage in discretionary activities. Hence, if the ratio described above is equal to one, then it can be concluded that lending to the banks is one of the most important discretionary tools for that country. On the other hand, the ratio close to zero would imply that the country mostly uses other discretionary instruments. These ratios in the CBAs, together with the standard deviations of monthly changes in the domestic assets (normalized on reserve money), are presented in table 3 below.

[24] It is not a strong assumption for Estonia and Argentina, whereas for Lithuania and Bulgaria it is doubtful to hold. However, violation of the assumption is not likely to misdirect the implications of the analysis.

Table 3. Relative Importance of lending to banking institutions in context of general discretionary powers

Country	St. dev of Δcredit	St. dev. of ΔnDA	Ratio
Bulgaria	0.008	0.060	13.29%
Lithuania	0.006	0.015	39.33%
Estonia	0.020	0.038	52.45%
Hong Kongi	0.168	0.254	66.14%
Argentina	0.061	0.090	67.85%

Data for Hong Kong is half yearly and because of this reason st. dev. are higher than, and not comparable with, standard deviations for other countries which are based on monthly dataData source: IFS

It turns out that that assistance to the banks in Argentina and Hong Kong was quite important as a tool of general discretionary activities. In Estonia the scope of lending to the banks was just one half of overall monetary discretion. While in Lithuania the changes in net domestic assets on average tended to be around three times higher than the changes in credit to the banking system. Bulgaria being a moderate sterilizer among the CBAs allowed relatively less discretion through LOLR, which was about ten times less volatile than general discretionary activities.

Finally, it turns out that Argentina and Estonia were involved in LOLR activities more intensively in the period prior to 1996. For the later period, the standard deviation of lending to the banks decreases sharply in both countries: in Argentina it drops by two thirds to 0.018 and in Estonia it falls even more precipitously by almost four fifths to 0.004. Thus, after 1996 Estonia joins the other two CBA countries, while Argentina, though still more heavily involved in lending to the banks than other CBAs, finds itself at the bottom of the CBC group.

To summarize, this chapter shows that Lender of Last Resort activities were limited in Lithuania, Bulgaria, Estonia and Bosnia (the former does not provide credit at all) when compared to the CBCs. The evidence from these countries validates theoretical assumptions about the lack of LOLR

in CBAs. Among the CBAs which lent to the banks moderately, Estonia showed substantially higher involvement in LOLR activities; nevertheless, it was still much lower than in the majority of CBCs, particularly after 1996. On the other hand, Argentina proved to be very similar to CBCs with regard to LOLR, except in the post-1996 period. This is one more argument that supports the assertion of Hanke (2002b) and Schuler (2003a) that Argentina was far from having a true currency board arrangement. Hong Kong also strayed far from orthodox principles. Finally, it was shown that lending to the banks in Bulgaria and Lithuania had minor importance in their overall use of discretionary powers, while in Argentina and Hong Kong assistance to the banking sector was a relatively substantial instrument of general monetary discretion.

Conclusions

This paper showed that — with the exception of Argentina — sterilization activities in modern CBAs were limited, when compared to countries with central banks. More recently Bulgaria and Hong Kong have also been keen to sterilize significantly, although the degree of discretion remained much lower than in Argentina and in the majority of CBCs. The two Baltic CBAs and Bosnia and Herzegovina sterilized quite negligibly over the last seven years. In addition the paper showed that lender of last resort activities were very limited in four out of the six currency board-like countries. Again Argentina was much more similar to central bank countries than to CBAs in this respect. Likewise, the data for Hong Kong indicated that it was as active in supporting the banking sector as an average CBC. At the same time, function of LOLR in these two countries was quite important as compared to the other tools of monetary discretion.

These results contribute to the existing literature in the following ways. First, it is misleading to assign Argentinean deviation from orthodox principles to the whole range of recent currency board countries as was done in Hanke (2002b). Nevertheless, the idea of Hanke (2002b) and Schuler (2003a) that Argentina was not a currency board in the way it actually performed, and that therefore the existence of a currency board cannot be blamed for the collapse of the Argentinean economy is strongly supported in this paper. Other CBAs can be considered either as closely obeying orthodoxy like Lithuania, Bosnia and Herzegovina and Estonia (though only recently) or as unorthodox (Bulgaria and Hong Kong). However, even these do not allow as much sterilization as an average CBC. Secondly, the paper empirically investigates CB lending to commercial banks and reveals that despite the legal provisions for lender of last resort, this function was very constrained in CEE CBAs. On the other hand Hong Kong's unorthodox CBA and the Argentinean monetary arrangement actively assisted the banking system. Therefore, the theoretical assumption about incompatibility of orthodox currency boards with LOLR seems to be empirically justified.

However, some limitations of this work are acknowledged and they indicate directions for future research in this field. First of all, since there are some dynamics hidden in the sterilization phenomena, more thorough

research has to be done in order to investigate any long term relationship between changes in net domestic and net foreign assets, rather than merely examining the short term effects, as it is done in this paper for the purposes of comparability with the other research in the field. Secondly, only half yearly data on the HKMA's lending to banking institutions is available, as a result the picture on LOLR activities in this country might be inaccurate. Furthermore, the data sample for Hong Kong on sterilization and LOLR is limited and represents less than the last 10 years' experience rather than the whole period of the currency board's existence. Hence, full data of relevant periodicity is needed to carry out a thorough and comprehensive analysis of this country.

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Appendix

Table 1a. Estimation of sterilization activities across CBAs and some CBCs with government deposits included in net domestic assets

Country	DFAQ [i]	P value	Other RHS variables [ii]	Adjusted R-squared	Durbin-Watson stat	Prob (F-statistic)	Sample Period
Bosnia	**-0.02**	0.090	Const. DDAQ (-1, -3, -4, -6, -9)	0.43	2.12	0.00	1997:11 2004:02
Bulgaria	**-0.78**	0.090	Const. DDAQ (-1, -3, -4, -6, -7, -9, -10) DFAQ (-1, -3, -4, -6, -7, -9, -10)	0.84	2.19	0.00	1997:07 2004:01
Estonia	**-0.12**	0.009	Const. DDAQ (-1, -3, -4, -6, -7, -9, -10) DFAQ(-10)	0.62	2.08	0.00	1992:10 2004:02
Lithuania	**-0.78**	0.000	Const. DDAQ(-1, -3, -4) DFAQ(-1, -3, -4)	0.88	1.97	0.00	1994:04 2003:12
Czech Republic	**-0.66**	0.000	Const. DDAQ (-1, -3 to -7, -9, -10) DFAQ (-1, -3, -4, -6, -7, -9, -10)	0.66	2.10	0.00	1993:04 2003:12
Hungary	**-1.11**	0.000	Const.	0.85	1.66	0.00	2000:03 2004:03
Latvia	**-0.57**	0.000	Const. DDAQ (-1 to -4, -6, -7, -9, -10) DFAQ (-1 to -4, -4, -6, -7, -9, -10)	0.71	2.03	0.00	1993:10 2004:01
Poland	**-1.10**	0.000	Const. DDAQ (-1, -3 to -5, -8) DFAQ (-1, -3, -4, -6)	0.80	2.11	0.00	1992:03 2003:12
Romania	**-0.58**	0.000	Const. DDAQ(-1 to -7, -9) DFAQ(-2 to -3, -7, -9)	0.76	1.81	0.00	1993:12 2004:01
Slovakia	**-0.83**	0.000	Const. DDAQ (-1 to -3, -5, -6, -8) DFAQ (-2, -3, -5, -6, -8, -9)	0.84	1.73	0.00	1993:04 2004:03
Slovenia	**-1.01**	0.000	Const. DDAQ (-2 to -4, -5, -6, -8, -9) DFAQ (-2 to -4, -5, -8, -9)	0.97	1.75	0.00	1992:03 2004:03
Hong Kong	**-0.88**	0.000	Const. DDAQ (-1 to -4) DFAQ (-1 to -3, -5, -6)	0.95	1.86	0.00	1997:03 2004:02
Indonesia	**-0.93**	0.000	Const. DDAQ (-1, -3, -4, -6, -7, -9, -10) DFAQ (-1, -3, -4, -6, -7, -9, -10)	0.96	2.19	0.00	1993:03 2004:04
Japan	**-1.03**	0.000	Const. DDAQ (-1 to -4, -6, -7, -9, -10) DFAQ (-1, -3)	0.65	2.05	0.00	1990:04 2003:05

South Korea	**-0.98**	0.000	Const. DDAQ (-1, to -4, -6, -7) DFAQ (-1 to -4, -6, -7)	0.94	2.00	0.00	1990:04 2004:02
Malaysia	**-0.95**	0.000	Const. DDAQ (-1, -3, -4, -6 to -8) DFAQ (-1, -3, -4)	0.90	2.08	0.00	1990:04 2004:03
Singapore	**-0.88**	0.000	Const. DDAQ (-1, -3, -4, -6, -7, -9, -11) DFAQ (-1, -3, -4, -6, -7, -9, -11)	0.92	2.11	0.00	1990:04 2004:03
Thailand	**-0.97**	0.000	Const. DDAQ (-1, to -4, -6, -7, -9, -10) DFAQ (-1 to -4, -6, -7, -9, -10)	0.83	2.05	0.00	1990:04 2004:03
Argentina	**-0.77**	0.000	Const. DDAQ(-1, -3, -4) DFAQ(-1, -3 to -5)	0.86	2.02	0.00	1991:04 2001:12
Brazil	**-0.98**	0.000	Const. DDAQ(-1, -3 to -10) DFAQ (-1, -3 to -10)	0.99	2.02	0.00	1990:04 2004:03
Chile	**-1,02**	0.000	Const. DDAQ (-1, -3) DFAQ (-1, -3)	0.87	1.99	0.00	1990:04 2004:03
Colombia	**-0.93**	0.000	Const. DDAQ (-1, -3, -4, -6, -7, -9, -10) DFAQ (-1, -3, -4, -6, -7, -9, -10)	0.84	2.20	0.00	1990:04 2004:04
Mexico	**-0.98**	0.000	Const. DDAQ (-1, -3, -4, -6, -7, -9, -10) DFAQ (-1, -3, -4, -6, -7, -9, -10)	0.94	2.13	0.00	1990:04 2004:03
Paraguay	**-0.92**	0.000	Const. DDAQ (-1 to -4, -6, -7, -9, -10) DFAQ (-1, -3, -4, -6, -7, -9, -10)	0.93	2.24	0.00	1990:04 2004:04
Peru	**-0.71**	0.000	Const. DDAQ (-1 to -7, -9, -10) DFAQ (-1 to -8, -12)	0.80	1.95	0.00	1990:04 2004:03
Uruguay	**-0.78**	0.000	Const. DDAQ (-1, -3, -4, -6, -7, -9, -10) DFAQ (-1, -3, -4, -6, -7, -9, -10)	0.92	2.21	0.00	1990:04 2004:04
Venezuela	**-0.92**	0.000	Const. DDAQ(-1 to -10) DFAQ (-1 to -4, -6, -7, -9, -10)	0.95	1.90	0.00	1990:04 2004:03

Data source: IFS

[i] *DFAQ is variable of changes in net foreign assets; the column represents sterilization coefficients.*

[ii] *DDAQ is variable of changes in net domestic assets (with government deposits included); numbers in brackets indicate lagged variables included in the estimation.*

Table 2a. Estimation of sterilization activities across CBAs and some CBCs with government deposits excluded from net domestic assets

Country	DFAQ [i]	P value	Other RHS variablesii	Adjusted R-squared	Durbin-Watson stat	Prob (F-statistic)	Sample Period
Bosnia	**-0.02**	0.254	Const. DDAWOGQ (-1, -2) DFAQ (-2, -4, -5)	0.31	1.99	0.00	1997:11 2004:02
Bulgaria	**-0.18**	0.047	Const. DDAWOGQ (-1, -3, -4, -6, -7, -9)	0.51	2.13	0.00	1997:07 2004:01
Estonia	**-0.11**	0.013	Const. DDAWOGQ (-1, -3, -4, -6, -7) DFAQ (-1, -4)	0.63	2.03	0.00	1992:10 2004:02
Lithuania	**-0.01**	0.305	Const. DDAWOGQ (-1, -5) DFAQ (-1)	0.80	1.76	0.00	1994:04 2003:12
Czech Republic	**-0.40**	0.000	Const. DDAWOGQ (-1, -3 to -8, -10) DFAQ (-1, -3 to -8, -10)	0.75	1.93	0.00	1993:04 2003:12
Hungary	**-0.88**	0.000	Const. DDAWOGQ (-1, -3) DFAQ (-1, -3)	0.71	2.10	0.00	2000:03 2004:03
Latvia	**-0.19**	0.000	Const. DDAWOGQ (-1, -3, -4, -6, -7)	0.62	1.98	0.00	1993:10 2004:01
Poland	**-1.00**	0.000	Const. DDAWOGQ (-1, -3, -4, -6, -7, -9, -10) DFAQ (-1, -3, -4, -6, -7, -9, -10)	0.76	1.97	0.00	1992:03 2003:12
Romania	**-0.14**	0.036	Const. DDAWOGQ (-1, -3, -4, -6, -7, -9, -10)	0.67	1.88	0.00	1993:12 2004:01
Slovakia	**-0.44**	0.000	Const. DDAWOGQ (-1, -3, -5, -6) DFAQ (-3, -5, -6)	0.62	1.74	0.00	1993:04 2004:03
Slovenia	**-0.70**	0.000	Const. DDAWOGQ (-1, -3, -4, -6) DFAQ (-1, -3, -4, -6, -10)	0.80	2.07	0.00	1992:03 2004:03
Hong Kong	**-0.08**	0.507	Const. DDAWOGQ (-1 to -3, -6, -7, -9) DFAQ (-2, -3, -8, -9, -10)	0.80	1.88	0.00	1997:03 2004:02
Indonesia	**-0.70**	0.000	Const. DDAWOGQ (-1, -3, -4, -6, -7, -9, -10) DFAQ (-1, -3, -4, -6, -7, -9, -10)	0.83	2.12	0.00	1993:03 2004:04
Japan	**-0.54**	0.000	Const. DDAWOGQ (-1, -3, -4, -6, -7, -9, -10)	0.68	2.12	0.00	1990:04 2003:05
South Korea	**-1.04**	0.000	Const. DDAWOGQ (-1, -3, -4, -6, -7, -9, -10) DFAQ (-1, -3, -4, -6, -7, -9, -10)	0.89	2.19	0.00	1990:04 2004:02
Malaysia	**-1.06**	0.000	Const. DDAWOGQ (-1, -3, -4) DFAQ (-1, -3, -4)	0.88	2.14	0.00	1990:04 2004:03

Singapore	**-0.90**	0.000	Const. DDAWOGQ (-1, -3, -4, -6, -7, -9, -10, -11) DFAQ (-1, -3, -4, -6, -7, -10)	0.85	1.90	0.00	1990:04 2004:03
Thailand	**-0.79**	0.000	Const. DDAWOGQ (-1, -3, -4, -6, -7) DFAQ (-1, -3, -4, -6, -7)	0.68	1.92	0.00	1990:04 2004:03
Argentina	**-0.51**	0.000	Const. DDAWOGQ (-1, -3, -5) DFAQ (-1, -3, -5)	0.84	1.89	0.00	1991:04 2001:12
Brazil	**-0.88**	0.000	Const. DDAWOGQ (-1, -3 to -6, -8, -9) DFAQ (-1, -3 to -6, -8, -9)	0.97	2.00	0.00	1990:04 2004:03
Chile	**-0.77**	0.000	Const. DDAWOGQ (-1, to -4) DFAQ (-1 to -3)	0.77	1.89	0.00	1990:04 2004:03
Colombia	**-0.67**	0.000	Const. DDAWOGQ (-1, -3, -4, -6, -7, -9, -10) DFAQ (-1, -3, -4, -6, -7, -9, -10)	0.83	1.84	0.00	1990:04 2004:04
Mexico	**-1.02**	0.000	Const. DDAWOGQ (-1, -3, -4, -6, -7, -9, -10) DFAQ (-1, -3, -4, -6, -7, -9, -10)	0.78	1.96	0.00	1990:04 2004:03
Paraguay	**-0.30**	0.000	Const. DDAWOGQ (-1, -3, -4, -6, -7, -9, -10) DFAQ (-1, -9, -10)	0.77	2.07	0.00	1990:04 2004:04
Peru	**-0.24**	0.008	Const. DDAWOGQ (-1 to -4, -6, -7, -9) DFAQ (-1, -3, -4, -7, -12)	0.63	1.96	0.00	1990:04 2004:03
Uruguay	**-0.66**	0.000	Const. DDAWOGQ (-1 to -5, -10) DFAQ (-1, -3 to -7, -9, -10)	0.92	1.99	0.00	1990:04 2004:04
Venezuela	**-0.91**	0.000	Const. DDAWOGQ (-1, -3, -4, -6, -7, -9, -10) DFAQ (-1, -3, -4, -6, -7, -9, -10)	0.95	1.91	0.00	1990:04 2004:03

Data source: IFS

i DFAQ is variable of changes in net foreign assets; the column represents sterilization coefficients.

ii DDAQ is variable of changes in net domestic assets (without government deposits); numbers in brackets indicate lagged variables included in the estimation.

List of Abbreviations

CB — central bank
CBA — recent currency board-like country
CBC — central banking country
CEE — Central and Eastern Europe
HKMA — Hong Kong Monetary Authority
LOLR — lender of last resort
IFS — International Financial Statistics of the International Monetary Fund

Table 3a. Chow tests for structural breaks in sterilization activities for the currency board-like countries [1]

Argentina	
Chow Breakpoint Test: 1996:01	
F-statistic	4.06
Probability	0.000297
Log likelihood ratio	32.60
Probability	0.000073
Chow Breakpoint Test: 1999:01	
F-statistic	4.84972
Probability	0.00004
Log likelihood ratio	38.0586
Probability	0.000007
Bosnia and Herzegovina	
Chow Breakpoint Test: 1999:04	
F-statistic	2.463008
Probability	0.027993
Log likelihood ratio	18.76289
Probability	0.008963

Bulgaria	
Chow Breakpoint Test: 2000:06	
F-statistic	3.07942
Probability	0.006225
Log likelihood ratio	26.3086
Probability	0.00093
Estonia	
Chow Breakpoint Test: 1997:01	
F-statistic	11.7818
Probability	0
Log likelihood ratio	86.6009
Probability	0
Hong Kong	
Chow Breakpoint Test: 1999:12	
F-statistic	3.49192
Probability	0.000755
Log likelihood ratio	49.2571
Probability	0.000004
Lithuania	
Chow Breakpoint Test: 1997:01	
F-statistic	3.30009
Probability	0.008374
Log likelihood ratio	16.7937
Probability	0.004908

Data source: IFS

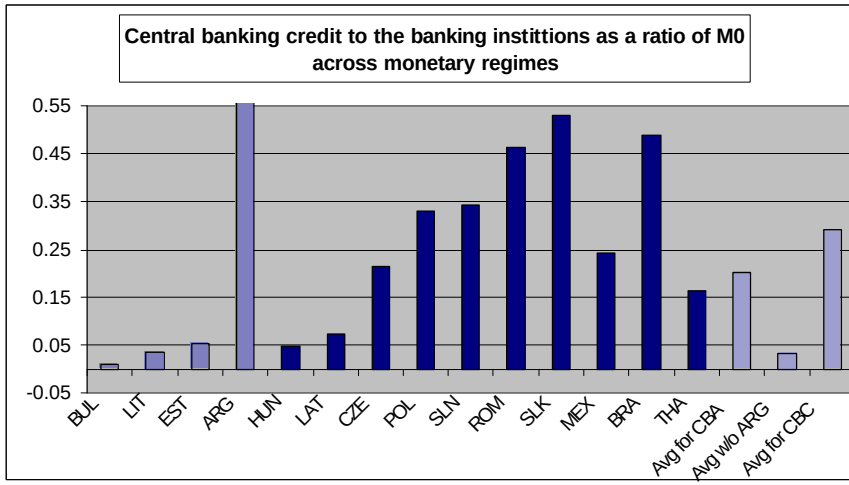
i the test is based on the regression with government deposits excluded from net domestic assets

Table 1b. Description of the panel data utilized in LOLR analysis

Country	Abbreviations of the country names	Sample Period
Argentina	ARG	1991:06-2001:12 (1994:12-2001:12) [i]
Brazil	BRA	1990:01-2004:1
Bosnia	BSH	N/A
Bulgaria	BUL	1997:06 – 2004:01
Czech	CZE	1993:01 – 2003:12
Estonia	EST	1992:07 – 2004:02
Hong Kongii	HK	1995:12 – 2003:12
Hungary	HUN	1999:12 – 2004:02
Latvia	LAT	1993:07 – 2004:01
Lithuania	LIT	1994:04 – 2003:12
Mexico	MEX	1990:01 – 2004:02
Poland	POL	1990:01 – 2003:12
Romania	ROM	1993:12 – 2002:07
Slovakia	SLK	1993:01 – 2003:12
Slovenia	SLN	1991:12 – 2004:02
Thailand	THA	1990:01 – 200312

shorter period is used to calculate the averages because absolute values of credit are high in the beginning of the period due to the leftovers from the previous monetary regime. This modification does not change the implications of the analysis.ii data is half yearly.Data source: IFS

Graph 2b



Data Source: IFS

Table 3b. Test for equality of variance of changes of CB credit to banks between CBA and CBC country groups [i].

Categorized by values of DUMMY [ii]
Included observations: 1608
Included observations: 1835

Method	df	Value	Probability
F-test	(458, 1375)	7.283371	0.0000
Siegel-Tukey	19.52562	0.0000	
Bartlett	1	464.0166	0.0000
Levene	(1, 1833)	55.68876	0.0000
Brown-Forsythe	(1, 1833)	54.47279	0.0000

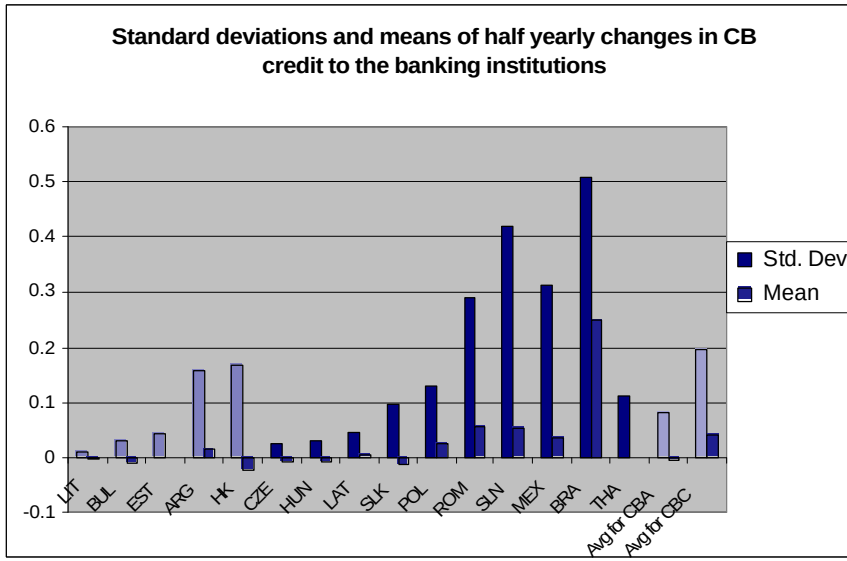
Category Statistics

DUMMY	Count	Std. Dev.	Mean Abs. Mean Diff.	Mean Abs. Median Diff.	Mean Tukey-Siegel Rank
0	1376	0.091846	0.038860	0.038185	778.5124
1	459	0.034033	0.009130	0.008612	1336.159
All	1835	0.081352	0.031424	0.030787	918.0000

Bartlett weighted standard deviation: 0.081347

Data source: IFS
i H0: variances of the two groups are equal
ii Dummy stands 1 for CBA and 0 for CBC

Graph 4b



Data source: IFS and HKMA