Empirical evidence of the compensation principle in the Brazilian economy: 1994 to 2011[*]

Enzo Gerioni, Julia Omizzolo, Lilian Rolim and Nikolas Schiozer[†]

This is a draft, please do not quote or cite.

Abstract

The compensation principle extends the concepts of endogenous money and exogenous interest rate to the open economy analysis. Yet, even within post-Keynesians, it is rarely acknowledged as an essential feature for debating short-term interest rate setting in open economies. As a result, the search for empirical validity of the principle is still not extensive and only limited to a few economies. Monetary policy in developing countries is especially implicated with the compensation principle considering that these countries have accumulated substantially more foreign reserves than developed economies during the past decade (and seem more compelled to try to control the exchange rate). Most commonly, the compensation principle has been presented in opposition to the Mundell-Fleming framework and the trilemma view. We add to our theoretical assessment a more recent contestant approach, the "dilemma" view and argue that the compensation principle is also an alternative view to this approach. In order to subsidize the debate, we tested the empirical validity of the compensation principle for Brazil's case. Autoregressive distributed lags (ARDL) models were estimated and results suggest that the compensation principle was valid in Brazil from 2004 to 2011. As a robustness check, the validity of the principle is also tested for the period between 1994 to 1998.

Keywords: compensation principle, endogenous money, open economy, exogenous interest rate, developing economies.

[†]Enzo Gerioni, Julia Omizzolo and Lilian Rolim are PhD students at the University of Campinas (Brazil). Nikolas Schiozer is PhD student at the University of São Paulo (Brazil). Contact: enzogerioni@gmail.com.

1 Introduction

The compensation principle[1] extends the concepts of endogenous money and exogenous interest rate to the open economy analysis, as it demonstrates that, regardless of exchange rate regime, foreign currency flows do not impose operational constraints on monetary authority's ability to set the short-term interest rate nor change the money supply of the economy. While endogenous money (more than exogenous interest rate) has been a common feature to all different strands of post-Keynesianism,[2] relatively recently it has also been recognized by mainstream authors such as Woodford (2000, 2002) and Furfine (2000). Yet, even post-Keynesians, when debating monetary policy in the context of an open economy, rarely bring up the existence and/or acknowledge the consequences of the compensation principle for interest rate[3] setting. As a result, the search for empirical validity of the principle is still not extensive and only limited to a few economies.

This debate is especially relevant for developing economies, which have accumulated substantially more foreign reserves than developed economies during the past decade (Rodrik, 2006), making compensation a key principle to understand monetary policy in the recent period of these countries. By acknowledging the compensation principle, it is possible to offer an alternative perspective about monetary policy autonomy in developing economies and contribute to a more thorough debate grounded on essential features of post-Keynesianism. We should emphasize that our definition for "monetary policy autonomy" is fairly technical, meaning that the short-term interest rate is a variable controlled by government policy. This is similar to the definition of interest rate exogeneity commonly adopted by post-Keynesians (Wray, 2006a).

The compensation view has been concerned about debunking the well-known trilemma, derived from the Mundell-Fleming model. Most recently, however, there has been a contestant perspective, which received the title of "irreconcilable duo" or simply "dilemma" (Rey, 2015, p. 3), suggesting that the trilemma is insufficiently connected to the reality of the current global economy. Thus, we add to our theoretical assessment a verification if this contestant perspective is somewhat an approximation to the endogenous money approach or if it remains an extension of the Mundell-Fleming framework.

Most of the empirical literature investigating the validity of the compensation principle is directed to Asian emerging markets (Angrick, 2017, Lavoie and Wang, 2012), with exception of Bozhinovska (2015) who focuses on the Macedonian case. In order to subsidize the debate, we built an empirical model to test the validity of the compensation principle in the case of Brazil from 2004 to 2011, which is particularly interesting for examination.[4] Brazil as the

---

[1] Also known as the "compensation view" (Angrick, 2017), "compensation thesis" (Bozhinovska, 2015, Lavoie, 2001, 2014, Lavoie and Wang, 2012), or "Banque de France view" (Lavoie, 2014, p. 469). These terms are used interchangeably throughout the paper.

[2] We adopt a broad definition of post-Keynesianism, following Lavoie (2011).

[3] Hereafter, "interest rate" means the short-term interest rate targeted by the Central Bank.

[4] As a robustness check, the validity of the principle was also tested for the period between 1994 to 1998, as the country experienced a loss in foreign reserves and adopted a crawling peg in the period. The results of this model are reported in the appendix section.

largest economy in Latin America, complements towards the argument of general validity of the compensation principle. Additionally, Brazil was able to accumulate considerable amount of foreign reserves while exercising relatively large exchange market intervention. The estimation strategy consists in identifying cointegration relationships among the variables through the estimation of autoregressive distributed lag models (ARDL) and the use of the bounds testing procedure (Pesaran and Shin, 1999, Pesaran et al., 2001). The existence of cointegration among the variables suggests that they share a long-run relationship. This means that the effect of foreign reserves will cause a permanent change in the level of the dependent variable, and not only transitory changes. Thus, the existence of cointegration between the foreign reserves and an item in the CB's balance sheet can be interpreted as a sign that this specific item compensated the change in the former. In line with the compensation thesis, we would not expect that the monetary base to share a cointegration relation with the foreign reserves, while we do expect another item in the CB's balance sheet to be cointegrated with the foreign reserves.

The remaining of this article is organized as follows. The next section presents a brief explanation of the Mundell-Fleming model and differentiate between the trilemma and dilemma perspectives. The third section contains an explanation of the compensation principle. The fourth section comprises a theoretical assessment of the trilemma and dilemma perspectives in light of the compensation principle. The fifth section provides a description of the CBB institutional arrangement (those characteristics that are relevant for compensation) and the recent evolution of foreign reserves in Brazil. The sixth section comprises the methodology and analysis of results. Concluding remarks follow.

2   Mundell-Fleming: trilemma and dilemma

In the conventional model of open economies, based on the Mundell-Fleming framework, under assumption of perfect capital mobility and asset substitutability, a fixed exchange rate regime is considered to constrain the monetary policy effectiveness to increase output whereas floating exchange rate regime would render full effectiveness. This constraint would stem from accumulation (loss) of foreign reserves by the CB to sterilize foreign currency inflows (outflows) due to surpluses (deficits) in the overall balance of payments (Serrano and Summa, 2015). Exchange market intervention would be mandatory for a CB willing to control the exchange rate, otherwise there would be appreciation (depreciation) of the domestic currency.

Foreign currency outflow (inflow) would result from an initial attempt by the CB to execute an expansionary (contractionary) monetary policy that lowers (raises) the domestic interest rate below (above) the international level. To keep the exchange rate from fluctuating, the CB has to sell (buy) foreign currency in the exchange market which means debiting (crediting) reserve

balances in banks' accounts.[5] Hence, by intervening in the exchange market, the CB would decrease (increase) the monetary base and, consequently, bid up (down) the domestic interest rate back to the international level (Serrano and Summa, 2015). To put it simply, any change in CB's monetary policy would be automatically reverted by foreign currency flows and inevitable (due to the fixed parity) exchange market intervention.

One would conclude that the monetary base and money supply respond endogenously[6] to accumulation (loss) of foreign reserves by the CB (Lavoie, 2001).[7] Interest rate would be set exogenously[8] at the international level and CB's attempt to move it would end up being offset by automatic forces. In case the CB not only wishes to sterilize the impact of foreign currency flows on the exchange rate but also keep control over the monetary base and money supply, it would have to engage in open market operations, *at its own initiative*, to buy or sell government securities and thus keep the monetary base from changing. It should be stressed that this would be considered a discretionary decision by the CB to establish a quantitative target on monetary aggregates (Lavoie, 2001, 2014, Angrick, 2017).

Things would happen differently in an economy operating a floating exchange rate regime. The CB would not be forced to intervene[9] in the exchange market because it does not have a fixed parity to defend. Expansionary (contractionary) monetary policy would drive the interest rate below (above) international level and, consequently, lead to foreign currency outflow (inflow) and ultimately cause the exchange rate to depreciate (appreciate). Assuming nominal rigidity of wages and prices, nominal becomes real exchange rate depreciation (appreciation) which in turn, assuming that the Marshall-Lerner condition is observed, increase (decrease) exports. Output would increase (decrease) correspondingly to exports, entailing a higher (lower) demand for money and bidding interest rate up (down). This process would only cease when the interest rate is back to international level, but conversely to the fixed exchange rate regime, effectively increasing output. Exchange rate flexibility would grant a self-adjusting feature for the balance of payments, while preventing the CB to lose control over the monetary base and money supply.

Derived from the Mundell-Fleming model, the "impossible trinity" or simply "trilemma" states that monetary authorities can choose only two out of three: free capital mobility, control over the exchange rate and independent monetary policy. Hence, in a world of free capital mobility, only floating exchange rate could grant monetary authority the capacity to exercise

---

[5]Commonly, CBs prefer to hold interest yielding assets rather than foreign currency (which do not yield interest). Foreign currency purchased by the CB is mostly used to acquire interest yielding assets (most likely US Treasury securities).

[6]This is a supply-led endogeneity, different from the post-Keynesian demand-led endogeneity. For a more detailed discussion, see Lavoie (2006, 2014).

[7]This process assumes a stable money multiplier (Lavoie, 2001).

[8]Similar to the supply-led endogeneity of monetary base and money supply, this is not the post-Keynesian exogeneity of interest rate. Instead of being exogenously set by government policy, domestic interest rate is conditioned by foreign currency flows.

[9]Of course, most countries operate a managed floating regime, which means the CB occasionally buys or sells foreign currency to avoid undesired exchange rate fluctuations.

an independent monetary policy. By adopting a fixed exchange rate regime, monetary policy autonomy would be inevitably forfeited.

Most recently, Rey (2015, 2016) has put forward what seems to be a challenge to the famous trilemma, suggesting that it has "morphed into a dilemma" due to large international financial flows (global financial cycle). Financial globalization would be responsible for ever-increasing capital flows, which would constrain monetary policy, regardless of a floating exchange rate regime. The dilemma, therefore, suggests that contemporary open economies are under heavier constraints to pursue domestic goals than originally concluded by the conventional trilemma. However, there is an alternative view that could lead us to a different outcome relatively to both trilemma and dilemma, by extending endogenous money and exogenous interest rate to the open economy.

3   The compensation principle

An alternative to the Mundell-Fleming (and its derivations) is the compensation principle which implies that even under a fixed exchange rate regime, the CB retains control over the interest rate and the money supply is endogenously demand-led determined.[10] Indeed, defending a fixed parity requires that the CB accumulates foreign reserves when there is a balance of payments surplus, which in turn leads to crediting reserve balances into the banking system. However, at this point the compensation principle part ways with the Mundell-Fleming framework. The additional reserve balances do not cause banks to increase credit concession because "[i]n real world, banks extend credit, creating deposits in the process, and look for reserves later" (Wray, 2015, p. 88).

Effectively, banks accommodate creditworthy clients' demand for loans and the CB accommodates banks' demand for reserve balances because it has an interest rate target and it needs to ensure the soundness of the payment system. Additional reserve balances created by exchange market interventions do not initiate a money multiplier process. Banks that end up with reserve balances created by the sterilization, will have already granted as many loans as creditworthy clients have solicited. Therefore, they will either use excessive reserve balances to buy back their interest-bearing liabilities owed to the CB[11] (overdraft economies) or buy interest

---

[10]Rochon and Setterfield (2007, pp. 19-20) clarify that by stressing the exogeneity of the interest rate, "Post Keynesians emphasize the administrative nature of interest rate policy. In other words, policy is independent from market forces: any decision to increase or decrease interest rates is an administrative decision taken by central bankers and not the result of automatic forces. For proponents of the new consensus, however, whereas interest rates may be exogenous, the Taylor rule endogenizes monetary policy by linking it to market forces—that is, deviations from an inflation target".

[11]Albeit individual banks may decide to buy interest yielding assets held by private agents or repay their debt owed to private agents, this is not a possibility for the whole of the banking sector. For instance, buying a privately held bond will only exchange ownership of the bond and excessive reserve balances remain in the banking system, only in another bank's account.

yielding assets from the CB (asset-based economies), depending on the institutional arrangement in place between private banks and the CB.[12]

It is at the private sector's initiative that the compensation principle unfolds. There is no reason *ceteris paribus* for banks to hold noninterest yielding assets (reserve balances) instead of reducing their interest-bearing debt or acquiring interest yielding assets (Lavoie and Wang, 2012). As long as in the endogenous money approach the money multiplier is "simply an *ex post* ratio of reserves to deposits" (Wray, 2015, p. 104), if banks which had their accounts credited are too slow to buy government securities[13] or to repay their debt, the most likely consequence would be a falling 'money multiplier', not a change in quantity of money in the economy (Serrano and Summa, 2015).

Inasmuch as the CB sets an interest rate target and adopts a defensive position – being a residual buyer and seller of government securities and/or lending reserve balances as requested – there will be changes in its own balance sheet composition that compensates for the increased foreign reserves without concomitant increase of the monetary base. Such changes will occur through a market mechanism, regardless of the CB taking the initiative to sell government securities, because the private sector will not hold noninterest yielding assets. If private agents repay their outstanding debt or buy Treasury securities from the CB, an increase in foreign reserves is compensated by a decrease in other CB's assets. Likewise, if the CB issues its own securities or provides repurchase agreements (hereafter, repos), an increase in foreign reserves is compensated by an increase in CB's liabilities other than the monetary base.

Similarly, a balance of payments deficit is compensated at the initiative of banks, that borrow from the CB, sell government securities or engage in reverse repos when reserve balances are drained by exchange market interventions. However, a distinction between surplus and deficit positions is necessary. While surpluses do not find restrictions because they simply entail foreign reserve accumulation, persistent deficits, over time, deplete foreign reserves, thus, reducing the CB's capacity to defend the fixed parity, at first, and eventually forcing the peg to be abandoned (Lavoie, 2001, Wray, 2006*b*). In that case, compensation will only continue up to the point that CB still has foreign reserves.

Finally, one should note that an inflow of foreign currency, when sterilized, will lead to an increase of the public debt when compensation unfolds in asset-based economies (but not in overdraft ones). According to Calvo et al. (1996, p. 134), sterilization could raise the "public debt so large as to undermine the credibility of policymakers" which could "halt the inflows". We believe there are two important aspects that should be considered here: first, public debt denominated in the government's own currency is not related to government's ability to make payments in foreign currency, therefore, one should not expect foreign investors to make decisions based on domestic public debt indicators. Second, we recognize that there is a relevant

---

[12]See (Lavoie, 2001, 2014) for more details about the classification between asset-based and overdraft economies.

[13]Government securities can be issued by the Treasury or the CB itself, depending on institutional arrangements in each case.

distributive effect caused by the payment of interest for public debt holders. Public debt increased due to sterilization seems likely to result in interest payments to parts of the private sector with low propensity to spend, consequently, with low impact on aggregate demand (Serrano and Summa, 2015). We conclude that although there is a potential distributive impact derived from sterilization, there is no automatic mechanism that limits foreign reserve accumulation.[14]

4   Neither trilemma nor dilemma

In light of the compensation principle, we proceed to make a theoretical assessment regarding the Mundell-Fleming model and its derivations. Commonly, the compensation view has been presented in contrast with the Mundell-Fleming framework and also pointing out disagreement with the trilemma proposition that sterilization cannot be sustained for long and that it is ineffective to control the exchange and interest rates, as suggested by Obstfeld and Rogoff (1995). In this section, the additional restriction suggested by Rey (2015, 2016) is also object of further examination.

For Mundell-Fleming followers, there is an important distinction to be established between sterilized and unsterilized[15] interventions. This distinction, however, is only relevant because they understand sterilization as a policy decision undertaken by the CB rather than normal behavior of the private sector trying to get rid of noninterest yielding assets. If we assume that (1) the private sector prefers to have risk-free interest yielding assets (or to repay interest bearing liabilities) in their portfolios, and (2) the CB undertakes defensive action to keep interest rate within limits of acceptable deviation from the established target, there is no room for unsterilized intervention. Any amount that goes unsterilized is not due to CB's conscious choice of avoiding sterilization costs but actually a result of the private sector demanding more reserve balances.[16]

Rey shares a similar view with the trilemma concerning sterilization. When there is a foreing currency inflow, CB's exchange market interventions lead to "the tradeoff of higher inflation or increased sterilization costs with a likely side effect of an increased interest rate leading to further inflows" (Rey, 2015, p. 22). As mentioned by Lavoie and Wang (2012), it is a Mundell-Fleming view that connects increase of foreign reserves and rising domestic prices, because of increased money supply. It also must be noted that in the compensation view, sterilization is not responsible for increasing interest rate, as suggested by Rey. A higher interest rate can only be achieved by CB's decision, hence sterilization cannot be the cause of increase of interest rate. If the CB decides to elevate the interest rate, indeed there will be further inflows

---

[14]The distributive impact of sterilization is an important element to be considered, but it would drive us away from the purpose of this work.

[15]Also called nonsterilized intervention.

[16]Private sector's reasons to keep hold of reserve balances are plentiful, but usually induced by higher economic activity. In this case, additional reserve balances do not bid down the interest rate (Angrick, 2017, Serrano and Summa, 2015). We do not know of a direct mechanism through which foreign currency inflows induce higher demand for reserve balances.

that will continue to be sterilized, but this is not a consequence of previous decision to sterilize the result of exchange market interventions.

It is also noteworthy that the dilemma suggested by Rey cannot be distinguished from the conventional trilemma when dealing with a fixed exchange rate regime. As she explains, "under a fixed exchange-rate regime and full capital mobility, policy makers cannot set the interest rate at the level they believe appropriate for monetary conditions in their economy" otherwise "they would be quickly flooded by large capital flows reversing their measures" (Rey, 2016, p. 1). Not only the conclusion is in line with the trilemma, but also the explanation provided to explain the loss of monetary policy autonomy is identical. Capital flows would offset CB's decision to raise interest rate (in this example put forward by Rey) by increasing the monetary base and bidding down interest rate back to the previous level. It ought to be clear that although Rey presents the dilemma as a challenging approach relatively to the conventional Mundell-Fleming trilemma, they seem to share an exogenous money supply perspective.

Arguably, the proposition that financial globalization has turned the trilemma into a dilemma is not so much a break away from the Mundell-Fleming framework as it is an attempt to include a credit rationing discussion, clearly based on New Keynesian elements. According to Rey (2016), larger financial flows (most likely triggered by US expansionary monetary policy) would raise asset prices and, consequently, reduce agency costs imposed by information asymmetry (adverse selection and moral hazard), inducing credit growth which would not be prevented by floating the exchange rate. We do not wish to make the case against New Keynesian credit rationing theory since it would move us away from the aimed purpose of this work (and there already is very compelling post-Keynesian literature to propose an alternative approach, see (Wolfson, 1996)).

Neither trilemma nor dilemma are compatible with an endogenous money and exogenous interest rate approach, since both rely on the Mundell-Fleming framework. Albeit the dilemma has been posed as an alternative to the conventional trilemma view, similarly to the compensation principle, it shares a lot more features with the first. That is why compensation principle contradicts both dilemma and trilemma. From a technical perspective (consistent with our definition of monetary policy autonomy), monetary policy autonomy is not reliant on the exchange rate regime. Whereas it is reasonable to accept that a fixed exchange rate regime demands accumulated foreign reserves to avoid default risk and to successfully defend the parity, both floating and fixed exchange rate do not technically constrain CB's ability to reach its targeted interest rate.

In short, the compensation principle offers a different interpretation about the limits of monetary policy. More specifically, whereas one should not expect monetary policy decisions to be constrained by the choice of exchange rate regime, CB's decisions may follow a (explicit or implicit) reaction function and will likely take into consideration variations of foreign reserves, especially to counteract large foreign currency outflows. But as long as there are no automatic mechanisms tying monetary policy to foreign currency flows, constraints are predominantly

of political nature. Consequently, empirical evidence in favor of the compensation principle may corroborate the interpretation that there is space for discussing alternative monetary policy decisions. The case of Brazil, which is discussed below, provides further evidence in favor of this view.

5 Compensation principle in Brazil: empirical evidence

The validity of the compensation principle in the Brazilian economy in the 2000s is analyzed through two sets of empirical evidence. As discussed below, given the expressive foreign currency inflows in the period, the CBB intervened in the exchange market and, consequently, the country accumulated considerable foreign reserves (especially after 2006). The compensation principle suggests that even with accumulation of foreign reserves, the base interest rate should have remained exogenous and the monetary base should not have responded to changes in the foreign reserves. While the former condition is analyzed through the success of the CBB in meeting its base interest rate target, the second condition is analyzed through an econometric model which provides evidence of which item in the CBB's balance sheet compensated the increase in foreign reserves.

5.1 Central Bank of Brazil and evolution of foreign reserves

Before we proceed to empirically test the validity of the compensation principle in the Brazilian case, we provide a brief overview of the evolution of foreign reserves and changes in the institutional arrangement of the CBB that took place in the 2000s. After the build up of an exchange crisis that culminated with a series of speculative attacks against the domestic currency from 1999 to 2003, foreign currency inflows became the rule. Simultaneously, the CBB had noticeable modifications in its institutional arrangements.

In the aftermath of the exchange crisis, the CBB had broken the peg, adopting a managed floating exchange rate. Besides, inflation targeting regime was implemented as a substitute policy tool to stabilize prices by anchoring expectations. Nonetheless, the CBB still intervened considerably to mitigate exchange rate variations, resulting in appreciable foreign reserve accumulation. Thus, it is reasonable to say that the compensation principle was operative, which would not be the case of a free floating regime. To make things clearer, we rely on the analysis of exchange market intervention suggested by Caldentey and Vernengo (2013) who calculated an index named foreign exchange intervention statistic (FEIS). The index ranges from 0, pure floating regime, to 1, which means the CB intervenes to hinder exchange rate variations.[17] According to the index computed by the authors, for the Brazilian economy the index was equal to 0.72 before the adoption of the inflation targeting regime and 0.61 afterward. Thus, even after

---

[17]More details are found in Caldentey and Vernengo (2013). The index is defined as $FEIS = \sigma \Delta Forex / \sigma \Delta Forex + \sigma \, exchange \, rate$.

a managed floating regime was in place, the CBB still carried out substantial exchange market interventions that would have affected considerably the liquidity of the domestic banking system had the compensation principle not been valid.

After the burst of the dot-com bubble, in 2001, the world economy experienced a period of elevated growth, mainly driven by China, followed by the "commodity boom" - a combination of high prices and strong imports of these goods (Ocampo, 2007). Major commodity exporters, such as Brazil, greatly benefited from this growth dynamic. This could be observed by recurrent surpluses in the balance of goods and services (hereafter, BS), from 2002 to 2006, exceeding 4% of GDP and current account surpluses exceeding 2% of GDP. Additionally, expansionary monetary policy in the US, as a response to the dot-com crisis, amplified global liquidity and boosted CBB's growing stock of foreign reserves. As we can see in figure 1 below, Brazil accumulated a considerable amount of foreign reserves throughout this period.
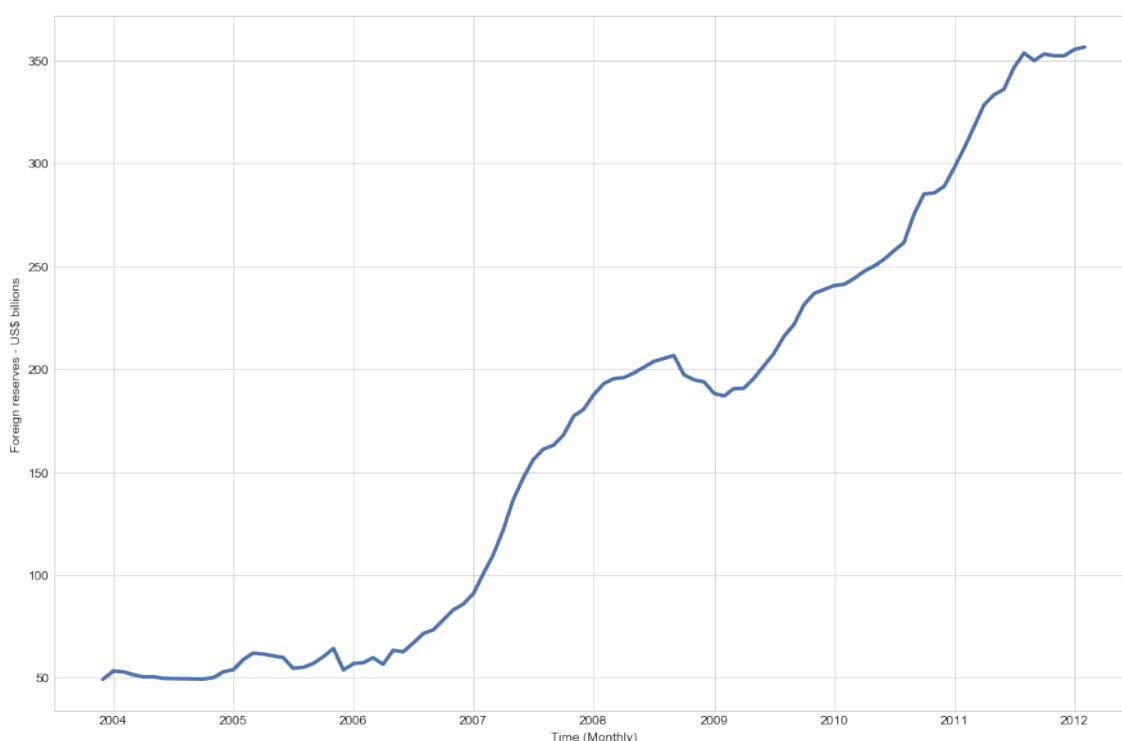

Figure 1: Foreign reserves - total, CBB data (in billions of US$)

After the Global Financial Crisis (GFC) of 2007/2008, CBs around the world adopted counter cyclical measures, including unconventional monetary policy that drove interest rate close to (or even below zero). Federal Reserve's quantitative easing flooded financial markets with liquidity that searched for higher yields in emerging markets (Biancarelli et al., 2017). Slower global economic growth and lower commodity prices turned Brazil's current account surplus into a deficit, however, still (more than) covered by capital inflows. One could say there was a qualitative change in foreign currency inflow to Brazil.

As of 2012 there were indications of a reversal of the quantitative easing conducted after the GFC,[18] leading to a halt in Brazil's foreign reserve accumulation. This could be interpreted as the end of the "double bonanza" period, expressed by high commodities prices and substantial capital flows directed to emergent markets (Reinhart et al., 2016). Since then, Brazil has been able to attract capital inflows in the approximate amount necessary to finance its current account deficit, yet, not enough to accumulate foreign reserves. Besides small short-term fluctuations, foreign reserves have remained practically unaltered from April 2012 (US$ 374 billions) until April 2019 (US$ 383 billions). Due to the lack of accumulation/loss of foreign reserves, the period between 2012 and 2019 is uninteresting in terms of the compensation thesis.

Alongside the aforementioned external sector and exchange rate regime changes, the CBB also went through alterations in its institutional arrangement, especially during the first years of the 2000s, which reflected in modifications of its balance sheet. Consequential to modifications in the CBB's balance sheet is the way compensation takes place. An important change was in May 2000, when the Law of Fiscal Responsibility[19] forbade the CBB to issue new bonds after May 2002.[20] This was a relevant prohibition as the CBB issued bonds represented 40,02% of total CBB's liabilities denominated in domestic currency, at the time. As Lavoie and Wang (2012) explain, it is common that in developing countries the CB issues bonds, as those are perceived by financial markets as less risky than Treasury securities. Indeed, the dataset presented by Angrick (2017) and Bozhinovska (2015) seem to confirm that CB bonds are a relevant component of CB's liabilities in developing economies.

That was also the case of Brazil until 2002, however, the prohibition[21] to issue new bonds forced a gradual decrease in CBB bonds available to monetary policy operation.[22] Not coincidentally, repos – which amounted to 0,5% of GDP in 2000 – quickly grew to reach 10,88% of GDP in 2012.[23] In absence of CBB bonds to operate the monetary policy, repos became the most important item to compensate for autonomous sources of reserve balances (Santos et al., 2017).[24] This includes but is not limited to foreign reserve accumulation, whereas the payment of high interest rate on existing stock of repos, redemption of Treasury bonds, primary result of

---

[18]See Eichengreen and Gupta (2015) for more details about the "tapering talks".

[19]In Portuguese, *Lei de Responsabilidade Fiscal*.

[20]Complementary law N° 101, article 34, May 2000.

[21]The prohibition is not without controversy, as the CBB has conveyed its desire to resume issuing bonds. On the other hand, in a discussion paper of the Treasury, it has been expressed the desire to remain as the sole issuer of government bonds, on the argument of a more efficient management of the monetary policy with a single bond issuer, and on the constitutional attribution of the ministry of finance to manage the public federal debt (Leister, 2016).

[22]By November 2006, there were no more CBB bonds held by the private sector.

[23]Data is available in CBB (2018).

[24]Shortly after the issuance of CBB bonds was terminated, reverse repos were allowed to be engaged with financial institutions that are not "dealers", facilitating access to reverse balances. More details are found in circular n°3132/2002 and circular n°3108/1999.

central government, and changes in compulsory reserve requirement are some of the factors that were also compensated by the growing stock of repos (Santos et al., 2017, CBB, 2018).[25]

Table 1: CBB Balance sheet: 2004 to 2011

Assets	Liabilities
Foreign reserves	Monetary base
Treasury securities	Treasury account
	Compulsory reserves
	Repos

Table 1 depicts a simplified version of current CBB's balance sheet, in which Treasury securities and foreign reserves are the most important items in the asset side, and repos, Treasury account, and compulsory reserve requirements are the most relevant in the liability side. The CBB (2018) and literature dedicated to study CBB's operation (Santos et al., 2017) seem to agree that, currently, repos are the most important compensating item in the balance sheet. Banks engage in repos that yield interest rate rather than hold noninterest yielding assets. Thus, our empirical test comply with the literature indication of how the compensation currently occurs in Brazil.

5.2 Interest rate setting by the CBB

Until the 1980s central banks around the world used to pay attention to the quantities of money supply and the monetary policy aimed at controlling monetary aggregates in order to control inflation. Since then, the focus on inflation control did not change, however, the monetary authorities began to explicitly target the short-term interest rate rather than monetary aggregates in order to achieve monetary policy goals. This is the case of the CBB, which announces a target for the interest rate after periodic meeting of monetary policy committee.

As we can see in figure 2, the target interest rate established by the CBB is closely followed by the actual short-term interest rate. In other words, the CBB only needs to announce the target interest rate so that the private sector behavior moves the short-term interest rate to the target. The green line in figure 2 represents the difference between the short-term interest rate and the target interest rate. As we can see, the deviation between both rates is close to zero. As the two series are practically overlapped, one would be inclined to recognize that the CBB does not seem to have any difficulty to keep short-term interest rate within what seems to be an acceptable deviation from the target.

---

[25]The CBB accumulates a substantial stock of repos while reverse repos are not frequent, indicating a structurally liquid banking system.
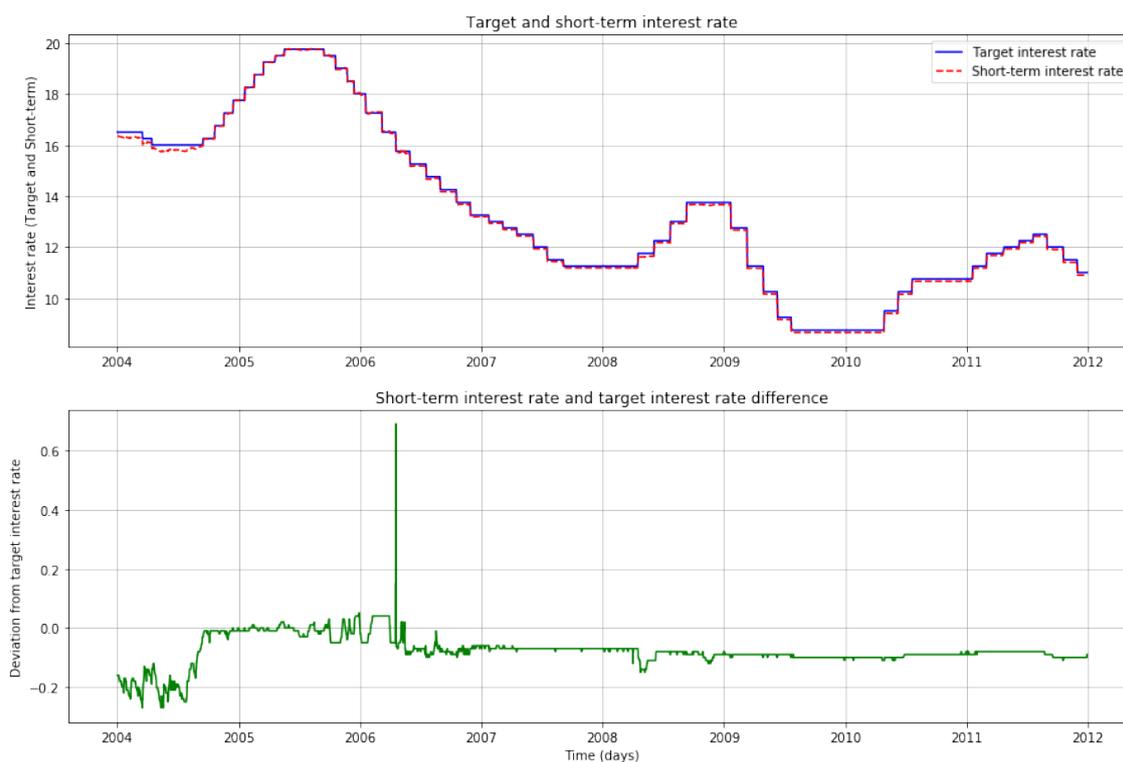
Figure 2: Interest Rates, CBB daily data

5.3 Foreign reserves and compensatory items

The identification of which item in the CBB's balance sheet compensated the increase in foreign reserves may offer additional support for the validity of the compensation principle in the country. The main research question is whether the accumulation of foreign reserves was compensated by increases in the monetary base and/or in the repos. The compensation thesis and the analysis provided by the CBB (2018) suggest that the monetary base should not have had a long-run relation with foreign reserves, while we expect to find evidence that the repos presented a long-run relation with the latter. The next subsections presents our estimation results and sheds a light in the compensatory item for the Brazilian economy during the analysed period.

5.3.1 Estimation strategy

The possibility of a long-run relation between the variables is tested by estimating an autoregressive-distributed lag (ARDL) model and applying the bounds tests proposed by Pesaran et al. (2001). ARDL models have been reintroduced by Pesaran and Shin (1999) as a valuable method to test for the presence of a cointegration relation between time-series variables. For a number of reasons, as the fact that it is better suited to small samples and that it allows for both I(1) and I(0) variables, it is an interesting approach to our model.[26]

---

[26]Unit root tests are reported in the appendix section.

The model is a standard least squares regression that includes lags of the variable in the right hand side of the equation (the AR part) as well as lags and contemporaneous values of the explanatory variables. Long term coefficients and the error-correction (ECM) form can be derived from the estimated equation by applying a linear transformation. In our models, the lag order of the equations followed the Bayesian information criterion (SIC), which renders more parsimonious models. When needed, the lag order was adjusted and other information criteria were used until there was evidence of absence of residual autocorrelation. Also, heteroskedasticity-robust standard errors were applied.

The presence of a cointegration relation among the variables is identified by the so-called bounds tests (Pesaran et al., 2001). This first test consists of performing a *F*-test to test the null hypothesis of no level relation between the dependent and the explanatory variables. Thus, it tests the joint null hypothesis that the coefficients are equal to zero against the alternative that at least one of them is different from zero. There are two sets of critical values, which provide a band that covers all possible classifications (purely I(0), purely I(1), or mutually cointegrated). If the *F* statistic falls outside the critical value bounds, inference can be made without assessing the order of the variables or determining the cointegration rank of the variables (Pesaran et al., 2001, p. 299). In case this first test leads to the rejection of the null hypothesis, Pesaran et al. (2001) suggest testing for the exclusion of the Y_{t-1} variable by applying a *t*-test. Once again, there are two sets of critical values, with inference being possible if the *t* statistic falls outside the critical value bounds.

5.3.2 Dataset

The data included in the model is reported in table 2 and was collected from the Central Bank of Brazil. The estimation period goes from January 2004 to December 2011, rendering 96 monthly observations. All series are denominated in domestic currency and taken in levels as it is assumed that they share a level relation rather than an elasticity relation. When needed, the X12 ARIMA adjustment method was applied to attenuate cyclical fluctuations.[27]

Table 2: Dataset (2004 to 2011)

Variable	Description
FOREX	Foreign reserves
TSECURITIES	Treasury securities at the Central Bank
MB	Monetary base
TACCOUNT	Treasury account at the Central Bank
CRESERVES	Compulsory reserves at the Central Bank
REPOS	Repurchase agreements

[27]This was the case for the monetary base, treasury account and repos.

Three of these variables were modified to properly test the compensation principle. First, the concept of monetary base adopted by the CBB includes compulsory reserve requirements on demand deposits. To obtain a monetary base concept compatible with cash plus reserve balances only held voluntarily, we subtracted the compulsory reserve requirements. Second, the series for repos is given by the net difference between the stock of repos and reverse repos. Third, exchange rate variations may cause considerable capital gain/loss on the stock of foreign reserves (denominated in domestic currency), which is undesirable for testing the compensation principle. Hence, following Lavoie and Wang (2012) we removed capital gain/loss resultant from exchange rate fluctuations.[28] Furthermore, during the period there was a decrease in foreign liabilities. In order to eliminate foreign reserve decreases due to decreasing foreign liabilities, which do not entail destruction of reserve balances in the domestic banking system, we subtracted foreign liabilities from the stock of foreign reserves (similarly to Angrick (2017, p. 9)).

5.3.3 Results

In order to test the validity of the compensation thesis for the Brazilian economy between 2004 and 2011, two equations are estimated. The equation for the monetary base includes the foreign exchange reserves, the Treasury securities, the Treasury account at the Central Bank, the compulsory reserves and the repos as explanatory variables, while the equation for the repos includes the foreign exchange reserves, the Treasury securities, the Treasury account at the Central Bank and the compulsory reserves as explanatory variables.

The F and t bounds tests on these models are reported in table 3. Both the F-test ad t-test for the monetary base equation suggest that the monetary base is not cointegrated with the dependent variables included in the model. On the other hand, both the F-test and t-test provide evidence that the repos are cointegrated with the explanatory variables.

Table 3: Bounds tests: monetary base and repos

Variable	Specification	Test	Test statistic	Critical value (lower)	Critical value (upper)
MB	Constant and no trend	F-test	2.59	2.62	3.79
		t-test	-1.22	-2.86	-4.19
REPOS	Constant and no trend	F-test	6.27	2.86	4.01
		t-test	-4.05	-2.86	-3.99

Note: Critical values correspond to the 5% significance level.

Ergo, the result for the monetary base equation are in agreement with the compensation thesis and its claim that the monetary base does not compensate the changes in the foreign exchange reserves. Similarly, the results for the repos equation also provide evidence for the compensation thesis, as there is support for cointegration between the variables. This conclusion

---

[28]The stock of foreign reserves was calculated by $FOREX = \sum \Delta FR_{t+n} EX_{t+n} + FR_{t-1} EX_{t-1}$, where FR is the stock of foreign reserves denominated in US dollars, EX is the nominal exchange rate (between domestic currency and US dollar), t is the first observation of data sample, and n is the number of periods after t.

is further reinforced by the analysis of the cointegration equation for this model, reported in table 4, which shows that the repos presented a long-run response to changes in the level of all variables (all variables are significant at the 5% significance level). In particular, it suggests that, on average, an increase of one unit in the forex led to an increase of 1.28 units in the repos account *ceteris paribus* during the estimation period.

Table 4: Cointegration equation for repurchase agreements

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FOREX	1.28	0.18	7.19	0.00
TSECURITIES	0.89	0.15	5.94	0.00
TACCOUNT	-0.40	0.23	-1.98	0.05
CRESERVES	-2.19	0.34	-6.47	0.00

6 Concluding remarks

The compensation principle lays out an alternative perspective to monetary policy in open economies, including developing countries, which is based on essential features of post-Keynesian economics. If the CB sets an interest rate target, sterilization will occur at the amount demanded by the private sector, keeping the monetary base from increasing or decreasing due to foreign currency flows. In light of this principle, we assessed both the trilemma and dilemma views. Albeit the dilemma has been posed as a contestant perspective relatively to the well-established trilemma, we concluded that both are based on exogenous money supply. Thus, the approach suggested by Rey (2015, 2016) cannot be said to be an approximation to the endogenous money perspective.

Empirical evidences obtained for the Brazilian economy are in line with the (still limited) existing empirical literature supporting such principle. Evidences suggest that despite the substantial foreign reserve accumulation, the CBB could successfully set the nominal interest rate at its target. Also, monetary base is not cointegrated with foreign reserves whereas repos seem to have a long-term relationship with foreign reserves. To put it simply, we found evidences that repos are the main compensating item in CBB balance sheet from 2004 to 2011.

Therefore, even countries with considerable exchange market interventions, foreign reserve accumulation is neither responsible for increasing the monetary base nor for driving the interest rate down. Monetary policy remains a variable under government control even if the CB adopts a fixed exchange rate regime. It is possible that in case of rapid depletion of foreign reserves the CB may decide to raise interest rate to contain it, however, this is a policy decision, not a market mechanism. We conclude that throughout the 2000s, when there was substantial accumulation of foreign reserves, Brazil had more monetary policy autonomy than the conventional Mundell-Fleming framework would have suggested.

References

Angrick, S. (2017), 'Global liquidity and monetary policy autonomy: an examination of open-economy policy constraints', *Cambridge Journal of Economics* **42**(1), pp. 117–135.

Barbosa-Filho, N. (2008), 'Inflation targeting in brazil: 1999–2006', *International Review of Applied Economics* **22**(2), pp. 187– 200.

Biancarelli, A., Rosa, R. and Vergnhanini, R. (2017), 'New Features of the Brazilian External Sector Since the Great Global Crisis', in P. Arestis, C.T. Baltar and D.M. Prates (eds), *The Brazilian economy since the great financial crisis of 2007/2008*, Palgrave Macmillan.

Bozhinovska, S. (2015), 'The compensation thesis and its application to central bank balance sheets: an empirical analysis of the balance sheet components of the macedonian central bank', *Paper presented at the 19th FMM Conference: Money and Credit* .

Caldentey, E. P. and Vernengo, M. (2013), 'Is inflation targeting operative in an open economy setting?', *Review of Keynesian Economics* **1**(3), 347–369.

Calvo, G. A., Leiderman, L. and Reinhart, C. M. (1996), 'Inflows of capital to developing countries in the 1990s', *Journal of economic perspectives* **10**(2), 123–139.

CBB (2018), 'Fatores condicionantes da evolução da dívida pública', Nota Técnica do Banco Central do Brasil, Nº 47.

Cruz, P. R. D. C. (1995), 'Endividamento externo e transferência de recursos reais ao exterior: os setores público e privado na crise dos anos oitenta', *Nova Economia* **5**(1), pp. 121–144.

Eichengreen, B. and Gupta, P. (2015), 'Tapering talk: The impact of expectations of reduced federal reserve security purchases on emerging markets', *Emerging Markets Review* **25**, pp. 1–15.

French-Davis, R., Titelman, D. and Uthoff, A. (1994), 'International competitiveness and the macroeconomics of capital account opening', *ECLAC Working Papers* **29**.

Furfine, C. H. (2000), 'Interbank payments and the daily federal funds rate', *Journal of Monetary Economics* **46**(2), pp. 535–553.

Lavoie, M. (2001), 'The Reflux Mechanism and the Open Economy', in L.P. Rochon and M. Vernengo (eds), *Credit, Effective Demand and the Open Economy: Essays in the Horizontalist Tradition*, Cheltenham, UK and Northampton, MA, USA: Eldward Elgar, pp. 215–242.

Lavoie, M. (2006), 'Endogenous money: accommodationist', in P. Arestis and M. Sawyer (eds), *A Handbook of Alternative Monetary Economics*, Edward Elgar, pp. 17–34.

Lavoie, M. (2011), 'History and methods of post-Keynesian economics', in E. Hein and E. Stockhammer (eds), *A Modern Guide to Keynesian Macroeconomics and Economic Policies*, Cheltenham, UK: Edward Elgar.

Lavoie, M. (2014), *Post-Keynesian Economics: New Foundations*, Cheltenham, UK and Northampton, MA, USA: Edward Elgar.

Lavoie, M. and Wang, P. (2012), 'The 'compensation' thesis, as exemplified by the case of the Chinese central bank', *International Review of Applied Economics* **26**(3), pp. 287–301.

Leister, M. D. (2016), 'O banco central deveria emitir títulos públicos?', Texto para discussão Nᵒ26. Tesouro Nacional.

Obstfeld, M. and Rogoff, K. (1995), 'The mirage of fixed exchange rates', *Journal of Economic perspectives* **9**(4), 73–96.

Ocampo, J. (2007), 'La macroeconomía de la bonanza económica latinoamericana', *Revista de la CEPAL* **93**, pp. 7 – 29.

Pesaran, M. H., Shin, Y. and Smith, R. J. (2001), 'Bounds testing approaches to the analysis of level relationships', *Journal of Applied Econometrics* **16**(3), 289–326.

Pesaran, M. and Shin, Y. (1999), 'An autoregressive distributed lag modelling approach to cointegration analysis' in S. Strom (ed), *Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium*, Cambridge: Cambridge University Press.

Reinhart, C. M., Reinhart, V. and Trebesch, C. (2016), 'Global cycles: Capital flows, commodities, and sovereign defaults, 1815-2015', *American Economic Review* **106**(5), 574–80.

Rey, H. (2015), 'Dilemma not trilemma: the global financial cycle and monetary policy independence', *National Bureau of Economic Research Working Paper* **21162**.

Rey, H. (2016), 'International channels of transmission of monetary policy and the Mundellian trilemma', *National Bureau of Economic Research Working Paper* **21852**.

Rochon, L.-P. and Setterfield, M. (2007), 'Interest rates, income distribution, and monetary policy dominance: Post keynesians and the" fair rate" of interest', *Journal of Post Keynesian Economics* **30**(1), 13–42.

Rodrik, D. (2006), 'The social cost of foreign exchange reserves', *International Economic Journal* **20**(3), pp. 253–266.

Santos, C. H. M. d., Ferreira, A. N., Silva, A. C. M., De Conti, B., Prates, D. M. and Oliveira, G. C. d. (2017), 'A Caracterização estrutural do sistema financeiro brasileiro: uma agenda de pesquisa' in Claudio H. M. dos Santos (org), *Características estruturais do sistema financeiro brasileiro: um registro da reflexão do Ipea no biênio 2014-2015*, vol 1, Ipea.

Serrano, F. (1998), 'Tequila ou tortilha? Notas sobre a economia brasileira nos noventa', *Revista Archetypon. set/dez* .

Serrano, F. and Summa, R. (2015), 'Mundell–fleming without the lm curve: the exogenous interest rate in an open economy', *Review of Keynesian Economics* **3**(2), pp. 248–268.

Wolfson, M. H. (1996), 'A Post Keynesian theory of credit rationing', *Journal of Post Keynesian Economics* **18**(3), 443–470.

Woodford, M. (2000), 'Monetary policy in a world without money', *International Finance* **3**(2), pp. 229–260.

Woodford, M. (2002), 'Financial market efficiency and the effectiveness of monetary policy'.

Wray, L. R. (2006*a*), 'When are interest rates exogenous?' in *Complexity, Endogenous Money And Macroeconomic Theory: Essays in Honour Of Basil J. Moore* edited by Mark Setterfield, Edward Elgar Publishing, pp. 271–289.

Wray, L. R. (2006*b*), 'To Fix or to Float: theoretical and pragmatic considerations' in L.P. Rochon and S. Rossi (eds), *Monetary and Exchange Rate Systems: A Global View of Financial Crises*, Edward Elgar Publishing, pp. 210–231.

Wray, L. R. (2015), *Modern money theory: A primer on macroeconomics for sovereign monetary systems*, Palgrave Macmillan.

A   Appendix A: Unit root tests

Table 5: Phillip-Perron unit root test

	constant and trend	constant	none
CRESERVES	-0.78	1.41	2.79
D(CRESERVES)	-8.05***	-7.76***	-7.41***
MB	-1.83	1.93	11.96
D(MB)	-13.51***	-12.86***	-7.44***
REPOS	-1.77	-0.64	0.95
D(REPOS)	-10.59***	-10.65***	-10.44***
TACCOUNT	-3.75**	-0.95	1.37
D(TACCOUNT)	-11.5***	-11.39***	-10.95***
TSECURITIES	-1.42	1.42	4.03
D(TSECURITIES)	-14.26***	-13.29***	-11.9***

Significance levels: * 10%, ** 5% and *** 1%.

B   Appendix B: Pegged exchange rate (1994 to 1998)

During the 1980s, Brazil like many other developing countries, had to deal with very high inflation and a severe external debt crisis. Channels to international credit were practically terminated, which means imports had to be financed only by exports revenue.[29] Only in early 1990s, capital inflows to Brazil resumed, and were a key factor for the success of the price stabilization "Real plan" (1994). Due to the return of foreign currency inflow - foreign reserves more than double between 1991 and 1992 (Serrano, 1998) - it was possible to adopt a crawling peg exchange rate. While the exchange rate was kept appreciated (to control domestic inflation) and after years of import restriction, there was a rapid increase in current account deficits, which depleted previously accumulated foreign reserves. To slowdown foreign reserve loss, the CBB used high interest rate to attract capital inflows and (most importantly) to elevate the cost of capital outflows. Complementarily, the government started a privatization plan that, among other motivations, had the explicit objective of attracting foreign direct investment (Barbosa-Filho, 2008). Throughout this period, the CBB sterilized practically all foreign currency flows to defend the exchange rate peg.

As of 1995 several crises occurred in different emerging markets, such as Mexico (1995), East and Southeast Asia (1997) and Russia (1998). The Asian and Russian crises increased the fragility of the Brazilian external position through a contagion effect which hampered CBB's capacity to sustain the peg. By the end of 1998, Brazil's current account deficit had reached 4.5% of gross domestic product (GDP) and the stock of foreign reserves was lower than the required to carry on defensive action by the CBB to sustain the peg. Inevitably, in the last semester of 1998, Brazil's own exchange crisis triggered an speculative attack against the domestic currency (Barbosa-Filho, 2008).[30]

Institutional arrangement of the CBB in the 1990s was also considerably different from the current configuration. A simplified representation of CBB's balance sheet between 1994 and 1998 is depicted in table 6, which shows Treasury securities and claims on banks as the most relevant items in the asset side, and CBB bonds, compulsory reserve requirements, and Treasury account as the most relevant items in the liability side.

Table 6: CBB Balance sheet: 1994 to 1998

Assets	Liabilities
Foreign reserves	Monetary base
Treasury securities	Treasury account
Claims on banks	Compulsory reserves
	CBB bonds

---

[29]Literature about the 1980s external debt crisis of developing economies is extensive. For more information, see Cruz (1995), Serrano (1998) and French-Davis et al. (1994).

[30]The magnitude of the speculative attack against Brazilian domestic currency can be expressed by the loss of 57% of its value against the dollar, between December 1998 and February 1999 (Barbosa-Filho, 2008).

B.1 Dataset

Table 7 reports data included in the model for the 1990s. The monetary base presented strong cyclical behavior and was seasonally adjusted. In this specification, all series are in logarithm form, so the coefficients capture elasticities.

Table 7: Dataset (1994 to 1998)

Variable	Description
FOREX	Foreign reserves
TSECURITIES	Treasury securities at the Central Bank
MB	Monetary base
TACCOUNT	Treasury account at the Central Bank
CRESERVES	Compulsory reserves at the Central Bank
CBSECURITIES	Bonds issued by the CBB
CLAIMS	Central Bank claims on domestic banks

Two of these variables had minor modifications to properly test the compensation principle. First, the concept of monetary base adopted by the CBB includes compulsory reserve requirements on demand deposits. To obtain a monetary base concept compatible with cash plus reserve balances only held voluntarily, we subtracted compulsory reserve requirements.

Second, although the exchange rate was pegged, there were still variations that could cause considerable capital gain/loss on the stock of foreign reserves (denominated in domestic currency), which is undesirable for testing the compensation principle. Hence, following Lavoie and Wang (2012) we removed capital gain/loss resultant from exchange rate fluctuations.[31] Furthermore, due to increasing current account deficits, the CBB responded by borrowing abroad (increasing foreign liabilities) to replenish foreign reserves required to sustain the pegged exchange rate. In order to eliminate foreign reserve accumulation obtained through increasing foreign liabilities, which does not entail creation of reserve balances in the domestic banking system, we followed the suggestion by Angrick (2017, p. 9) to subtract foreign liabilities from the stock of foreign reserves.

The estimation period goes from July 1994 to December 1998, rendering 54 observations. It is a period of deteriorating external conditions for the Brazilian economy and was the build up for an exchange crisis. It is not clear in the existing literature which were the most likely items to have compensated for foreign currency flows. In absence of indications, we tested the variables that seemed to be the most relevant in CBB's balance sheet, at the time, identified in the previous section.

---

[31]The stock of foreign reserves was calculated by $FOREX = \sum \Delta FR_{t+n}EX_{t+n} + FR_{t-1}EX_{t-1}$, where FR is the stock of foreign reserves denominated in US dollars, EX is the nominal exchange rate (between domestic currency and US dollar), t is the first observation of data sample, and n is the number of periods after t.

B.2 Unit root tests

All tests reject the null hypothesis that the series is integrated of order one, except for the first difference of the foreign exchange reserves in the 1990s. However, the unit root with break test, reported in table 9, rejects the null hypothesis of non-stationarity, suggesting that there is a break in the series.

Table 8: Phillip-Perron unit root test (1994 to 1998)

	constant and trend	constant	none
D(CLAIMS)	-8.71***	-8.36***	-8.25***
D(FOREX)	-0.90	-0.03	-0.01
D(MB)	-9.67***	-9.59***	-8.64***
D(CRESERVES)	-6.18***	-5.99***	-5.83***
D(CBSECURITIES)	-8.44***	-7.87***	-7.29***
D(TACCOUNT)	-8.77***	-8.95***	-6.96***
D(TSECURITIES)	-5.65***	-5.45***	-5.17***

Significance levels: * 10%, ** 5% and *** 1%.

Table 9: Unit root with intercept break test (1994 to 1998)

	constant and trend	constant
D(FOREX)	-5.83***	-6.01***

Significance levels: * 10%, ** 5% and *** 1%.

B.3 Results

In order to test whether the compensation thesis was verified in this period, the main accounts in the CBB balance sheet are tested. Due to the behavior of the foreign exchange reserves variable, an interaction dummy which takes the value of the trend from April 1998 to December 1998 was added in all specifications.

Table 10 reports the bounds tests for the estimated models. The results for the monetary base model[32] suggest the existence of a cointegration relation between the monetary base and the exogenous variables, which is further scrutinized below. The other specifications refer to the CBB claims on private banks,[33] Treasury securities,[34] and the CB securities.[35] For these equations, the t bounds tests do not offer support for the hypothesis of cointegration between the variables at the 5% significance value.

---

[32] ARDL(1, 0, 1, 4, 4, 0, 0), order: CRESERVES, FOREX, TACCOUNT, CBSECURITIES, TSECURITIES, CLAIMS.

[33] ARDL(1, 1, 0, 0, 0, 2), order: CRESERVES, FOREX, TACCOUNT, CBSECURITIES, TSECURITIES.

[34] ARDL(4, 3, 1, 4, 4, 4), order: CLAIMS, CRESERVES, FOREX, TACCOUNT, CBSECURITIES.

[35] ARDL(2, 0, 0, 2, 4, 2), order: TSECURITIES, CLAIMS, CRESERVES, FOREX, TACCOUNT,

Table 10: Bounds tests (1994 to 1998)

| | | F-test | |
Dependent variable	F-statistic	Critical value (lower)	Critical value (upper)
MB	7.09	2.63	3.62
CLAIMS	3.17	2.81	3.76
TSECURITIES	4.32	2.81	3.76
CBSECURITIES	5.53	2.81	3.76
		t-test	
Dependent variable	t-statistic	Critical value (lower)	Critical value (upper)
MB	-6.88	-3.41	-4.69
CLAIMS	-3.76	-3.41	-4.52
TSECURITIES	0.45	-3.41	-4.52
CBSECURITIES	-3.06	-3.41	-4.52

Note: Critical values correspond to the 5% significance level.

While the results in table 10 suggest that neither of the three main accounts (except the monetary base) were compensating the changes in the net foreign exchange reserves, the results reported in table 11 suggest that this role was not exerted by the monetary base either, as there is no support for a long-run relationship between the the monetary base and the foreign exchange reserves.

Table 11: Cointegration equation for monetary base (1994 to 1998)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CRESERVES	-0.26	0.1	-2.64	0.01
FOREX	0.03	0.05	0.53	0.60
TACCOUNT	0.16	0.08	2.07	0.05
CBSECURITITES	0.1	0.12	1.00	0.32
TSECURITIES	0.14	0.05	2.79	0.01
CLAIMS	0.02	0.02	0.91	0.37

Consequently, the results for this period support the compensation thesis inasmuch as they show that the monetary base was not permanently affected by changes in the net foreign reserves. Yet, the results do not indicate which account compensated the movements in the latter variable. Given the particularities of the period, it is possible that this role was exerted by different variables in different subperiods, thus preventing the direct identification of the compensating variables. Ergo, the results for this period are in line with the affirmation that "[w]hen a currency is under attack, the domestic central bank may in fact take measures that run counter to the endogenous compensation principle" (Lavoie, 2001, p. 235). Therefore, the 1990s period still requires further investigation.