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Inflation Dynamics and Monetary Policy in Bolivia

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Abstract

This paper explores inflation dynamics and monetary policy in Bolivia. Bolivia's monetary policy framework has been effective in stabilizing inflation in recent times. This has been a challenging task given high price volatility of key consumer goods subject to recurrent supply shocks, especially food items. Empirical testing indicates that the monetary policy framework has contributed to the stabilization of inflation, with effective transmission through the bank lending channel, while the defacto dollar peg has also played a role. Looking ahead, the current framework will be tested by the new commodity price normal and a potentially permanent adjustment in relative prices. Against this background, consideration could be given to a more flexible exchange rate policy arrangement, with short term interest rates as the main policy instrument.

JEL Classification Numbers: F3, E3, E4, E5.

Keywords: Inflation, monetary policy, exchange rate flexibility, Exchange rate peg, Bolivia.

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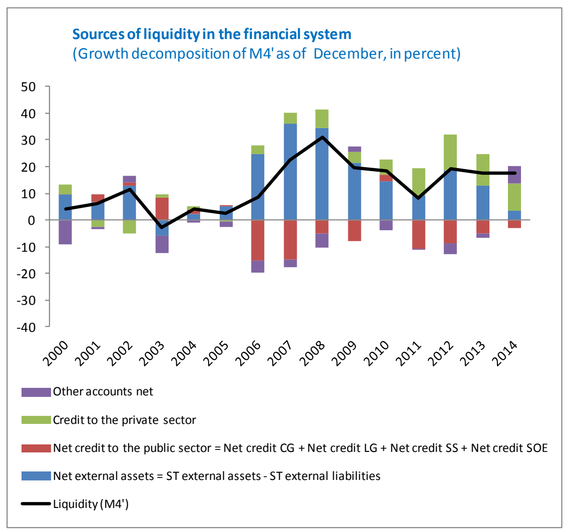
Contents Page

I. Introduction and Background

Bolivia has a history of volatile inflation and high levels of financial dollarization. Inflation was very high in the 1980s, including a hyperinflation episode in 1984. Since the 1990s inflation has remained under control, although with occasional spikes mainly as a result of volatile food prices sensitive to weather conditions (Figure 1a). In this period, the exchange rate acted as the nominal anchor under a crawling peg. The hyperinflation episode was followed by a period of high financial dollarization, as agents sought hedging to safeguard savings and nominal assets from inflation (Figure 1b). Specific policies to discourage transactions and savings in foreign currency (such as higher reserve requirements on foreign exchange exposures and a financial transactions tax on FX transactions) also contributed to the substantial decline in dollarization. Since 2003, however, financial dollarization has declined steadily.[2] This happened in a context of exchange rate stabilization by the central bank, an export commodity boom, and real exchange rate appreciation trend.

The nationalization of the hydrocarbon industry in 2006 marks the beginning of a steady expansion and sustained liquidity inflows into the financial system. Since 2006, much of the government's sizable hydrocarbon revenues in US$ dollars have been deposited at the central bank (text chart).[3] These revenues also boosted international reserves and allowed the financing of increasing amounts of government spending (Figures 1c and 1d), which in turn resulted in a sustained inflow of domestic currency into the financial system. Government revenues from the nationalization were also boosted by an oil price boom, as hydrocarbon export contracts with Argentina and Brazil are linked to oil prices. Since 2010, the central bank balance sheet expanded not only because of the increase in international reserves, but also as a result of direct lending operations to state-owned enterprises (SOEs) (Figure 1f). Government spending and credit to SOEs resulted in a steady injection of liquidity to the financial system.



Bolivia's monetary policy framework has been effective in keeping inflation under control in the environment of high liquidity in the domestic financial system prevalent since 2006. Despite the steady inflow of liquidity, inflation has remained at around 5 percent

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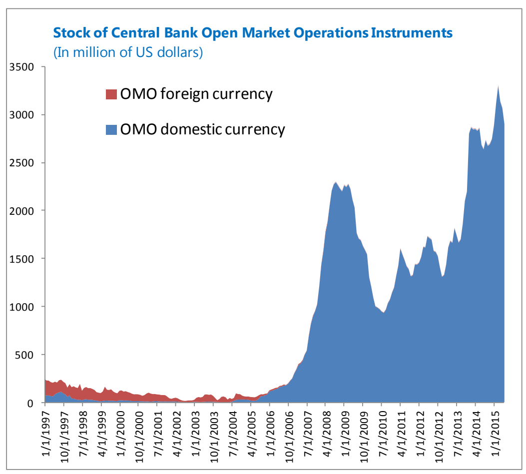
[2] Aguilar Pacajes (2012) analyzes the determinants of the decline of financial dollarization in Bolivia. It concludes that the stability of the exchange rate contributed to reducing the dollarization of portfolios, and that the de-dollarization of deposits lead the de-dollarization of loans. According to their results, currency appreciation and differential banks' reserve requirements by currency are the main variables explaining the decline in deposits' dollarization.

[3] This pattern has also been documented in Cernadas Miranda (2012).

per year. Substantial GDP growth of more than 5 percent per year on average has resulted in a steady increase in the demand of money and deposits. In this context, open market operations were the main policy instrument to manage liquidity and control inflation. The central bank has also used other instruments, including one-off savings bonds issuances accessible to the general public; and management of banks' reserve requirements to control excess reserves in the banking sector. The decline in financial dollarization also likely contributed to improving monetary policy transmission.[4] Occasionally, the central bank has also used the nominal exchange rate as a policy instrument to control inflation pressures and avert second round inflationary effects, typically in the face of inflation spikes in food items. The hydrocarbon revenues after the 2006 nationalization and increase in oil prices boosted economic activity and supported a real currency appreciation. In this context, the central bank faced no pressures against the maintenance of the U.S. dollar peg (Figures 1g and 1h).

According to the central bank's stated policies, inflation is anchored on quantitative targets, mainly the growth rate of the central bank's net domestic credit. These quantitative targets are set in a Monetary Program, in conjunction with the overall fiscal balance target and net credit to the public sector. This program includes an inflation estimate that is indicative of the central banks' inflation target for the year, along with other key macroeconomic assumptions.

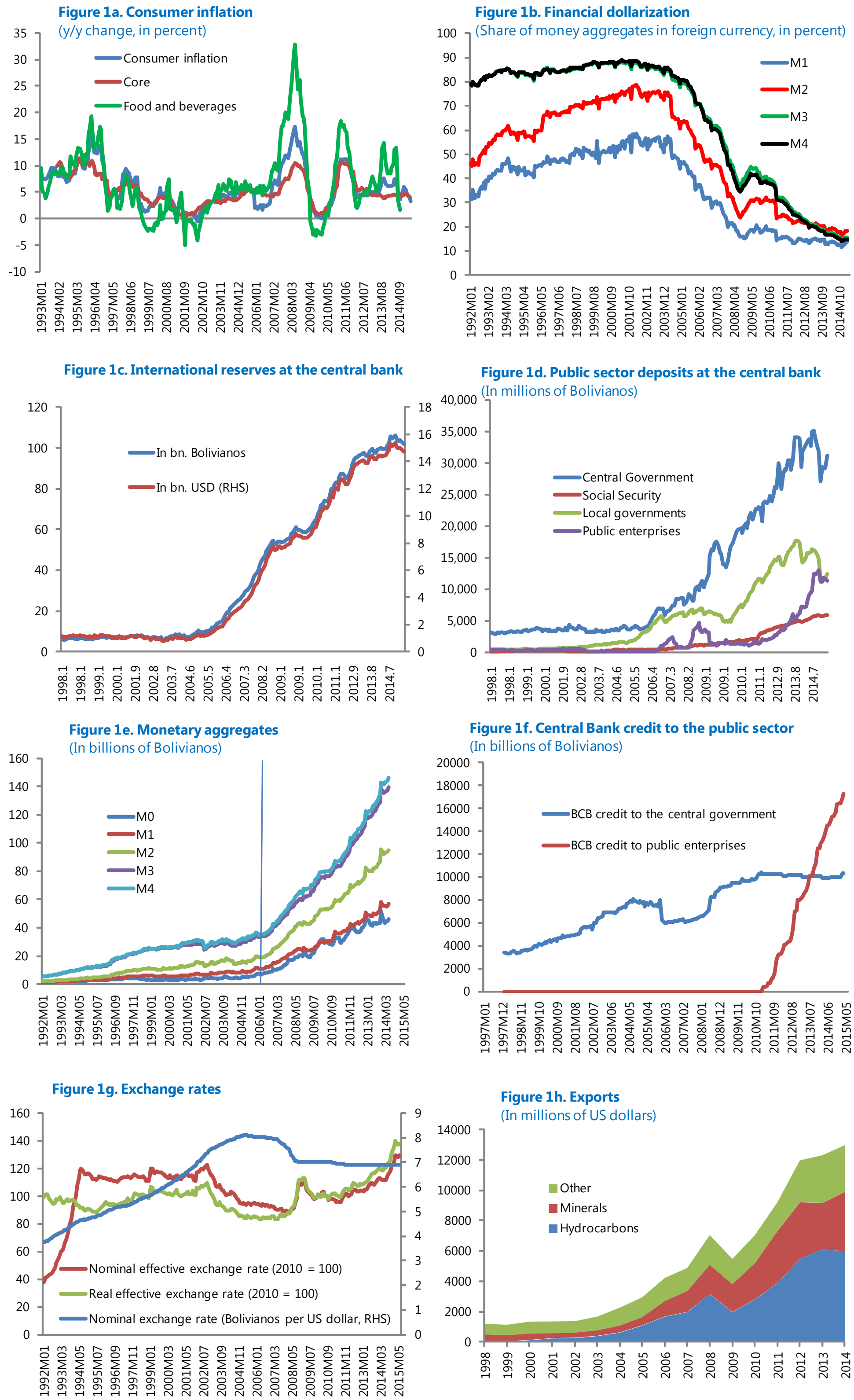
While the current monetary policy framework weathered the Global Financial Crisis well, it has not faced a shock like the new commodity price normal. The favorable conditions prevalent since 2006 supported a trend of real exchange rate appreciation, with virtually no pressures for currency depreciation.[5] Abstracting from seasonal and cyclical considerations, the need for central bank intervention was mostly one-sided, sterilizing excess money balances and acumulating international reserves. This explains the steady and substantive increase in the stock of central bank sterilization bills (text chart). The global financial crisis of 2008 and 2009, however, tested the framework. Commodity export prices collapsed, and several trading partners in the region experienced a growth deceleration, affecting Bolivia's external demand. On this ocassion the central bank managed to control a short-lived speculative increase in demand for foreign exchange with market interventions. External conditions quickly reversed, oil prices rebounded back to high levels, and. hydrocarbon-related exports and fiscal revenues recovered. Conditions returned to the appreciating equilibrium within a year (see Figure 1).



[4] See Aguilar Pacajes (2012).

[5] This real appreciation of the currency was largelly an equilibrium phenomenon, as it was driven by a growing demand for money balances resulting from the increase in the net foreign asset position after the nationalization of the hydrocarbon revenues and the debt relief program of 2004; the process of de-dollarization; and sustained economic growth.

Figure 1. Financial System Developments



Source: central bank of Bolivia, International Financial Statistics, and staff calculations.

This paper analyzes empirically the effectiveness of monetary policy since 2006 and discusses possible challenges under more adverse conditions. This period is characterized by a steady inflow of liquidity into the financial system after the nationalization of the hydrocarbon industry, as mentioned above, and differs from the previous regime with regards an increased emphasis on de-dollarization measures. The first objective is to analyze the workings of the current monetary policy framework and to assess its ability to smooth business cycle fluctuations. Section II presents the empirical strategy. Based on the model estimated in II, Section III analyzes the power of the monetary policy framework to affect prices at different time horizons, including the indirect impact of monetary policy through the bank lending channel. Section IV characterizes the central bank’s monetary policy reaction function to inflation. Section V disentangles the effectiveness and power of the available monetary policy instruments to affect the economy. Finally, Section VI concludes and discusses possible challenges to the current monetary policy framework in a more a challenging environment, drawing from the findings in Sections II–V.

II. Empirical Strategy

The analysis is based on a Vector Auto-regression (VAR) model. This specification captures long term inflation determinants and also short term dynamics of the monetary equilibrium. The model has the following specification:

$$y_t = c + \sum_{i=1}^{p} \emptyset_i \, y_{t-i} + \gamma x_t + \varepsilon_t \qquad (1)$$

$$\begin{aligned} &E[\varepsilon_t] = 0 \\ &E[\varepsilon_t \varepsilon_\tau^{'}] = \sigma \; for \; t = \tau \\ &E[\varepsilon_t \varepsilon_\tau^{'}] = 0 \; for \; t \neq \tau \end{aligned} \qquad (2)$$

where:

c: vector of constants;

y_t: vector of endogenous variables dated at month *t*;

x_t: matrix of exogenous variables dated at month *t*;

$\emptyset_i$: matrix of auto-regressive coefficients, $i = 1,\ldots,p$;

γ: matrix of coefficients of exogenous variables or controls;

ε_t: vector of white noise residuals.

The vector *y* of endogenous variables includes 11 indicators and the sample includes monthly data from January 2006 to July 2015. This corresponds to the period with the surge in gas export revenues. For presentational purposes can be grouped in four categories**:**

- ***Monetary policy instruments:*** the stock of central bank bills issued in open market operations (OMO); the interest rate on 91 day-central bank bills; and central bank flow intervention in foreign exchange markets.

- ***Nominal anchors:*** the nominal exchange rate and base money.[6]

- ***Monetary policy transmission indicators:*** the interbank interest rate; banks' lending rate; and the stock of bank credit to the private sector.

- ***Monetary policy impact indicators:*** the consumer price level[7]; an index of economic activity that is a close proxy of GDP; and the real effective exchange rate as a measure of competitiveness.

Endogenous variables in the VAR are ordered starting with the most rapidly moving and cascading down towards more slow-reacting variables. The identification of the model is achieved by a Cholesky decomposition of residuals. This very general identification strategy allows a relatively agnostic analysis that focuses on the co-movement of the variables of interest over time, and the results are less subject to the imposition of specific identification assumptions. The endogenous variables are included in the following order: (1) the stock of OMO bills; (2) the interest rate on 91 day OMO bills; (3) the amount of central bank intervention in foreign exchange markets; (4) the nominal exchange rate; (5) base money; (6) the interbank interest rate; (7) banks' lending rate; (8) the stock of banks' credit to the private sector; (9) the consumer price index; (10) the real effective exchange rate; and (11) the index of economic activity.[8] The monetary policy instruments (1)–(3) are included first as it is assumed that it would take some time for the central bank to learn about developments in the economy, so it can only react with some lag. The nominal anchors (4)–(5) are set second in order because these are target indicators of the central bank according the monetary program. It is therefore interpreted that the central bank's policy interventions would target specific values for these variables, and would therefore remain relatively more exogenous. The indicators of bank credit conditions (6)–(8) are next in order, allowing these to have a contemporaneous (within month) reaction to central bank policy interventions. These indicators are also expected to have a relatively more rapid reaction to the central bank policy instruments. In this ordering, indicators of bank credit conditions are above in order relative to the impact indicators (9)–(10) that capture the conditions in the real economy, which would typically have more parsimonious dynamics, taking more time to react and moving relatively more slowly in reaction to shocks.

The model is estimated in levels for all nominal variables and interest rates. Several of the regresors are non-stationary, but strong evidence of cointegration implies that the estimated coefficients are super-consistent.[9] Two lags for each endogenous variable are

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[6] The analysis was also conducted for other money aggregates, including M1 through M4. The results are robust to the change of the money aggregate used, but some impulse response functions showed a decline in the level of statistical significance of the findings for the broader money aggregates.

[7] The consumer price index series has been updated starting in 2007. This new data series has been linked with prior data according to inflation rates.

[8] The results are robust to changes in the ordering of the endogenous variables.

[9] See Stock (1987); West (1988); and Sims, Stock and Watson (1990).

included in the estimate (*p* = 2). Given limited degrees of freedom as determined by the sample constraints, the model was tested with 1 to 3 lags, with tests for the selection of lag length showing mixed results, with several tests pointing at the need to include 3 lags. However, lag exclusion tests indicate that lag 3 was statistically significant in only one of the 11 equations. In any case, the impulse-response functions and variance decomposition analysis used to obtain the main conclusions were robust to the specification of the model with either 2 or 3 lags. Appendix I presents tables with the diagnostic tests.

This empirical strategy allows an agnostic estimation of the monetary policy reaction function and its impact on the real economy. The equations for the four monetary policy instruments capture the central bank response to changes in liquidity, including intervention in foreign exchange markets and base money. Operationally, the main instrument used by the central bank is OMO. It includes a wide range of instruments of varying maturities, including of more than a year. The cutoff interest rate of the 91 day central bank bill auctions is used as representative of the short-term interest directly affected by central bank. This allows the assessment of the extent to which the OMO operations affect the interbank interest rate, and the transmission to banks' lending rates and credit volumes to the private sector.[10]

Base money and the exchange rate are introduced in the model as competing "candidate" nominal anchors. The central bank narrative mentions the growth rate of net domestic credit as the main quantitative target. It also refers to the use of banks' reserve requirements as a tool to control liquidity levels. In this paper, however, money base is used instead of domestic credit. The reasons are that: (i) it is closely related with the explicit quantitative targets by the central bank balance sheet identity; (ii) it is in line with the theoretical literature on nominal anchoring of the price level; and (iii) it is more directly linked to liquidity held by households in the form of currency in circulation, which can explain inflationary pressures outside the bank lending channel. The results are presented in the following sections.

III. MONETARY POLICY POWER

Monetary policy instruments affect about 20 percent of price variability in the near term, and close to 30 percent in the medium term. Variance decomposition analysis of the price level shows that, apart from inflation inertia (defined as the percent of variance in consumer prices explained by its own lags)[11], monetary policy variables explain the largest share of the variability of the consumer price level (Figure 2). This includes the total variance explained by open market operations, the interest rate on central bank bills, base money and

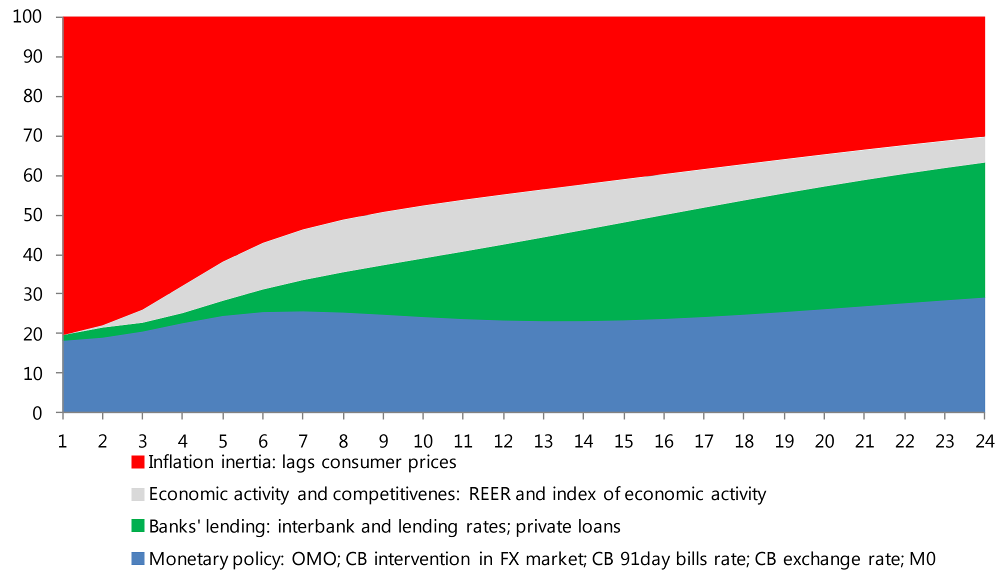
[10] International interest rates are not included as an exogenous variable because Bolivia is not financially integrated. Also, empirical testing indicated that the Fed Funds rate was not statistically significant as an exogenous variable.

[11] See Palmero Pantoja and Rocabado Antelo (2012) for a historical analysis of inflation inertia in Bolivia.

the nominal exchange rate.[12] This can be interpreted as the size of the "direct" impact of monetary policy on the price level.

Bank credit intermediation is a significant determinant of price variability with a lag of about 6 months. The total share of the variance explained by the interbank interest rate, banks' lending rate, and banks' credit to the private sector is small in the near term, but it becomes more substantial and increasingly important after six months. At a horizon of one year, the share of total variance explained by banks' lending behavior is about 20 percent, and after two years it is near 35 percent. This captures the "indirect" effect of monetary policy on the variability of prices, given the possibility that the central bank policy interventions affect banks' lending behavior.

Figure 2. Determinants of Consumer Price Variability
(In percent of total variance explained, months after a shock)



Source: author's calculations based on data from the Central Bank of Bolivia.

IV. Monetary Policy Reaction Function

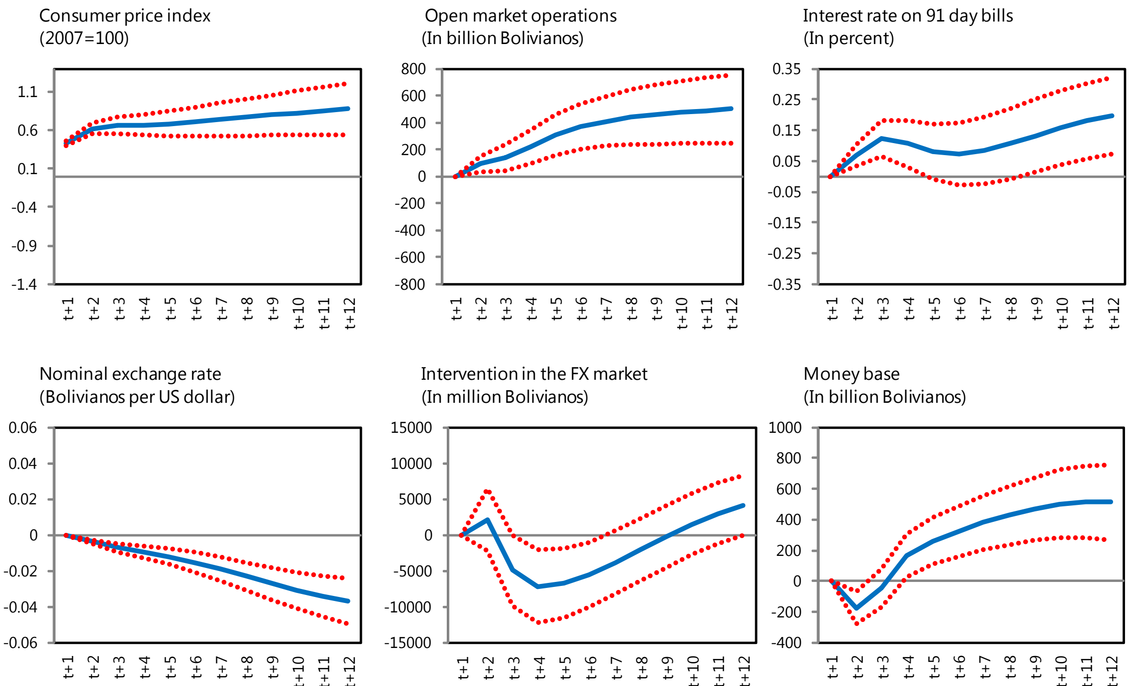
This section analyzes how the central bank responds to different economic developments with its policy instruments. To this end, the paper scrutinizes the impulse-response functions of six indicators that capture the central bank response to changes in economic conditions (the monetary policy instruments; the nominal anchors; and the intervention in foreign exchange markets). The central bank response is evaluated against four different shocks: consumer prices; core prices; food prices, and economic activity.
An increase in consumer prices triggers a contractionary monetary policy reaction. This is obtained from the impulse response function of the monetary policy instruments to a

[12] A caveat to this analysis is that the central bank has also relied on other instruments to manage liquidity that are not included in this analysis, including bank reserve requirements; complementary reserves; one-off saving bond issuances with access to the general public; and special deposits for monetary policy regulation.

positive shock to the price level. The results indicate that an unexpected increase in the price level triggers an increase in OMO bills (Figure 3). This quantitative intervention also results in higher interest rates of 91 day bills, indicating a tightening of the monetary policy stance.

The policy reaction to an increase in the price level also includes an appreciation of the central bank nominal exchange rate. This is consistent with the use of the exchange rate as an instrument to control inflation. However, the amount of such intervention as identified in the impulse response function appears small in magnitude, although it is statistically significant.[13] Interestingly, the impulse response analysis also shows that about three months after a contractionary monetary policy reaction the central bank faces a decline in the demand for foreign exchange. This coincides with an increase in the demand for base money at around the same time. These dynamics appear consistent with the public's need to recompose money balances in real terms after an increase in the price level (see Figure 3).

Figure 3. Central Bank Reaction to an Increase in Consumer Prices
(Impulse-response functions to a 1 std. dev. shock to consumer prices)



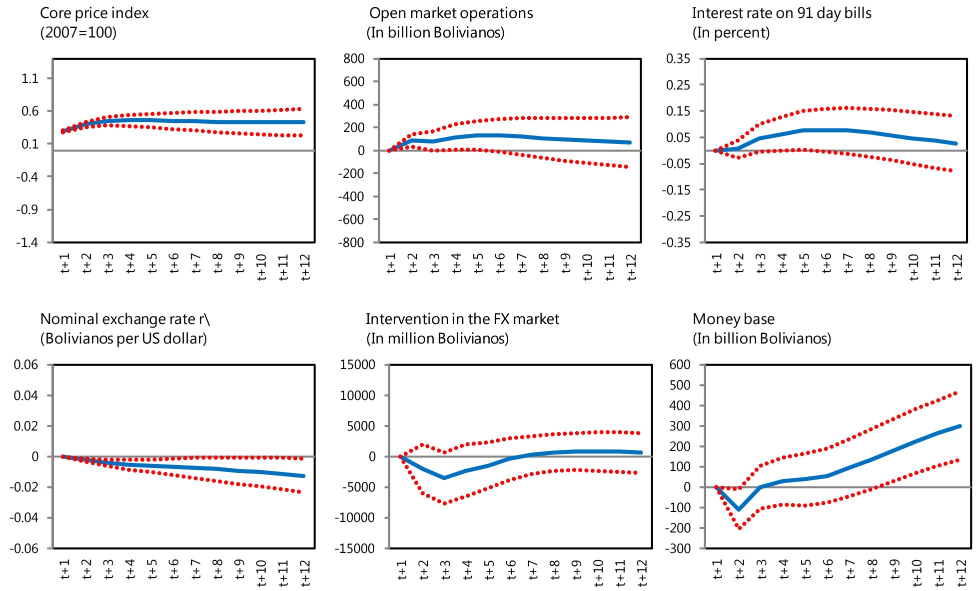
Source: author's calculations based on data from the Central Bank of Bolivia.

The central bank reaction to an increase in core prices is similar to that of consumer prices. Figure 4 shows the impulse response functions of the monetary policy instruments to a shock of core prices. These results are obtained by estimating the same dynamic model but replacing consumer prices with core and food prices. The central bank responds to an increase in core prices with a monetary policy tightening. The stock of OMO increases, and

[13] This may capture the fact that this instrument is not used as actively as OMOs, and as a result the coefficients are averaging periods with and without changes in the exchange rate parity.

liquidity withdrawal results in higher short term interest rates. These results indicate a decisive central bank intervention to avert second-round inflation pressures. It may also indicate that the central bank appears to focus on controlling concurrent inflation in the near term, as opposed to ensuring convergence to the target in the medium term.

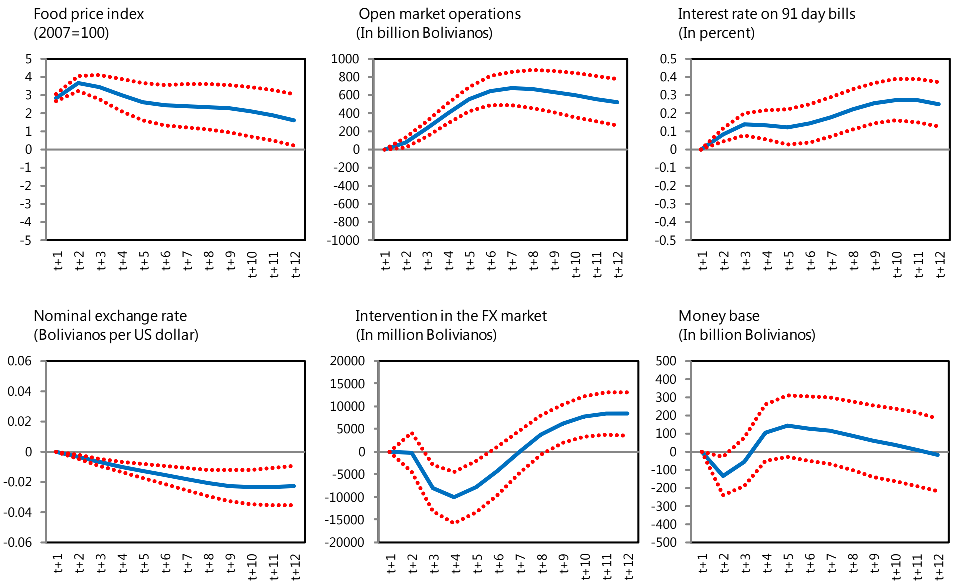
Figure 4. Central Bank Reaction to an Increase in Core Prices
(Impulse-response functions to a 1 std. dev. shock to core prices)



Source: author's calculations based on data from the Central Bank of Bolivia.

Negative supply shocks, identified from a shock to food prices, also trigger a contractionary central bank response. This result is also obtained by decomposing the consumer price index into food and core prices, and estimating the model with these two price sub-components. Notice that this shock can be used to identify a negative supply shock, as food prices are generally affected by weather conditions, as mentioned above. In the face of this type of shock, a central bank would ideally accommodate it if there are no significant second round effects and inflation is well anchored. However, the results indicate that the central bank reaction is contractionary (Figure 5). This is consistent with a central bank reacting pro-cyclically, possibly to avert second-round inflation effects. This may also be an indication that inflation expectations are not well anchored, and therefore the central bank sees the need to withdraw liquidity in the face of a negative supply shock to prevent unexpected inflation spikes from affecting inflation expectations.

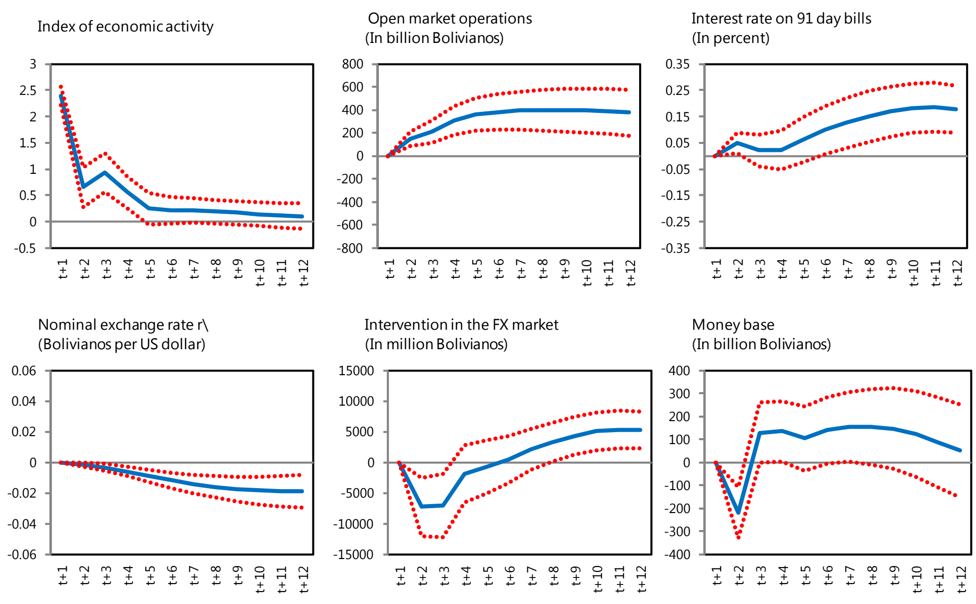
Figure 5. Central Bank Reaction to an Increase in Food Prices
(Impulse-response functions to a 1 std. dev. shock to food prices)



Source: author's calculations based on data from the Central Bank of Bolivia.

Despite the contractionary central bank reaction to supply shocks, in practice the central bank intervention has been mostly countercyclical. Interventions to withdraw liquidity typically took place during periods in which economic activity was above anticipated levels (Figure 6).

Figure 6. Central Bank Reaction to an Increase in Economic Activity
(Impulse-response functions to a 1 std. dev. shock to the economic activity index)



Source: author's calculations based on data from the Central Bank of Bolivia.

V. MONETARY POLICY TRANSMISSION AND IMPACT

This section analyzes the impact on the economy of the monetary policy instruments. The analysis is also based on impulse response functions, but in this case shocking the various monetary policy instruments in the model and then scrutinizing the dynamics of the remaining endogenous variables. The indicators shocked are OMO; the interest rate on central bank bills; and the exchange rate.[14] Transmission is assessed based on the dynamic behavior of the interbank interest rate, the banks' lending rate, and the volume of bank lending to the private sector. The impact on the real economy is analyzed according to the dynamics of consumer prices; the real effective exchange rate; and economic activity.

An increase in the stock of OMO bills (a monetary contraction) is followed by a decline in bank lending and economic activity. This intervention, however, does not appear to be driven by a central bank intention to increase short term interest rates. Notice that the central bank could, in principle, target an increase in this interest rate by accepting a higher volume in the bidding process for bills at a higher cutoff rate. However, the interest rate on 91 day bills does not show a higher level within the first 6 months relative to without an intervention (second chart in the top row of Figure 7).

OMO interventions coincide with a decline in the sales volume of foreign exchange by the central bank that lasts three months. A possible rationale for this observation is that the OMO intervention initially stimulates some selling (or less purchases) of foreign exchange to purchase OMO bills. There is also a statistically significant appreciation of the exchange rate, albeit small, which would be consistent with the reasons argued above. The decline of money base, however, implies that the intervention amount is beyond the point needed to keep money aggregates on a relatively neutral position. One possible reason for this size of intervention is a perceived need to avert second-round inflation pressures.

Liquidity absorption with OMO is followed by a slowdown in banks' credit to the private sector, implying that monetary policy transmission is indeed effective. In the near term, the banks' lending rate is lower than without OMO interventions, possibly capturing the fact that these interventions typically occur during periods of high liquidity in the system and low interest rates. However, after one quarter interbank rates increase and the volume of credit declines (Figure 7, second row charts).[15] A puzzling result is the decline in banks' lending rates one quarter after the increase in the stock of OMO, despite the increase in interbank interest rates. This result is important because it may imply a relatively weaker transmission of monetary policy. One possible explanation is that banks reduce credit to the private sector by red-lining relatively riskier borrowers that would typically be offered higher interest rates, resulting in a decline in average lending rates.

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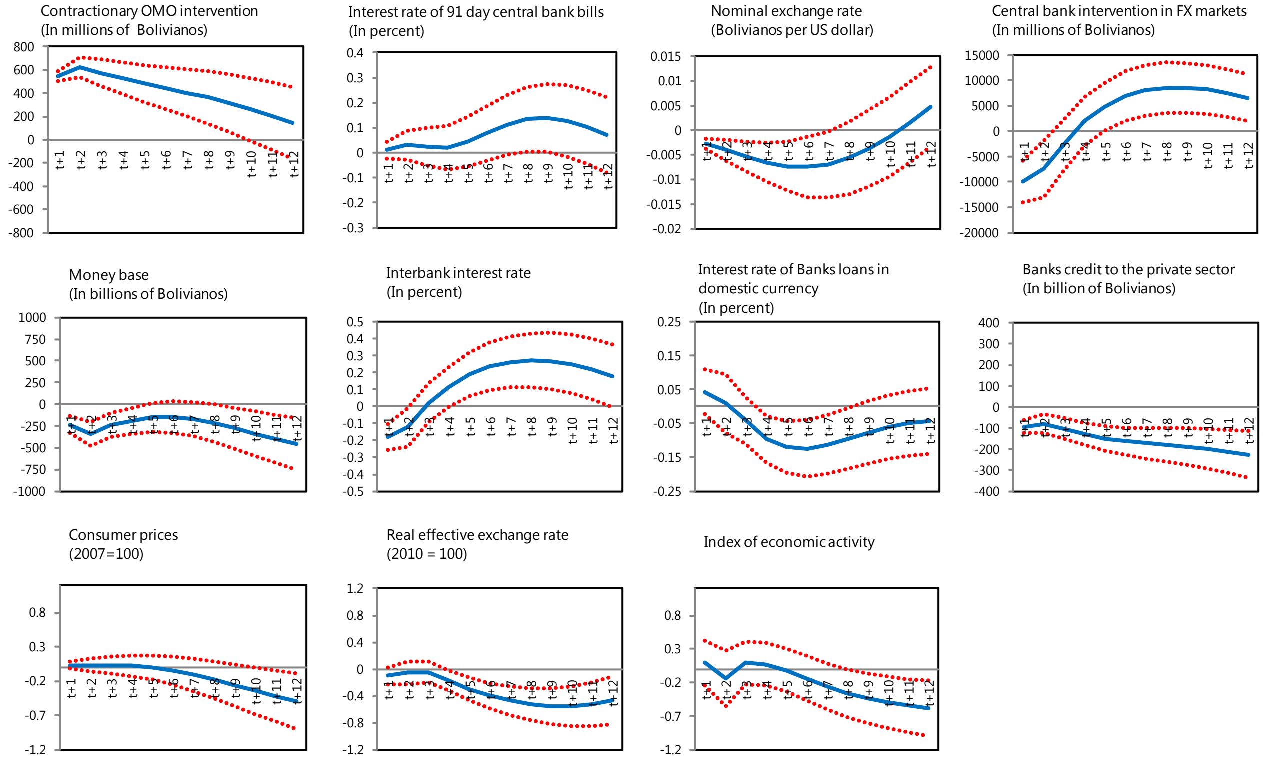
[14] Central bank intervention in foreign exchange markets and the monetary base are not shocked, despite having been categorized as within the instruments category in the variance decomposition analysis in section III. This is because these two indicators are not direct intervention instruments, although they form a core part of the central banks' quantitative targets framework.

[15] These results are consistent with those in Rocabado and Gutierrez (2009), based on individual bank data.

Figure 7. Increase in the Stock of Central Bank's Open Market Operation Bills

(Impulse-response function to a 1 std. dev. shock)



Source: author's calculations based on data from the Central Bank of Bolivia.

Liquidity absorption also has a contractionary impact on economic activity, while relaxing demand pressures on prices. In the fourth quarter after the OMO intervention economic activity slows down and the price level declines (figure 7, third row charts). The appreciation of the real exchange rate is consistent with the trajectory of the nominal exchange rate explained above. The impulse response analysis indicates that the increase in the stock of OMO would relieve these demand pressures on the real exchange rate after about one year.

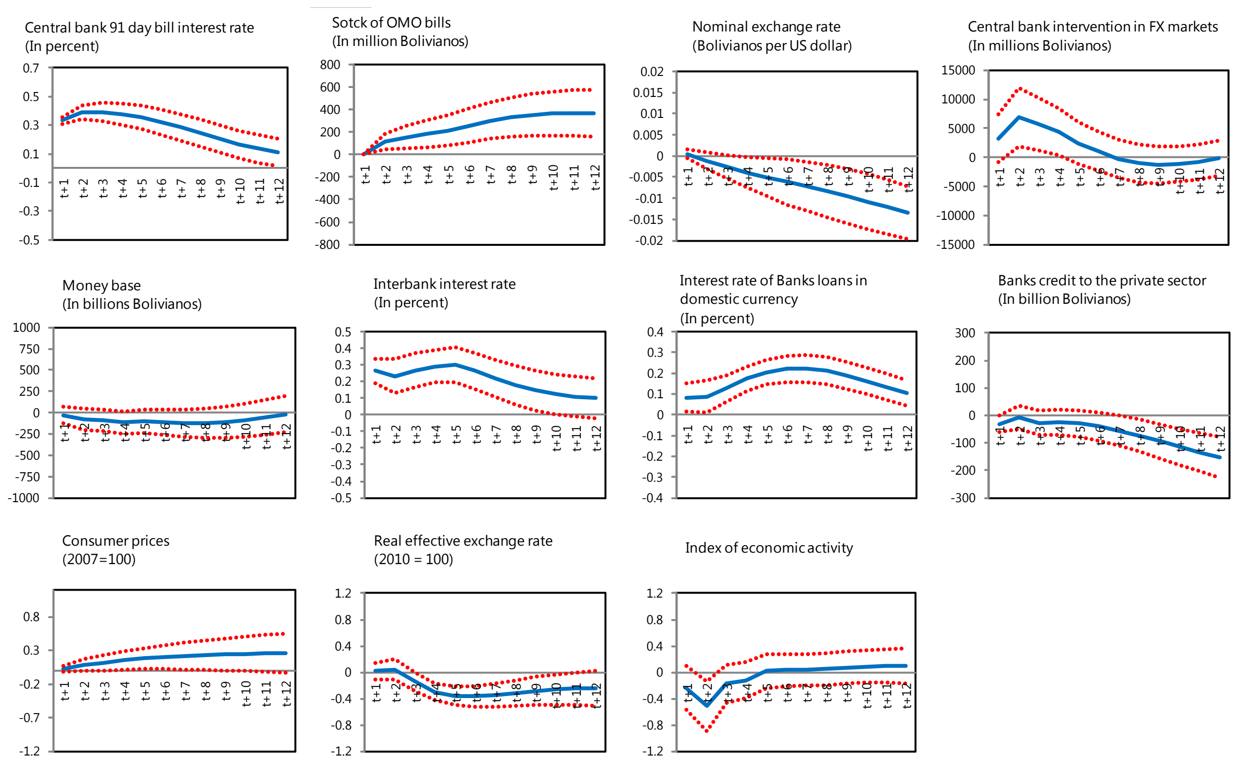
The increase in OMO interest rates also has a contractionary impact, and has a more clear effect on lending rates. OMO intervention can be an instrument to affect short-term interest rates if the central bank focused on the cutoff rate of the OMO bills bidding process, as opposed to on quantitative measures of liquidity.[16] It is therefore interesting to analyze the transmission and impact that follow the movements in the central bank bills' cutoff interest rates, even though these are not the primary focus of the central bank. This is because it may be a way to identify OMO interventions in response to demand shocks. As expected, the impulse response functions are in general similar to those for an OMO volume shock, and

[16] Vegh (2001) derives some basic equivalences among different policy rules, and shows that, under certain conditions, the following three rules are equivalent: (i) a "k-percent" money growth rule; (ii) a nominal interest rate rule combined with an inflation target; and (iii) a real interest rate rule combined with an inflation target.

take the expected direction (Figure 8). These increases in interest rates are associated with periods of liquidity withdrawal by the central bank and a decline in base money.

Figure 8. Increase in the Interest Rate on Central Bank's 91-day Bills

(Impulse-response functions to a 1 std. dev. shock)



Source: author's calculations based on data from the Central Bank of Bolivia.

However, credit transmission channels appear to operate more directly than in the case of the OMO sterilizing intervention. Higher OMO bills cutoff rates are followed by increases in interbank and lending rates—the later capture the full impact with a lag of about six months, possibly as a result of rigidities affecting the speed of adjustment in lending rates—and lower volume of bank credit. These increases also tend to occur under conditions in which demand pressures appear to dominate, with prices above normal and real exchange rate appreciation. [17] An important corollary of this result is that a monetary policy more focused on interest rates instead of liquidity volumes may be as effective in the face of demand shocks.

A monetary policy more focused on interest rates could therefore be conducive to managing inflation and output volatility. In this case, the monetary policy stance could be

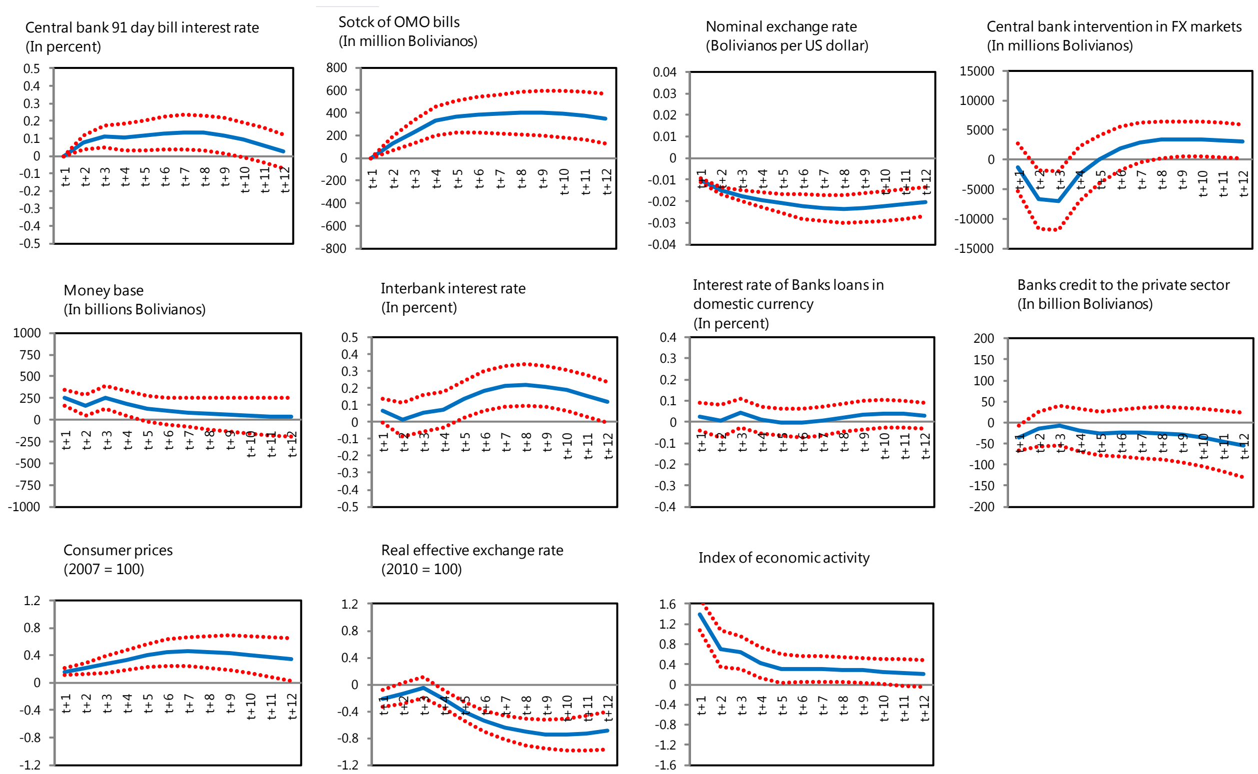
[17] The result of an increase in the price level following a positive shock in central bank policy rates is often found in VAR analysis, and is referred to as the "price puzzle". The interpretation in this paper, however, abstracts from assuming any causal relation between policy interest rates and inflation.

evaluated around inflation and output deviations from targets, and managed with indirect instruments such as a short-term policy interest rate with a more direct impact on lending interest rates, as the empirical results in this paper indicate. For this to be effective, however, it is important that inflation expectations are well anchored over the medium term, so that short-term deviations in inflation as a result of shocks do not materially feed into inflation expectations that require a pro-cyclical tightening in the face of negative supply shocks.

The possibility that inflation expectations are anchored on the exchange rate makes it informative to evaluate the economic response to a nominal exchange rate shock. The central bank explicitly recognizes that the exchange rate stability observed since 2006 has been one of the pillars of price stability. Also, given the historical experience of high inflation and dollarization discussed earlier, nominal exchange rate dynamics likely play a key role in the formation of inflation expectations. The impulse response functions to shock in the nominal exchange rate can shed some light on these ideas. The results are displayed in Figure 9.

Figure 9. Depreciation of the Central Bank Exchange Rate

(Impulse-response functions to a 1 std. dev. shock)



Source: author's calculations based on data from the Central Bank of Bolivia.

The results suggest that the exchange rate has been used as an additional instrument to control inflation, in support of the other main instruments. Since 2006, its use has been relatively sporadic and in more measured amounts than the OMO interventions. However, impulse response analysis reveals that the circumstances under which the central bank allowed a currency appreciation have in general coincided with periods in which the monetary policy stance was contractionary, in the context of inflation pressures. The results in Figure 9 show that appreciations of the Boliviano/USD rate on average took place during periods of an increase in the stock of central bank bills and higher interbank interest rates, higher levels of base money, inflation pressures, and relatively high levels of economic activity. These interventions did not appear to be related to changes in banks' lending rates or volumes. However, they appear to have triggered lower purchases of foreign exchange at the central bank window.

The responses to an exchange rate shock should be interpreted with caution. If taken at face value, they would indicate that, for example, an exchange rate depreciation by the central bank could be followed by declines in interest rates. Moreover, it would not trigger an increase in the demand for foreign exchange, as indicated by the response of the central bank purchases of foreign exchange. However, these results could be misleading, in the sense that the responses may be different under different circumstances. As mentioned above, the period in which these estimates are based (2006-2015) includes a sustained appreciation of the real exchange rate, in a context of high GDP growth of around 5 percent per year, inflation relatively stable by historical standards, a sustained increase in the demand for domestic currency, and de-dollarization. This happened in the context of a boom in export prices and an expansion in government expenditures. Under these circumstances, the exchange rate remained mostly unchanged, and the few changes observed were appreciations. The dynamics captured by the model are specific to this context. Under less benign conditions consistent with a currency depreciation, these dynamics may follow a very different pattern, particularly if inflation expectations were anchored on the nominal exchange rate.

VI. Conclusions and Challenges Ahead

The Bolivian monetary policy framework has been effective in controling inflation since 2006. The results in this paper indicate that the central bank responded decisively with liquidity withdrawal when inflation trended above target levels in the monetary program, and supplied additional liquidity to support aggregate demand during economic slowdowns. These interventions are found to have a significant transmission power, affecting bank lending activities and ultimatelly economic activity and the price level. Inflation stabilization was also supported by an exchange rate peg to the US dollar, which has remained unchanged since 2011 and showed only small and apreciating variations since 2008. The results also indicate that the exchange rate was ocassionally used as an additional instrument to address inflation pressures.

Higher central bank tolerance to short term deviations in inflation from the programed target could be considered as a way to facilitate a smoother cyclical adjustment in the face of shocks. The results in this paper can not reject the possibility that the central bank appears to intervene to stabilize near-term inflation, to keep it as close as possible to the indicative target in the monetary program. Although this reaction would be warranted if there was a need to prevent second-round inflation effects, a higher tolerance to deviations in inflation in the medium term could facilitate the real economic adjustment to shocks, provided inflation expectations are well anchored. To this end, the central bank would possibly need to set up policies that facilitate the delinking of inflation expectations away from the exchange rate.

Also, more exchange rate flexibility could facilitate an economic adjustment if a deterioration in economic conditions was highly persistent. Clearly, there are costs to allowing more exchange rate flexibility, for example if inflation expecations appear anchored on the exchange rate. If this was the case, a central bank could find it optimal to delay its decision to allow a currency to depreciate in the face of a negtive shock, under the expectation that conditions might revert and improve. However, if there are reasons to expect that weaker conditions are persistent, an excessive delay could be costly, involve excessive loss of international reserves, and disrupt economic activity further. Rebelo and Vegh (2008) show that delaying the abandonment of a peg and allowing a loss of reserves in the face of a permanent fiscal shock is suboptimal, and that the optimal exit timing is a decreasing function of the size of the fiscal shock. The results in Asici et. al. (2008) suggest that post-exits are better when the abandonment of a currency peg occurs under good macroeconomic conditions.

The results suggest that transitioning to a monetary policy framework with two-sided exchange rate flexibility and using interest rates as the primary instrument is worth consideration. Carefull planning, including the development of appropriate money and exchange rate markets' infrastructure, are key ingredients for a smooth transition**.** Drawing examples from recent economic history, Eichengreen (1999) offers practical suggestions and a framework under which the probability of a smooth transition can be maximised. Duttagupta et. al (2004) identify institutional and operational requisites for transitions to floating exchange rate regimes. In particular, they explore key issues underlying the transition, including developing a deep and liquid foreign exchange market, formulating intervention policies consistent with the new regime, establishing an alternative nominal anchor in the context of a new monetary policy framework, and building the capacity of market participants to manage exchange rate risks and of supervisory authorities to regulate and monitor them. They also assess the factors that influence the pace of exit and the appropriate sequencing of exchange rate flexibility and capital account liberalization. Some country experiences indicate that a transition to prepare for a more flexible exchange rate policy requires carefull planing, and could take several years. The Polish monetary strategy toward higher monetary and exchange rate flexibility has been performed smoothly, gradually and planned, resulting in a better transition compared to the Slovak and Czech cases.[18] If properly managed, this transition can be smooth. Eichengreen and Rose (2011) identify 51 instances since 1957 when an economy abandoned a fixed exchange rate for greater flexibility and saw its currency appreciate or remain broadly unchanged.

The results indicating a robust monetary policy transmission through the central bank bill rate could be a stepping stone towards a framework with more exchange rate flexibility. The success of such a monetary policy regime would depend on two factors: (i) maintaining a solid fiscal position and (ii) strengthening institutions for central bank independence. The first factor is critical to make any commitment to inflation over the medium term credible, regardless of the monetary policy framework in place. The fiscal

[18] See Josifidis, Allegret, and Beker Pucar (2009).

stance needs to be anchored on medium-term fiscal plans that ensure public debt sustainability and on solid fiscal institutions (i.e. the budget process; a medium term fiscal framework; fiscal rules; etc.) that make these plans credible. Bolivia has already made progress in the implementation of a medium-term fiscal framework. Credible institutions are important to ensure that the central bank has the authority to act when inflation stabilization objectives enter in conflict with other government objectives. This potential conflict has so far not emerged given ample liquidity from hydrocarbon exports since 2006, but could well under less favorable conditions. Given the latter, it is important that a central bank is appropriatelly capitalized, so that its ability to back up its monetary liabilities do not depend on discretionary government transfers.

Appendix I. Model Diagnostic Tests

Unit Root Tests

Null Hypothesis: OMO has a unit root (H0)

	Augm. Dickey-Fuller Test t-stat.	Augm. Dickey-Fuller Test Prob. H0	Phillips-Perron Test Adj. t-stat.	Phillips-Perron Test Prob. H0
Open Market Operation Stock	-0.689	0.846	-0.038	0.953
Interest rate on 91 day central bank bills	-1.776	0.391	-1.341	0.608
Nominal exchange rate	-2.232	0.196	-2.101	0.245
Central bank intervention in FX market	-3.821	0.004	-4.010	0.002
Base money	0.079	0.963	-0.370	0.909
Interbank interest rate	-1.721	0.418	-1.897	0.333
Banks' lending rate in domestic currency	-2.471	0.125	-2.405	0.143
Banks' loans	3.660	1.000	5.085	1.000
Consumer price index	-0.430	0.899	-0.154	0.940
Real effective exchange rate	-0.174	0.937	-0.394	0.905
Index of economic activity	3.024	1.000	-3.427	0.012

Sample is January 2006 to June 2015.
t-statistic estimates including a constant and no trend.

Cointegration Test 1: Unrestricted Cointegration Rank

	No deterministic trend				No deterministic trend (restricted constant)				Linear deterministic trend				Linear deterministic trend (restricted)				Quadratic deterministic trend			
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.666	462.1	263.3	0.000 *	0.671	512.4	298.2	0.000 *	0.628	467.7	285.1	0.000 *	0.632	502.6	322.1	0.000 *	0.623	448.8	306.9	0.000 *
At most 1	0.564	355.6	219.4	0.000 *	0.566	404.5	251.3	0.000 *	0.565	371.7	239.2	0.000 *	0.572	405.7	273.2	0.000 *	0.546	354.2	259.0	0.000 *
At most 2	0.522	275.0	179.5	0.000 *	0.548	323.5	208.4	0.000 *	0.519	291.0	197.4	0.000 *	0.524	323.4	228.3	0.000 *	0.452	277.6	215.1	0.000 *
At most 3	0.446	203.4	143.7	0.000 *	0.457	246.5	169.6	0.000 *	0.429	220.0	159.5	0.000 *	0.436	251.3	187.5	0.000 *	0.431	219.3	175.2	0.000 *
At most 4	0.378	146.2	111.8	0.000 *	0.394	187.3	134.7	0.000 *	0.375	165.6	125.6	0.000 *	0.395	195.8	150.6	0.000 *	0.348	164.6	139.3	0.001 *
At most 5	0.284	100.1	83.9	0.002 *	0.370	138.7	103.8	0.000 *	0.347	120.0	95.8	0.000 *	0.348	147.0	117.7	0.000 *	0.320	123.1	107.3	0.003 *
At most 6	0.270	67.7	60.1	0.010 *	0.270	93.9	77.0	0.002 *	0.269	78.6	69.8	0.008 *	0.297	105.5	88.8	0.002 *	0.294	85.6	79.3	0.016 *
At most 7	0.189	37.2	40.2	0.097	0.239	63.4	54.1	0.006 *	0.189	48.2	47.9	0.047 *	0.268	71.3	63.9	0.010 *	0.238	51.9	55.2	0.096
At most 8	0.102	16.9	24.3	0.317	0.188	36.9	35.2	0.032 *	0.121	27.8	29.8	0.083 *	0.187	41.0	42.9	0.077	0.125	25.5	35.0	0.356
At most 9	0.064	6.5	12.3	0.382	0.102	16.7	20.3	0.145	0.099	15.4	15.5	0.052	0.120	20.9	25.9	0.185	0.091	12.5	18.4	0.274
At most 10	0.000	0.0	4.1	0.917	0.062	6.3	9.2	0.172	0.052	5.2	3.8	0.023 *	0.083	8.5	12.5	0.217	0.033	3.2	3.8	0.073
Result	7 cointegrating eqn(s) at the 0.05 level				9 cointegrating eqn(s) at the 0.05 level				8 cointegrating eqn(s) at the 0.05 level				8 cointegrating eqn(s) at the 0.05 level				7 cointegrating eqn(s) at the 0.05 level			

Cointegration Test 2: Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.666	106.5	67.1	0.000 *	0.671	107.9	71.3	0.000 *	0.628	96.0	70.5	0.000 *	0.632	97.0	74.8	0.000 *	0.623	94.6	73.9	0.000 *
At most 1	0.564	80.6	61.0	0.000 *	0.566	81.0	65.3	0.001 *	0.565	80.7	64.5	0.001 *	0.572	82.3	68.8	0.002 *	0.546	76.6	67.9	0.006 *
At most 2	0.522	71.6	55.0	0.001 *	0.548	77.0	59.2	0.000 *	0.519	71.0	58.4	0.002 *	0.524	72.1	62.8	0.005 *	0.452	58.3	61.8	0.104
At most 3	0.446	57.3	48.9	0.005 *	0.457	59.2	53.2	0.011 *	0.429	54.4	52.4	0.030	0.436	55.6	56.7	0.065	0.431	54.7	55.7	0.063
At most 4	0.378	46.1	42.8	0.021 *	0.394	48.7	47.1	0.034 *	0.375	45.6	46.2	0.058	0.395	48.8	50.6	0.076	0.348	41.5	49.6	0.270
At most 5	0.284	32.3	36.6	0.145	0.370	44.8	41.0	0.018 *	0.347	41.4	40.1	0.036 *	0.348	41.5	44.5	0.103	0.320	37.5	43.4	0.193
At most 6	0.270	30.5	30.4	0.049 *	0.270	30.5	34.8	0.148	0.269	30.4	33.9	0.122	0.297	34.2	38.3	0.139	0.294	33.7	37.2	0.117
At most 7	0.189	20.3	24.2	0.155	0.239	26.5	28.6	0.091	0.189	20.3	27.6	0.320	0.268	30.3	32.1	0.082	0.238	26.4	30.8	0.158
At most 8	0.102	10.5	17.8	0.438	0.188	20.3	22.3	0.094	0.121	12.5	21.1	0.500	0.187	20.1	25.8	0.236	0.125	13.0	24.3	0.679
At most 9	0.064	6.4	11.2	0.302	0.102	10.4	15.9	0.296	0.099	10.2	14.3	0.202	0.120	12.4	19.4	0.378	0.091	9.3	17.1	0.466
At most 10	0.000	0.0	4.1	0.917	0.062	6.3	9.2	0.172	0.052	5.2	3.8	0.023 *	0.083	8.5	12.5	0.217	0.033	3.2	3.8	0.073
Result	5 cointegrating eqn(s) at the 0.05 level				6 cointegrating eqn(s) at the 0.05 level				4 cointegrating eqn(s) at the 0.05 level				3 cointegrating eqn(s) at the 0.05 level				2 cointegrating eqn(s) at the 0.05 level			

* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values
Sample (adjusted): 2006M03 2014M03
Included observations: 97 after adjustments
Trend assumption: No deterministic trend
Series: OMO I_BCB_91D NER_BCB BOLSIN_FC M0 I_INTBNK_DC I_CRD_DC CRD_BNK_TOTAL P REER IGAE
Exogenous series: JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV
Lags interval (in first differences): 1 to 1

VAR Residual Normality Tests

Null Hypothesis: residuals are multivariate normal

Component	Skewness	Chi-sq	Prob.	Kurtosis	Chi-sq	Prob.	Jarque-Bera	Prob.
1	0.421	3.048	0.081	3.048	0.056	0.813	3.104	0.212
2	-1.565	42.125	0.000	10.193	247.940	0.000	290.065	0.000
3	-0.169	0.489	0.484	3.213	0.353	0.552	0.842	0.656
4	1.233	26.154	0.000	8.617	151.932	0.000	178.086	0.000
5	0.174	0.518	0.472	3.995	5.253	0.022	5.771	0.056
6	-0.156	0.419	0.518	2.776	0.124	0.724	0.543	0.762
7	-0.030	0.016	0.901	2.897	0.008	0.929	0.024	0.988
8	1.356	31.602	0.000	8.975	171.703	0.000	203.305	0.000
9	0.783	10.546	0.001	3.789	3.409	0.065	13.954	0.001
10	-0.182	0.570	0.450	3.069	0.080	0.777	0.650	0.723
11	0.206	0.729	0.393	2.895	0.009	0.924	0.739	0.691

Orthogonalization: Residual Covariance (Urzua)
Sample: 2006M01 2015M06

Chi-squared test statistics for lag exclusion

Numbers in the second row are probability-values

	OMO	I_BCB_91D	NER_BCB	BOLSIN_FC	M0	I_INTBNK_DC	I_CRD_DC	CRD_BNK	P	REER	IGAE
Lag 1	123.15	179.01	239.43	33.01	54.82	67.46	21.70	62.18	183.42	42.37	16.49
	0.00000	0.00000	0.00000	0.00052	0.00000	0.00000	0.02678	0.00000	0.00000	0.00001	0.12398
Lag 2	10.79	32.69	33.00	7.96	31.73	13.99	9.53	17.23	27.77	17.13	8.52
	0.46094	0.00059	0.00053	0.71679	0.00084	0.23336	0.57327	0.10123	0.00351	0.10400	0.66646
Lag 1	106.18	81.63	134.34	25.72	36.70	42.52	18.27	46.99	118.13	24.07	12.16
	0.00000	0.00000	0.00000	0.00715	0.00013	0.00000	0.07562	0.00000	0.00000	0.12430	0.35189
Lag 2	15.13	8.22	11.36	5.64	23.70	8.05	7.20	16.38	11.76	6.33	10.45
	0.17652	0.69371	0.41377	0.89635	0.01405	0.70854	0.78265	0.12749	0.38158	0.85019	0.49083
Lag 3	15.80	8.61	8.57	18.56	9.03	11.98	12.21	39.81	3.79	7.41	14.06
	0.14854	0.75659	0.66174	0.06955	0.61882	0.36501	0.34770	0.00000	0.97576	0.76503	0.22967

Sample: 2006M01 2015M06

VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-6297.63	NA	4.2E+44	133.9506	137.4766	135.3759
1	-4941.636	2062.241	3.08E+33	108.2216	114.9797*	110.9533*
2	-4793.073	191.8934	2.22E+33	107.6474	117.6376	111.6856
3	-4641.983	160.5332*	2.00e+33*	107.0205*	120.2429	112.3652

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

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