



Can Sterilized FX Purchases under Inflation Targeting Be Expansionary?

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Abstract:

Unlike common wisdom, sterilized FX purchases under inflation targeting, i.e., those that keep the interest rate at the level targeted by the central bank, generally increase aggregate demand. We resort to a simple model with a credit channel to argue that FX purchases, by funding bank credit, end up increasing aggregate and money demand, while expanding loans and reducing the loan interest rate. Therefore, restoring the interest rate to the level previous to the FX purchase may not be sufficient to avoid the expansionary effect; the new money market equilibrium, at the same interest rate, will entail a larger money supply, higher output and larger money demand. Recent Brazilian evidence is reviewed, showing that this effect may be empirically relevant. If this is the case, inflation targeters may have another reason to be concerned when conducting FX sterilized interventions, besides their high cost and controversial effectiveness in preventing nominal appreciation. FX sterilized purchases may not only fail to prevent nominal appreciation, but also boost activity and inflation, thereby appreciating the real exchange rate.

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Summary

1. Introduction.....	3
2. A Simple IS-LM Model with Two Assets	5
3. Effects of Sterilized Interventions	8
4. FX Sterilized Interventions in Brazil and Money	10
5. Concluding Remarks	15
6. References.....	17

1. Introduction

Given the abundant liquidity prevailing in international financial markets, together with the good prospects of many emerging markets, capital has been flowing very intensely to these economies.

Several emerging markets, like Brazil, have been conducting monetary policy according to the inflation targeting framework. Although such framework prescribes a free floating exchange rate, the exchange rate appreciation caused by capital inflows is being increasingly seen as very deleterious to long term growth. The specter of Dutch disease has been often brandished. Therefore, several forms of intervention in exchange rate markets without violating the open economy inconsistent trinity have been attempted. The main ones are controls on capital inflows and sterilized interventions.

In a country with extremely high interest rates, as is the case of Brazil, the FX reserves purchased through sterilized interventions are extremely expensive, thereby generating high fiscal costs. The theoretical and econometric evidences are also very mixed as to the effectiveness of sterilized purchases of FX in depreciating the home currency³. Nevertheless, sterilized interventions have been conducted in Brazil for quite a long time, generating a very large volume of foreign reserves (around USD 320 bi, or 16% of GDP).

Despite its flaws, sterilized purchases of FX are widely believed to have **no** effects on economic activity. To illustrate this point, imagine an open economy that is cruising along with unemployment at NAIRU, GDP growth at the normal rate, real interest rate at the neutral rate and inflation rate at π .

Suddenly, capital starts to flow into this economy. The inflation-targeting-monetary-policy maker decides to fully sterilize the capital inflow. Under the inflation targeting framework, this means purchasing all FX (USD) with domestic currency (BRL), thereby lowering the nominal interest rate, and conducting contractionary open market operations until the previous nominal interest rate is restored.

Are such sterilized interventions under inflation targeting expansionary? Most economists, at least those I have asked, will answer negatively. This paper argues that the answer is most likely to be positive.

Next section presents a simple model *à la* IS-LM that introduces a new asset. In section 3, the model is used to argue that sterilized interventions under inflation targeting will, in general, be expansionary. Section 4 presents empirical evidence from Brazil supporting the

³ Dominguez and Frenkel (1993) and Sarno and Taylor (2001).

expansionary effect of sterilized interventions under inflation targeting. Finally, section 5 concludes with a discussion of policy implications of expansionary effects of sterilized interventions under inflation targeting.

2. A Simple IS-LM Model with Two Assets

To illustrate how sterilized FX purchases under inflation targeting may be expansionary, we resort to a simple IS-LM model with two assets, akin to the one developed by Bernanke and Blinder (1988), henceforth the BB model.

In models inspired by the traditional IS-LM model, "... *loans and other forms of customer-market credit are viewed as perfect substitutes for auction-market credit ("bonds")*"⁴. In the BB model, a third asset, loans, is added to money and bonds.

Borrowers and lenders observe the relevant interest rates (i on bonds, and ρ on loans) and decide how to allocate their wealth. The loan demand is, therefore, represented by equation (1), where y (GNP) "... captures the transactions demand for credit"⁵:

$$L^d = L(\underset{-}{\rho}, \underset{+}{i}, \underset{+}{y}) \quad (1) .$$

The loans supply is done through the banking sector. To understand how it works, let's display the simplified balance sheet of the representative bank:

Bank Balance Sheet	
Assets	Liabilities
R (bank reserves)	D (deposits)
B^b (bonds)	
L^s (loan supply)	

Bank's assets are bank reserves (R), bonds (B^b), and loans (L^s). Bank's liabilities are deposits (D). Bank reserves (R) are composed of required reserves ($\tau \cdot D$) plus excess reserves (E). Therefore, from the bank's balance sheet:

$$B^b + L^s + E = D(1 - \tau) . \quad (2)$$

The portfolio shares of bonds (β), loans (λ) and excess reserves (ε), $\beta + \lambda + \varepsilon = 1$, are determined according to the returns (zero for excess reserves):

$$L^s = \lambda(\rho, i) D(1 - \tau) \quad (3);$$

$$B^b = \beta(\rho, i) D(1 - \tau) \quad (4);$$

$$E = \varepsilon(i) D(1 - \tau) \quad (5).$$

⁴ Bernanke and Blinder (1988), p. 435.

⁵ Bernanke and Blinder (1988), p. 435.

In this model, there is no paper currency. Money comprises only deposits (D). Equilibrium in the money market is represented by a conventional LM curve in the $y \times i$ space. Money supply (D , the model equivalent of M1) is given by the amount of reserves (R , the model equivalent to M0), under control of the central bank, multiplied by the money multiplier (m):

$$m(i) = 1 / [\varepsilon(i)(1 - \tau) + \tau] \quad (6).$$

Money demand (D) is quite conventional, depending on the interest rate and income (total wealth is assumed constant and *ipso facto* eliminated). Therefore, equilibrium in the money market is represented by the following LM curve, upward sloping in the $y \times i$ plane:

$$D(i, y) = m(i)R \quad (7).$$

Having determined the money market equilibrium, we turn to equilibrium determination in the remaining markets: loans, bonds and goods. The equilibrium in the **loans market** is given by equation (8):

$$L(\rho, i, y) = \lambda(\rho, i)D(1 - \tau) \quad (8).$$

Given loan demand, $L(\rho, i, y)$, and money demand, $D(i, y)$, the nonbank public's **demand for bonds** is implicitly defined because total financial wealth is supposed constant. Finally, let's turn to the **goods market** equilibrium. It is summarized by an IS curve where the loan rate, ρ , also enters:

$$y = Y(i, \rho) \quad (9).$$

The key novelty of the BB model is precisely that ρ affects the IS curve. Since, by the equilibrium in the loans market (equation (8)), ρ depends on D , which, in turn, by the equilibrium in the money market (equation (7)), depends on R , monetary policy, i.e. the amount of bank reserves (R), will also influence directly the goods market equilibrium.

The graphical representation is undertaken in the same familiar $y \times i$ plane, although a tridimensional $y \times i \times r$ representation could also be used. To represent the model in the $y \times i$ plane, we start by replacing D in the loans market equilibrium (equation (8)) by money supply, $m(i)R$, yielding:

$$L(\rho, i, y) = \lambda(\rho, i)m(i)R(1 - \tau)$$

Then, the resulting equation can be solved to yield ρ as a function of the other variables: i , y , R and τ :

$$\rho = \phi(i, y, R, \tau) \quad (10).$$

In (10), the derivative of ρ with respect to i is usually positive, because when i increases, banks tend to allocate more of the free deposits to bonds, thereby lowering the amount of loans. Given a downward sloped demand curve for loans, this will increase ρ . This effect is akin to the substitution effect in consumer theory.

However, there is another effect, akin to the income effect. When i increases, the money multiplier also increases, yielding more deposits from the same amount of bank reserves, R . If this “income” effect is very strong, it may overcome the former “substitution” effect, and make ρ a negative function of i .

Substituting the ρ , given by (10), into the goods market equilibrium condition (9), we get the new IS, which is baptized by BB as the CC (“commodities and credit”) curve, in honor of the late Don Patinkin.

$$y = Y\{i, [\phi(i, y, R, \tau)]\} \quad (11).$$

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The CC curve is also downward sloping in the $y \times i$ plane, for the same reasons of the typical IS curve. However, it now responds to shifts in R , as well as to shocks in the loan market, affecting either the supply or the demand side. Next section will apply this model to evaluate the effects of sterilized interventions under inflation targeting.

3. Effects of Sterilized Interventions

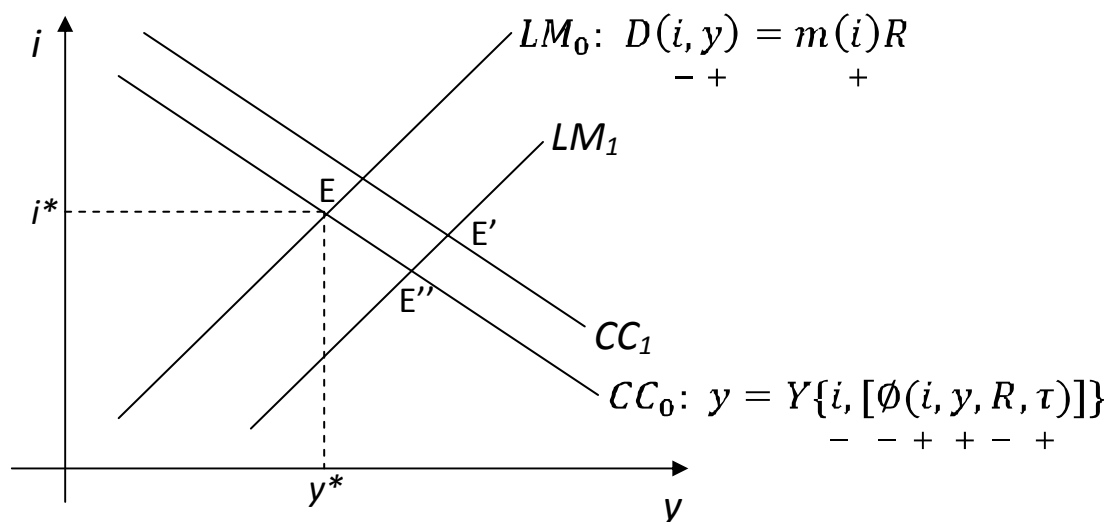
Although the previous model represents a closed economy, it will suffice for our purposes, since we are mainly concerned with the effects of sterilized interventions on money supply (R) under inflation targeting.

Sterilized interventions are usually defined as purchases or sales of FX that do not affect the monetary base (R). However, in the inflation targeting framework, or any other monetary policy framework in which the instrument is the interest rate (i) instead of a monetary aggregate, the term sterilized interventions usually refers to FX transactions that do not alter the target interest rate (i^*).

Often, it is implicitly assumed that both definitions are equivalent, but it will be shown that this is not the general case in models with a richer asset choice than the usual, IS-LM, one between bonds and money.

Chart 1, below, shows what happens when the CB conducts a sterilized FX purchase. The initial equilibrium is at [E]. First, the CB purchases foreign currency and issues domestic currency (R). The effect is to shift both the LM and the CC curves to the right, with [E'] being the new equilibrium. Given the shift of the CC curve, the resulting interest rate is always higher than it would be the case in the traditional IS-LM model ([E'']), where the IS curve does not respond to changes in R .

Chart 1



As defined in most textbooks, a sterilized intervention would be completed by a contractionary open market operation that would fully offset the increase in R , bringing back the equilibrium to [E]. However, in the inflation targeting framework, what the CB has to do is to restore i to its previous level. Given the change of the CC curve, this is, presumably, obtained with a smaller sale of bonds than would be the case in the IS-LM model.

In fact, BB calls attention to the possibility that “... a rise in bank reserves might conceivably raise the rate of interest in the credit model”⁶. If this were the case, the central bank would have to conduct an expansionary open market operation to put the interest rate (i) back to the level determined by the MPC.

In any case, it is reasonable to assume that the associated open market operation needed to put the interest rate (i) back to the level determined by the MPC would be smaller than the amount necessary to bring R back to its previous level.

After the sterilized intervention, i is back to its previous level, but y is larger. This occurs because there is more and cheaper credit in the economy. Given the shift in CC , due to more and cheaper credit, to restore the initial level of output, y^* , the CB would have to raise i above the initial level i^* .

To bring the economy back to its previous equilibrium, full offsetting of the increase in R would be necessary. However, such rule, in general, is **not** equivalent to restoring i to its previous level. As this model shows, other equilibria may exist where i remains unaltered after the sterilized intervention, with an expansionary effect on y .

Therefore, with monetary policy being conducted via an interest rule, as it is the case in the inflation targeting framework, the sterilized FX purchase is expansionary, in most cases. Of course, whether or not such effect is of practical importance is an empirical issue.

In the following section, empirical evidence will be provided in order to argue that such mechanism may be playing a relevant role in propping up aggregate demand in Brazil.

⁶ Bernanke and Blinder (1988), p. 437.

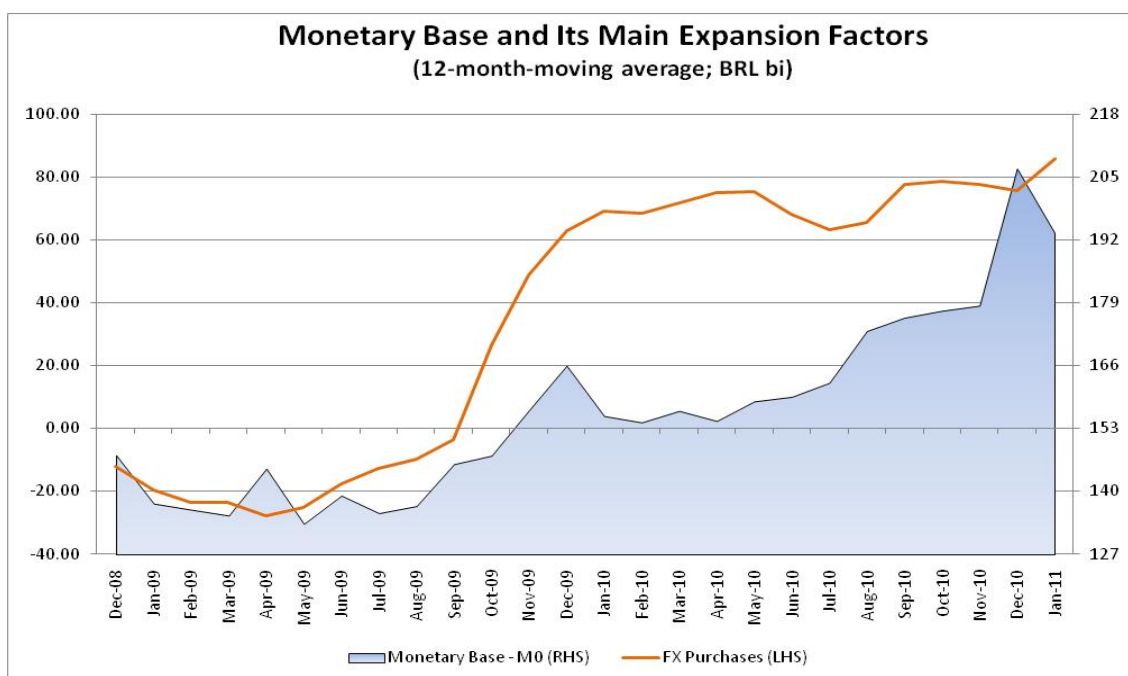
4. FX Sterilized Interventions in Brazil and Money

After the peak of the 2008 crisis, Brazil resumed FX sterilized purchases as early as February, 2009. Since then, foreign reserves have climbed from USD 187 bi to USD 320 bi, reaching 16% of GDP.

Chart 2 shows that the monetary base has also been expanding fast. In 2010, it increased 25%, or BRL 40 bi, for an inflation rate of 6%. Real GDP expanded by 7.5%.

As shown in Chart 2, FX purchases (almost BRL 80 bi in 2010) were one of the main factors that explained such robust increase in money. Of course other CB operations affected the monetary base, and it is very hard to show causality, but, *prima facie*, it seems plausible that the story told by the previous model explains at least part of what has been happening in Brazil.

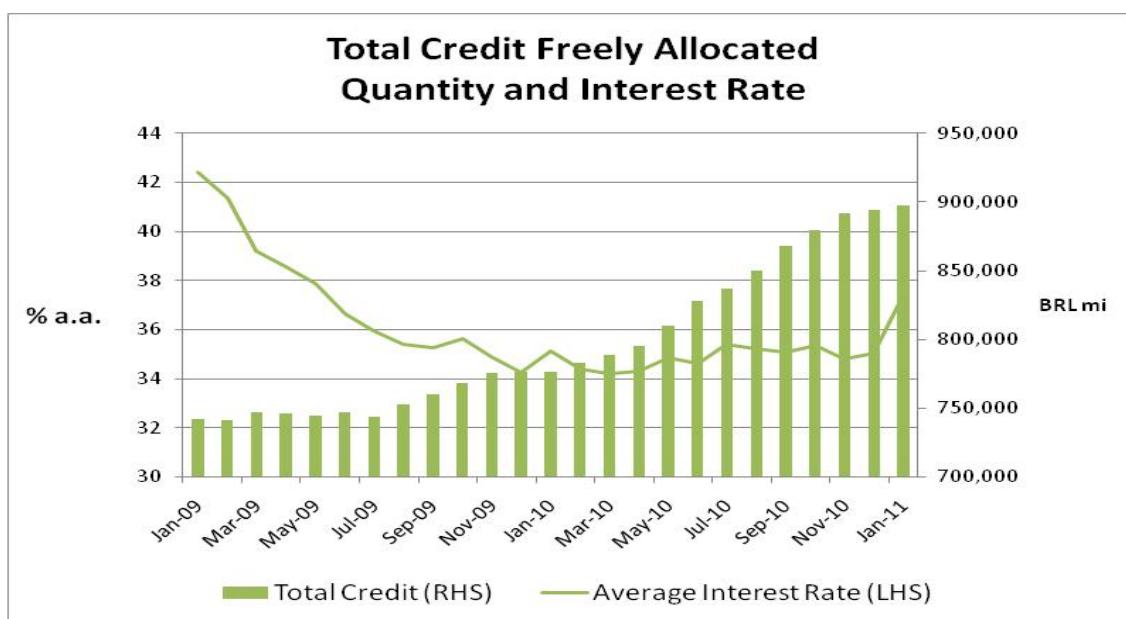
Chart 2



Source: BCB

Another important piece of evidence that the story behind this model might be relevant is the behavior of credit markets in Brazil. Chart 3 makes clear that, albeit very expensive, bank credit has been expanding in Brazil while the average credit interest rate has been declining. This is compatible with the expansion of the supply of credit being larger than the increase in credit demand, precisely what the model presented here prescribes it would happen with massive sterilized interventions.

Chart 3



Source: BCB

Furthermore, Chart 4 shows that the rate on loans to individuals follows almost perfectly the one-year-interbank rate, with a two-month lag⁷. This is quite reasonable, since the interbank rate is the best proxy for banks' cost of funding. However, since the beginning of 2010, the positive correlation seems to have been broken: while the interbank rate rose, the loan rate kept following until November⁸, the month previous to the imposition of macroprudential measures to deter credit growth⁹. The interbank rate follows the expectation of the interest rate set by the Central Bank, the Selic, equivalent to i in the model. The loan rate is the equivalent of the ρ in the model. The model asserts that, under massive FX sterilized purchases, a negative correlation, as observed in 2010, is what should happen.

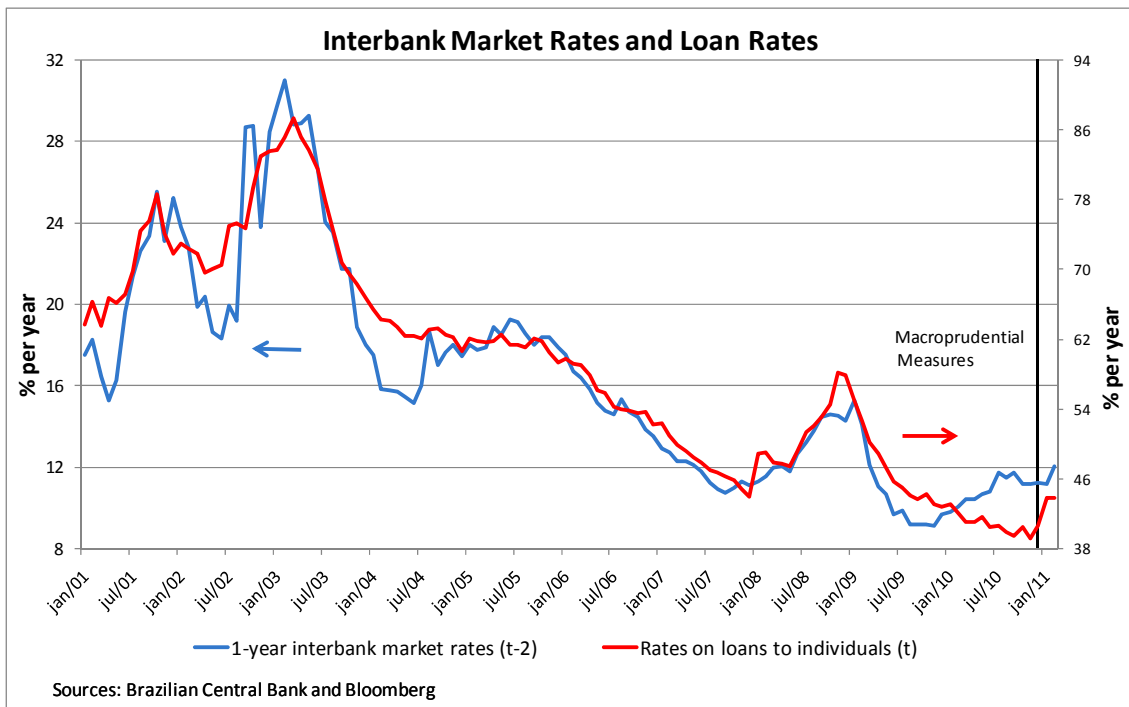
Finally, the macroprudential measures taken by the Brazilian policy-makers reinforce the idea that sterilized interventions may be having the effect to prop up aggregate demand even while the interest rate set by the Brazilian MPC (COPOM) is kept at the desired level. In 2010, reserve requirements were raised twice, one at the beginning of the year, to restore the rates that prevailed before the 2008 crisis, and the other in December, to deter credit growth. As shown by equations (6) and (7), an increase in τ reduces the money multiplier and the money supply, thereby shifting the LM curve inwards (to the left). The increase in τ also increases ρ , the credit interest rate (equation (10)), shifting the CC curve inwards (equation (11)). Both effects counteract the expansionary effect of sterilized interventions.

⁷ In Chart 4, the interbank rate is led two months.

⁸ I thank Eduardo Loyo for pointing this out to me.

⁹ The effects of the macroprudential measures may also be observed at the end of Chart 3, when credit volume stops growing and the average credit interest rate increases.

Chart 4



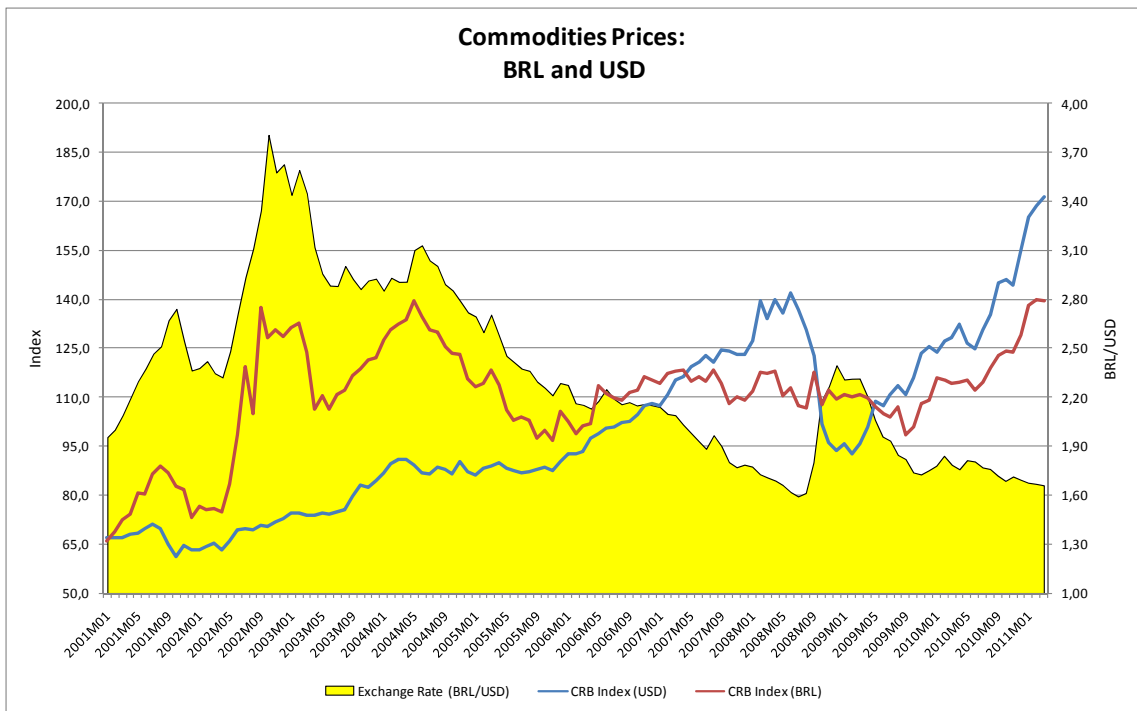
Another set of recent policy measures have targeted a subset of capital inflows. Since March 2011, short-term credit (up to two years) obtained by Brazilian banks abroad has been taxed to deter further capital inflows. These measures aim to deter the FX flows that prompt sterilized interventions.

An additional policy action was the decision taken in 2010 to let the Brazilian Central Bank return to derivatives markets, trading with currency swaps. The purchase of a currency swap by the Central Bank is equivalent to a sterilized intervention¹⁰, in the sense of interventions that keep money constant. As the previous results show, what is generally referred to as sterilized interventions under inflation targeting is not equivalent to the textbook definition. Therefore, the two ways to intervene may bring different results as to the effectiveness in altering the exchange rate.

Since 2010, something seemed to have changed in the behavior of the BRL/USD exchange rate. Although there has been a historical correlation between terms of trade and the exchange rate, since mid-2010, improvements in the terms of trade have not been accompanied by the corresponding appreciation of the BRL, thereby transmitting the commodities positive price (in USD) shock to domestic inflation. Chart 5 shows this phenomenon.

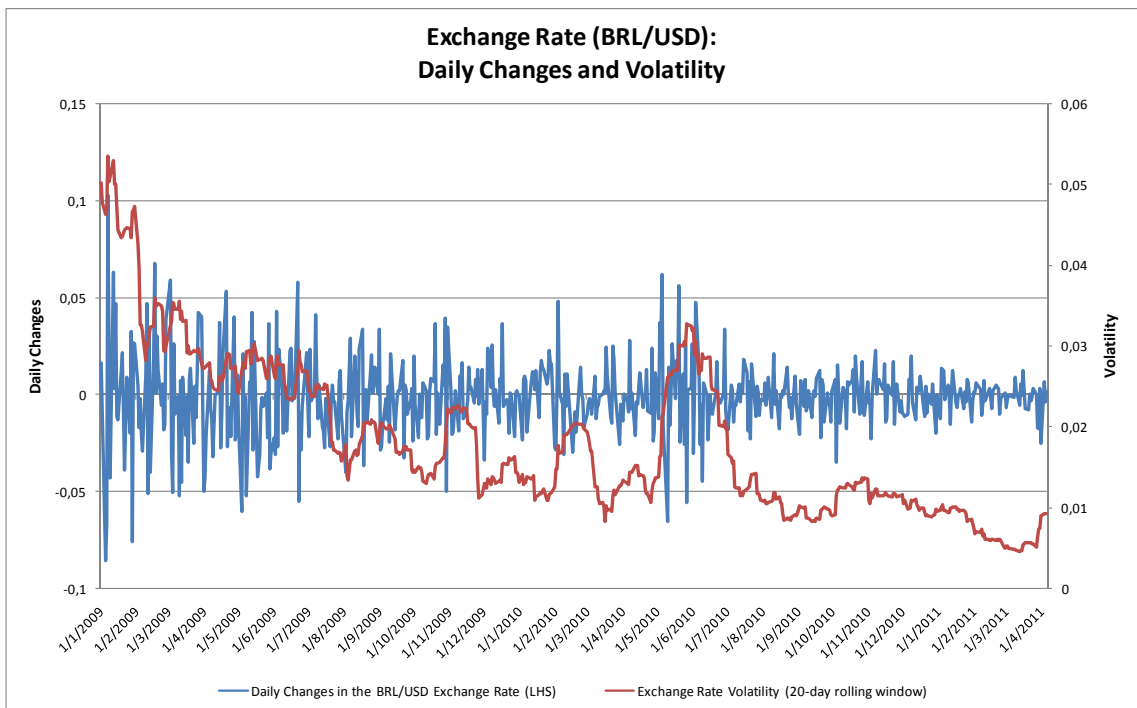
¹⁰ Obstfeld and Rogoff (1996), pp. 597-9.

Chart 5



In addition, the volatility of the BRL/USD rate has fallen remarkably, as shown in Chart 6. These are evidences that government interventions may be affecting the exchange rate, mitigating the appreciation that would occur under free floating.

Chart 6



As previously noted, the theoretical and econometric evidences on the effectiveness of sterilized interventions in altering the exchange rate are mixed. However, this paper argues that the kind of sterilized intervention conducted in Brazil does not correspond to the canonic definition of sterilized intervention. The sterilization of the increase in money caused by the FX purchase is only partial, because the expansionary effect on output increases money demand, thereby requiring less of a monetary contraction to return the interest rate to its previous level. In a nutshell, Brazil has not been fully sterilizing its FX purchases, in the “monetarist” sense of the expression. Therefore, it does not come as a surprise that the FX purchases may have been more efficient in mitigating the nominal exchange rate appreciation.

5. Concluding Remarks

Many countries have been increasingly resorting to sterilized FX purchases to mitigate exchange rate appreciation. Sterilized FX interventions are defined as FX purchases (sales) by the CB followed by open market operations that offset their monetary impact.

Under inflation targeting, or any monetary policy regime with an interest rate rule, sterilized FX interventions usually refer to FX operations followed by open market operations that restore the interest rate to its target. Restoring the interest rate to its previous level may not be equivalent to restoring the monetary base to its previous level.

We adapt a simple model¹¹ with a richer asset structure than the common money and bonds present in the classical IS-LM model in order to argue that, in general, FX sterilized interventions under inflation targeting are expansionary.

When bank credit is explicitly introduced in the IS-LM model, increases in the monetary base (bank reserves) affect not only the LM curve, but also the new IS curve, termed CC, for “commodities and credit”. This effect comes through bank loans, which become cheaper and more abundant when bank deposits rise because of the increase in bank reserves. Therefore, when credit is incorporated in the model, monetary policy, by affecting banks’ behavior, becomes more powerful. An increase in bank reserves will lead to a larger output expansion than in the usual IS-LM model. However, the fall in interest rate associated with monetary expansions will be smaller, or may not happen. In fact, if more bank reserves lead to a large fall in the interest rate on banks’ loans, it is theoretically possible that an increase in money end up raising the interest rate.

We use this model to argue that sterilized interventions under inflation targeting may also be expansionary. The main idea is that capital flows will impact aggregate demand. This is true for banks that fund their domestic loans borrowing from abroad, but is also valid for FDI or corporate securities issued abroad to fund investment projects. This is not true for capital flows directly targeted to purchase government bonds (e.g., carry-trade), for they would not increase aggregate demand.

Since capital flows not targeted to government bonds purchase raise aggregate demand, and therefore also raise money demand, restoring the interest rate to its previous level (before the FX purchase by the CB) will not require the full offsetting of the monetary increase. In the model, an increase in the monetary base is what leads, in the first place, to an increase in loans. Therefore, sterilized interventions under inflation targeting, in reality not fully sterilized, become expansionary.

One criticism to this idea is that sterilized interventions are conducted in a very short period of time, a few minutes, and that aggregate demand would not react in this short interval. To see why this criticism may not be valid, imagine a bank that borrows abroad to fund its domestic loans. It sells the foreign currency to the CB to get the domestic currency with which it will be able to make the domestic loans. The sterilization of the exchange rate

¹¹ Bernanke and Blinder (1988).

trade will be done immediately, but the effects on aggregate demand through the loans will happen over time. As capital flows have been flowing in for years, this effect is probably relevant. It is the nature of the capital inflow, not the timing of the open market operation, that matters.

The recent Brazilian experience was reviewed to argue that the expansionary effect of sterilized interventions may be relevant. The monetary base has expanded 25% in 2010, while GDP has grown 7.5%. Credit also increased substantially, with most loans becoming cheaper. Besides timid increases in interest rate, the government has resorted to macroprudential measures, such as increases in reserve requirements. All these evidences are compatible with the expansionary effect of sterilized interventions under inflation targeting.

The main policy implication of this paper is that when a country receives large influxes of FX that are not aimed at purchasing government bonds (including trade revenues), it is not sufficient for the CB to restore the previous interest rate level to fully sterilize the FX purchase. If the FX flows affect aggregate demand, e.g. via bank credit, sterilized interventions under inflation targeting will be expansionary.

Inflation targeting countries that conduct sterilized interventions to mitigate the appreciation of the exchange rate in face of massive capital inflows may have another reason to be concerned. Even if those sterilized interventions are effective in preventing nominal exchange rate appreciation, they might represent a positive shock to aggregate demand, thereby increasing inflation with its deleterious effects, among them, the appreciation of the real exchange rate.

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