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Inflation Targeting in Colombia, 2002–12

Over the last twenty years, nearly thirty countries have adopted inflation-targeting regimes to conduct monetary policy. In addition to the announcement of specific inflation targets, inflation-targeting regimes have been characterized by increased transparency, enhanced communication with the public, and explicit accountability mechanisms. Moreover, their policy strategy is based on setting short-run interest rates rather than on targeting monetary aggregates. In principle, inflation-targeting regimes also increase exchange rate flexibility.

The performance of inflation-targeting regimes has been a matter of extensive research. For instance, Ball and Sheridan and Lin and Ye conclude that in industrialized countries, inflation targeting did not make a difference in inflation and output behavior.¹ The spirit of these conclusions is echoed in two recent surveys on the performance of inflation targeting.² Another line of research on inflation targeting in industrialized countries studies its impact on sacrifice ratios—output losses per point of inflation during monetary-driven disinflations. According to proponents, inflation targeting anchors inflation expectations, and it should thus allow for less costly disinflation processes. While Gonçalves and Carvalho find strong evidence supporting this hypothesis in developed countries, Brito shows that the results are not robust to the inclusion of time effects.³ De Roux and Hofstetter conclude that inflation

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This paper was written for the Inter-American Development Bank (IDB) project “Towards a ‘New’ Inflation-Targeting Framework in Latin America and the Caribbean.” We thank the IDB Research Network for financial support and feedback. We are also grateful to Andrés Fernández and an anonymous referee for valuable comments. Excellent research assistance by Rafael Hernández and Emilio Wills is also acknowledged.

1. Ball and Sheridan (2005); Lin and Ye (2007).
2. Ball (2010); Walsh (2009).
3. Gonçalves and Carvalho (2009); Brito (2010).

targeting allows for less costly disinflations even when controlling for time effects, but only if disinflations are slow.⁴ For fast disinflations, it does not yield less costly disinflations.

For developing countries, the evidence is less conclusive. Gonçalves and Salles find that inflation targeting allows for a greater reduction in inflation and lower output volatility, a result confirmed by Lin and Ye.⁵ Brito and Bystedt, however, suggest that the greater inflation reduction came at the expense of poorer output growth.⁶ In the surveys, Walsh concludes that evidence on inflation targeting in developing countries is clearly favorable to the regime, while Ball is more skeptical, calling the outcomes inconclusive.⁷

More recently, de Carvalho Filho shows that during the recent global financial crisis, inflation-targeting nations outperformed non-inflation-targeting nations on several dimensions for both developed and developing economies: their policy response was more aggressive, they allowed the exchange rate to more effectively absorb the shocks, and they recorded a stronger macroeconomic performance (output, industrial production, and unemployment).⁸

The vast empirical literature comparing performance across different monetary regimes stands in contrast to the relatively scant research on the tools, strategies, goals, and dilemmas faced by inflation-targeting central banks, especially in developing countries. While there is good information on the overall comparative performance of these regimes, little information is available on the political economy dimensions, the increasing variety of instruments and goals of inflation-targeting central banks, and the challenges that lie ahead for them.

In this paper, we fill part of this gap by examining the experience of the Central Bank of Colombia (Banco de la República) over the last decade, a period of consolidation and innovation of its inflation-targeting strategy. Colombia is one of five large Latin American economies that have well-established inflation-targeting regimes, along with Brazil, Chile, Mexico, and Peru. All of these countries adopted inflation targeting more than ten years ago, yet their performance, tools, and goals have not been extensively studied. Central banks in the region have used a variety of tools beyond short-run policy interest rates, including liquidity and reserve requirements, credit provisions, capital controls, and interventions in the foreign exchange markets.

4. De Roux and Hofstetter (2012).

5. Gonçalves and Salles (2008); Lin and Ye (2009).

6. Brito and Bystedt (2010).

7. Walsh (2009).

8. de Carvalho Filho (2011).

We employ several strategies to study these issues. We propose and estimate a small-scale open economy policy model for the Colombian economy. This allows us to pinpoint crucial parameters through which we can study some of the policy trade-offs and policy reactions of the central bank. We also provide narrative and anecdotal evidence for understanding some important episodes, tools, challenges, and trade-offs that marked the first decade of inflation targeting.

Several findings are worth noting. Our model's estimates suggest that the impact of foreign variables on domestic outcomes is small and often insignificant. The pass-through of foreign shocks to domestic inflation and economic activity is negligible. While these findings might be surprising, they are consistent with other papers.⁹

Despite the estimated dichotomy between the foreign and domestic blocks of our model, the results also suggest that real exchange rate misalignments trigger foreign exchange interventions by the central bank. Moreover, the interventions have a short-lived impact on the exchange rate. Why does the central bank react to the exchange rate if its impact on output and inflation is negligible? The hypothesis is that some of the interventions are explained by political economy issues. The central bank has intervened in the foreign exchange market at times of strong political and media pressure to do so.

The foreign exchange interventions have been sizable: they have almost quadrupled international reserves over the last decade. This paper explores, in both the model and the narrative sections, whether these interventions have come at the cost of sacrificing the inflationary anchor or losing the credibility of the regime. It concludes that even though the Central Bank of Colombia has moved away from a purely floating inflation-targeting regime, the inflationary anchor and the credibility of the regime have not been affected.

A related result studied is the buildup of international reserves. This poses new challenges for the central bank, particularly recently, when yields on international reserves have been so low that they endanger the bank's budgetary independence. We propose creating a sovereign fund that would be shielded from some of the problems that the central bank would have if it tried to invest part of its international reserves more aggressively.

The rest of this paper is organized as follows. The next section presents a brief account of the road that led to the adoption of inflation targeting in Colombia by the turn of the century. The two subsequent sections present and estimate a simple macroeconomic policy model. The paper describes some

9. For example, Gómez, Uribe, and Vargas (2002); Rowland (2004).

trade-offs, political economy issues, and challenges faced by the central bank during the 2002–12 decade, including the buildup of international reserves, the role of financial stability and supervision, political pressures, and the use of a reserve requirement. The challenges in these areas are highlighted and policy recommendations are provided when appropriate. The final section concludes.

The Road to Inflation Targeting in Colombia

In 1999, Colombia abandoned the crawling peg that had been in place for thirty-two years and formally adopted the monetary policy of inflation targeting.¹⁰ During the crawling-peg and crawling-band era, the monetary instrument was the imperfect control of M1; afterwards, the central bank started using the short-run policy interest rates as the main policy tool.

Colombia began the transition to inflation targeting in 1991, when a new constitution conferred greater independence on the central bank's board and defined its principal function as maintaining the value of the national currency. In 1992, an amendment mandated that the board would announce annual inflation targets.

The 1991 reforms determined that the central bank's board would have seven members, including the finance minister, who would head the board. The other members are the governor of the central bank—named by the rest of the board members for four-year periods, with a maximum of two reelections—and five independent members. The latter are named by the president, with the caveat that the president can only name two members during the second half of his or her mandate. This structure was originally designed to guarantee that most of the board would be elected by previous presidents to ensure its independence. Nevertheless, in 2005 a constitutional change allowed for the president to be reelected once, so that toward the end of a potential second presidential term, the president could have chosen four of the members of the board.

In the first seven years following the reform, control of monetary aggregates was difficult, and inflation was slowly reduced from the 32 percent per year recorded in 1991. Between 1992 and 1999, the central bank instituted policies to deepen the money market and free different types of interest rates, while the Ministry of Finance actively created a market in government debt

10. From 1994 to 1999, the exchange rate floated within a crawling band.

in pesos by taking advantage of the declining inflation rate. These institutional changes facilitated a more effective use of interest rates as the monetary policy tool.

Full-fledged inflation targeting required more room to float the exchange rate. After more than a quarter of a century with a crawling peg and a few years with an exchange rate band, there were deep political constraints to floating the exchange rate. The crawling peg had been a popular policy, since many government officials and export lobbyists believed it was essential for stabilizing the exchange rate. By the 1980s, the export lobby had become the most influential lobby. As capital flows and oil development increased the supply of foreign exchange in that decade, the export lobbyists—fearing revaluation—mobilized against any policy that would free the exchange rate.

These exchange rate regimes, however, made the control of monetary aggregates difficult in the 1990s, amidst unprecedented volatility of capital flows—sharp inflows in the early part of the decade and outflows in the latter part of the decade. The export lobbyists favored floating only when the persistent and strong market pressure for devaluation that followed the Asian and Russian crises arose in the late 1990s. When this cornerstone was finally in place, Colombia adopted a full-fledged inflation-targeting policy framework in 1999. The legal changes in the early 1990s and the economic circumstances over the following years paved the way for the adoption of inflation targeting by the turn of the century.

In its early stages, the monetary strategy was a textbook inflation-targeting system. Gómez, Uribe, and Vargas identify three key aspects of the Colombian transmission mechanism: a persistent inflation process, a strong aggregate demand channel, and a relatively weak and indirect exchange rate effect.¹¹ The board's monetary policy concentrated on setting interest rates, taking into account the projection of inflation and the output gap. Exchange rate intervention was not in the toolkit, except for the necessary buildup of international reserves that had been partially depleted after the crisis, according to the standby arrangement with the International Monetary Fund (IMF). The central bank's toolkit expanded significantly over the following decade to include systematic foreign exchange interventions, capital controls, changes in reserve requirements, and changes in credit provisions.

Our analysis is divided into two parts. First, we estimate a small-scale macroeconomic model. The results of the model will be an input for analyzing the central bank's performance in the inflation-targeting era. Second, we

11. Gómez, Uribe, and Vargas (2002).

analyze the details of the trade-offs, pressures, operational characteristics, and the like for the central bank during the first decade of inflation targeting. This narrative section provides insights beyond those included in the model by emphasizing several political economy dimensions, while adding to the interpretations and policy lessons of the model's empirical findings.

The Model

We start with a three-block model à la Galí and Gertler, summarizing economic activity (via an investment-saving, or IS, curve), the determination of inflation (via a Phillips curve), and the monetary policy reaction function (via a Taylor rule).¹² We adapt these equations to Colombia and expand them to incorporate open economy dimensions that are crucial for understanding the policy options and dilemmas of the central bank.

Variables are expressed in deviations from trend—or long-run values—unless otherwise stated. A superscript e denotes the one-step-ahead expected value of the variable conditioned on all available information at date t . The symbol ε_t^j denotes a shock to variable j at time t .

Equation 1 represents an expectations-augmented Phillips curve:

$$(1) \quad \pi_t = a_0 \pi_t^e + (1 - a_0) \pi_{t-1} + a_1 d_t + a_2 y_t + \varepsilon_t^\pi,$$

where π_t is the annual inflation rate (in deviation from the inflation target); π_{t-1} is the lagged inflation rate; π_t^e are inflation expectations; d_t denotes the nominal depreciation rate; y_t is the output growth gap, defined as the deviation of observed annual GDP growth from its long-run value, which we assume is exogenous to the model; and ε_t^π is a supply shock.

Lagged inflation captures the inertia of the inflationary process or the adaptive component of expectations, while π_t^e captures the forward-looking component. The sum of their corresponding coefficients is one because in the steady state the observed inflation rate should converge to the inflation target, that is, $\pi_{t-1} = \pi_t = \pi_t^e = \bar{\pi}$, where $\bar{\pi}$ is the central bank inflation target. The term $a_1 d_t$ describes the potential pass-through effects from the nominal exchange rate to prices.

The second equation of the model is the IS curve:

$$(2) \quad y_t = b_0 y_{t+1}^e - b_1 r_t + b_2 e_t + \varepsilon_t^y,$$

12. Galí and Gertler (2007).

where r_t is the real interest rate (ex post), y_t^e is the expected output growth gap, e_t is the real exchange rate, b_2 links output to the exchange rate, and ε_t^y is the demand shock. This IS curve takes into account the effects of the real exchange rate on the output growth gap. The implicit assumption is that net exports are part of aggregate demand, and they depend on the real exchange rate.¹³ Whether the parameter b_2 is positive or negative has been a matter of debate. Some analysts argue that it should be positive because a real depreciation stimulates exports and deteriorates imports; others hold that real exchange rate depreciations are mostly associated with recessions and not with expansions.

For the central bank's policy reaction functions, it is important to have some background on the central bank's targets and policy instruments. Although the bank officially pursues an inflation-targeting regime, it actually has several targets, such as inflation, economic activity, financial stability, the exchange rate, and international reserves. This variety of goals creates the potential for trade-offs and conflicts, and it requires a variety of instruments. The central bank has thus used different tools during the inflation-targeting era. The two most important tools are the policy interest rate and interventions in the foreign exchange market, which are incorporated in the model. To a lesser extent, the central bank has also used macroprudential policies, reserve requirements, and capital controls. While these are not explicitly modeled, they are discussed later in the paper.

The way the central bank sets the nominal interest rate is modeled using a Taylor rule. As a starting point, we use a simple interest rate rule that captures the basic logic of the conventional monetary policy instrument, where the bank reacts to output and inflation gaps. The short-term interest rate is defined as

$$(3) \quad i_t = c_0 i_{t-1} + c_1 \pi_t + c_2 y_t + \varepsilon_t^i,$$

where i_t is the (domestic) nominal interest rate, defined as $i_t = r_t + \pi_t^e$. When the analysis delves deeper into foreign exchange intervention, we modify the interest rate rule.

Before describing the second instrument, foreign exchange interventions, we introduce the foreign block of equations in the model. We follow Ostry, Ghosh, and Chamon, who model the determination of the real exchange rate through the balance of payments (capital flows, the current account, and

13. We also assume that the foreign output gap does not affect net exports. This assumption is for convenience because we do not have good monthly estimates of foreign economic activity.

reserve accumulation).¹⁴ The capital flows and the current account are linked through the balance-of-payments identity:

$$(4) \quad k_t + ca_t = x_t,$$

where x_t represents the net foreign exchange purchases of the central bank. Capital flows, assumed to be imperfectly mobile, are described as

$$(5) \quad k_t = d_0 k_{t-1} + d_1 \left[r_t - r_t^* - (e_t^e - e_t) \right] + e_t^k,$$

where k_t is net capital flows and d_1 is a parameter that captures the degree of capital mobility. We expect this parameter to be positive, as the larger the interest rate differential, the greater the capital inflows. Also, the perfect capital mobility case would correspond to d_1 approaching infinity.

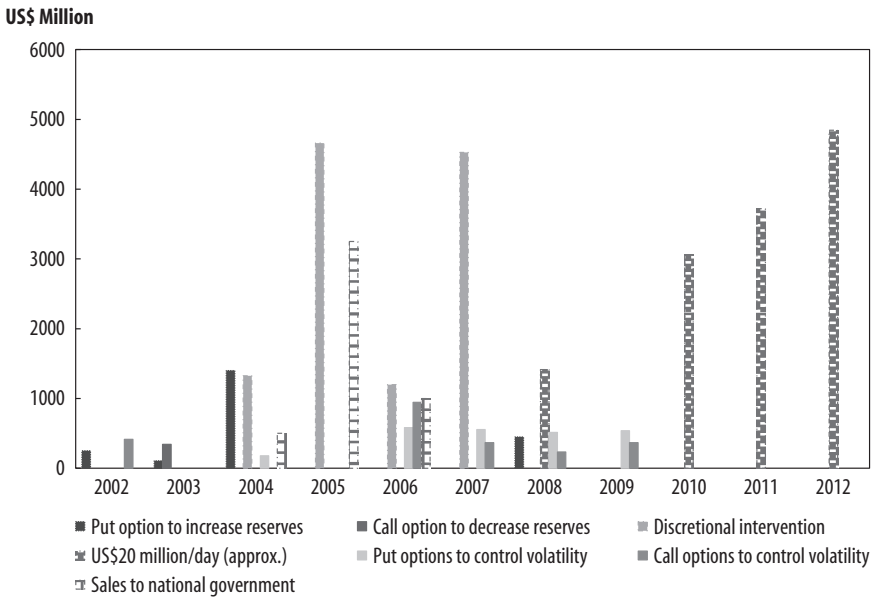
In addition, as is common in macroeconomic programming analysis, the current account, ca_t , depends positively on the real exchange rate and negatively on local domestic activity:

$$(6) \quad ca_t = f_1 e_t - f_2 y_t + \varepsilon_t^{ca}.$$

Thus, we expect f_1 and f_2 to be positive. An unusual rate of appreciation ($e_t < 0$) would imply a deteriorated current account. The opposite would happen if the exchange rate depreciates above its long-run equilibrium depreciation rate. Also, if the output growth gap is positive (negative), we expect a deterioration (improvement) of the current account.

We close the model with a foreign exchange intervention rule. Foreign exchange interventions—while rare at the beginning of this decade—took center stage after 2007. For the purposes of modeling the foreign exchange interventions, the relevant question is how the central bank intervenes. Over the past ten years, the Central Bank of Colombia has used a variety of intervention strategies in the foreign exchange market to fulfill its objectives: options for reserve accumulation, options for controlling volatility, discretionary interventions, and preannounced fixed daily interventions (see figure 1). The options for reserve accumulation are based on put/call option auctions to increase or decrease the amount of international reserves. They were established in November 1999 under the floating exchange rate regime to offset the strong reduction of reserves that took place in 1997–2000. These options were used until September 2004 and then again in the second quarter of 2008.

14. Ostry, Ghosh, and Chamon (2012).

FIGURE 1. Yearly Foreign Exchange Intervention, 2002–12


Exchange rate volatility control operations were the primary mechanism used by the central bank for selling foreign exchange in the period under analysis, when the central bank was eager to accumulate reserves. The central bank reduced its foreign exchange reserves only by this means and by sales to the government.¹⁵ Volatility options allowed the central bank to automatically auction call or put options if the exchange rate was above (call option) or below (put option) its twenty-day rolling average.¹⁶ They were used as both a purchase and a sale mechanism in 2002, 2004, and 2006–09.

In September 2004, the central bank adopted the discretionary interventions that explain most of the purchases in 2004–07. This instrument allowed the board of directors to decide, with no strings attached, the amount and the mechanism used to purchase international reserves. Using this mechanism,

15. The central bank also used the options for reserve accumulation strategy, but only in March and May 2003, selling a total of US\$344.5 million. Sales to the national government accounted for a total of US\$4.75 billion and took place in 2004, 2005, and 2006.

16. This percentage has fluctuated in the past ten years: it began at 4 percent, fell to 2 percent in February 2006, rose to 5 percent in June 2008, and fell back to 4 percent in October 2011.

the central bank purchased international reserves of over US\$4.65 billion in 2005 and US\$4.5 billion in 2007.

By mid-2008, the central bank introduced preannounced fixed daily purchases, which became the most important foreign exchange purchase strategy in the next five years. The idea of the strategy was to announce how much daily intervention there would be over the next few months, in an effort to influence market expectations. Most often, the central bank announced US\$20 million daily foreign exchange purchases over a three- to four-month period. In January 2013, the announced purchases were boosted to US\$30 million per day.

These facts highlight the importance of a monetary policy model to capture the alternative types of foreign exchange intervention used: unexpected discretionary interventions, rule-based interventions, and announced interventions. We therefore incorporate a foreign exchange intervention equation with systematic and nonsystematic components.

The first one works like a Taylor rule: the instrument is net foreign exchange purchases (as a share of the stock of international reserves) and adjusts to meet a real exchange rate target. The second component has two elements: a direct shock, which is interpreted as unexpected foreign exchange interventions, and a news shock, which is interpreted as announcements of planned purchases. Thus, the foreign exchange intervention equation encompasses three types of interventions: rule-based, discretionary, and preannounced:

$$(7) \quad x_t = g_0 x_{t-1} - g_1 e_t + \varepsilon_t^x,$$

which indicates that the bank follows a simple international reserves intervention rule with systematic and nonsystematic components. The first, captured by the first two terms of equation 7, says that when the real exchange rate deviates from its long-run level, the central bank responds systematically by buying or selling international reserves, x_t . That is, a positive real exchange rate gap denotes that the local currency is undervalued with respect to its long-run equilibrium, and the bank sells reserves. The opposite happens if the currency is overvalued.

The second term, ε_t^x , is the nonsystematic component of the intervention. The Colombian experience of the last ten years shows that foreign exchange intervention is performed not only through direct foreign exchange purchases or sales, but also through announcements, threats, and other events that do not necessarily involve any direct intervention. Therefore, we model ε_t^x as the sum of two orthogonal, independent, and identically distributed (i.i.d.) terms:

$$(8) \quad \varepsilon_t^x = u_t + n_{t-1},$$

where the time subscripts of the variables represent the date when they are known to private agents. Thus, n_{t-1} becomes known at the previous month, representing news or all other events that may affect the amount of foreign exchange intervention, even if no intervention happens at all on date t . This way, we seek to capture any event that becomes known to private agents in the month before the central bank surprises them by buying or selling foreign exchange intervention. Also, when $u_t = -n_{t-1}$, the announcement or news might not be transformed into actual interventions.

Just as the standard model assumes that the central bank's actions affect economic activity by changing the nominal interest rate, the nonstandard portion of our model assumes that the second instrument has some degree of effectiveness. A foreign-exchange-purchase shock leads to an adjustment of both capital flows and the current account, which in turn could affect the real exchange rate, output, inflation, and interest rates. Whether the central bank has been effective in influencing the real exchange rate and other variables through the use of all these instruments is an empirical question. To measure the relative importance of discretionary interventions (measured through the importance of u_t) and "announced" interventions (measured through the importance of n_{t-1}), a shock decomposition exercise is performed with the estimated model.

We postulate, and later test the hypothesis, that when the central bank intervenes in the foreign exchange market, it may send conflicting signals about the exchange rate regime. When the central bank sells or purchases reserves, agents will assign a probability—which can be estimated—of being in a peg, instead of a floating regime. Consider two polar cases. In a fixed exchange rate regime, the nominal interest rate would be fully determined by the foreign interest rate, that is, $i_t = i_t^*$; in a floating inflation-targeting regime, the nominal interest rate is determined by a Taylor rule. Let $q(x_t)$ be the probability that agents assign to the peg. It is an increasing function of the amount of foreign exchange purchases defined below. Conversely, $1 - q(x_t)$ is the probability that agents assign to being in the flexible regime. Then the nominal interest rate would be:

$$(9) \quad i_t = [1 - q(x_t)] [c_0 i_{t-1} + (1 - c_0)(c_1 \pi_t + c_2 y_t) + \varepsilon_t^i] + q(x_t) i_t^*,$$

where $q(x_t) = 1/(1 + e^{-x_t^2}) - q_0$.

When $x_t \rightarrow 0$ and $q_0 = 1/2$, $q(0) \rightarrow 0$, the economy behaves as in a full-fledged inflation-targeting floating exchange rate regime. On the contrary, any foreign exchange intervention ($x_t > 0$) implies a positive value of $q(x_t)$,

weakening the power of the interest rate rule. This is one way to capture the credibility cost of such interventions, performed during the past ten years in Colombia under the inflation-targeting regime. To our knowledge, this type of credibility cost has not been implemented in the literature on central banking.

The last set of equations in the model corresponds to the exogenous AR(1) process for the external real interest rate and foreign inflation:

$$(10) \quad r_t^* = \rho_{r^*} r_{t-1}^* + (1 - \rho_{r^*}) r^* + \varepsilon_t^{r^*} \text{ and}$$

$$(11) \quad \pi_t^* = \rho_{\pi^*} \pi_{t-1}^* + (1 - \rho_{\pi^*}) \pi^* + \varepsilon_t^{\pi^*},$$

where the external nominal interest rate $i_t^* = r_t^* + \pi_{t-1}^{*\varepsilon}$.

In practice, the central bank's toolkit included systematic foreign exchange interventions, capital controls, changes in reserve requirements, and changes in credit provisions. The focus so far has been on the role of foreign exchange interventions, but later we comment on the other instruments.

Estimation and Results

We estimate the model by Bayesian methods, incorporating additional information on parameters through the use of priors. We follow Schorfheide in proceeding in five steps.¹⁷ First, for a given set of parameters, we solve the model, according to Klein, to find the state transition equation.¹⁸ This approximation to the solution defines the behavior of the system around the deterministic steady state. Second, the state-space representation is then completed by adding a measurement equation to the model dynamics. Third, we compute the likelihood through Kalman filtering and combine it with the prior distribution of the parameters. This yields the posterior density. Fourth, we derive draws from the posterior density using the random walk Metropolis-Hastings algorithm. Finally, the algorithm is started at the posterior mode, or at some point nearby with a high probability density, found by numerical optimization.

Data

We used monthly data from 2002:1 to 2012:6. Most estimated models for policy analysis use quarterly data. By using monthly data, we sacrifice the

17. Schorfheide (2000).

18. Klein (2000).

reliability of some information, particularly about economic activity, since Colombia lacks monthly GDP data. However, part of our focus is on quantifying the impact of foreign exchange interventions, and a high-frequency dataset is better suited for this task.

All data were detrended using the Hodrick-Prescott filter, unless otherwise stated. The smoothing parameter was set following the frequency rule suggested by Ravn and Uhlig to the power of 8.¹⁹ This relatively high-power smoothing parameter removes only the very low frequency movements of the time series.

As a proxy for the nominal interest rate, we use the central bank's policy intervention rate. The inflation measure is the annual growth rate of the consumer price index (CPI). To account for the Colombian disinflation process, inflation data were detrended using the midpoint of the official central inflation target for that year. Output is measured as the year-over-year real GDP growth rate estimated by the IMACO, a twelve-month economic activity indicator calculated by the Central Bank of Colombia. As a proxy for the real exchange rate, we use the bank's TCR-IPC index, which is a real exchange rate index weighted by Colombian trade with the main trade partners and deflated by the consumer price index.

The central bank also provided us with its data on the net foreign exchange purchases. This series was not detrended, as net purchases can be positive or negative when the central bank buys or sells foreign exchange reserves. As a proxy for the foreign interest rate, we used the U.S. federal funds rate (as a deviation from a long-term value of 2 percent) adjusted by a risk term, which was measured as the VIX volatility index in deviations from trend.²⁰ We also incorporated a proxy time series data for the variable net capital flows, k . Finally, the central bank publishes a monthly statistical report on the foreign exchange balance (entitled *Balanza Cambiaria*), which was our data source for net private capital flows.²¹

19. Ravn and Uhlig (2002).

20. To compute the risk term, we take the VIX in levels and transform it into logs and then extract the Hodrick-Prescott trend. The difference between the observed log (VIX) and its trend is the risk factor in percent deviations. We add this factor to the deviations from trend of the U.S. federal funds rate.

21. We used the item *reintegros netos de capital privado*. Data are available from January 2002 to September 2012. We do not use the balance of payments because it contains only quarterly data. By using the foreign exchange balance, we are not fully capturing private net capital flows, but the foreign exchange balance is a timely tool used actively in the central bank's discussions and decisions about monetary policy.

Priors

Let $X_t = (y_t, \pi_t, i_t, e_t, x_t, r_t^*, \pi_t^*)$ denote the observed data, and let $\beta = (a_0, a_1, a_2, b_0, b_1, b_2, c_0, c_1, c_2, d_0, d_1, f_1, f_2, g_0, g_1, q, \rho, \sigma)$ be the parameters to be estimated, where $\rho = (\rho_\pi, \rho_y, \rho_k, \rho_x, \rho_{r^*}, \rho_{\pi^*})$ and $\sigma = (\sigma_i, \sigma_\pi, \sigma_y, \sigma_k, \sigma_x, \sigma_n, \sigma_{r^*}, \sigma_{\pi^*})$ are the vectors of parameters that characterize the autocorrelation and the variances of the shocks. The model has two sets of parameters: those that correspond to the standard neo-Keynesian model ($a_0, a_1, a_2, b_0, b_1, b_2, c_0, c_1, c_2$) and those of the small open economy block, including the foreign exchange intervention rule, ($d_0, d_1, f_1, f_2, g_0, g_1, q$).

In the micro-founded neo-Keynesian model, the values of parameters (a_0, \dots, b_2) depend on the discount factor of households, the degree of risk aversion, the labor supply elasticity, and the frequency of price adjustments, among other deep parameters. Our simple specification of the model is not microfounded, so we use as priors the posterior estimates obtained by González and Hamann, who estimate a microfounded neo-Keynesian model for the Colombian economy.²²

For the Taylor rule coefficients, c_0, c_1 , and c_2 , we also use as priors the posteriors obtained in that study because the estimates are similar to the values obtained in previous studies in Colombia: 0.2, 1.6, and 0.2. For the policy rate persistence, we use a beta distribution with standard deviation of 0.2, while for c_1 and c_2 , we use a gamma distribution with standard deviations of 0.16 and 0.02, respectively.

Parameters b_0, d_0 , and g_0 determine the degree of autocorrelation of output, capital flows, and foreign exchange intervention. We use beta distributions for them based on the estimated values obtained from independent ordinary least squares (OLS) estimations of their respective equations. For the remaining autoregressive parameters, we use a uniform prior between (0, 1) and, for all standard deviations of shocks, an inverse gamma distribution with mean obtained from running independent regressions for each equation of the model and computing its standard error of the regression.

We run independent OLS regressions to estimate the priors of equations 5, 6, and 7, which are part of the open economy bloc. The estimated results are as follows (statistically significant coefficients are reported in bold):

$$k_t = 0.002 + \mathbf{0.28}k_{t-1} + \mathbf{0.003} \left[r_t - r_t^* - (e_t^e - e_t) \right];$$

22. González and Hamann (2011).

$$ca_t = 0.003 + 0.017e_t - \mathbf{0.38}y_t;$$

$$x_t = 0.003 + \mathbf{0.25}x_{t-1} - \mathbf{0.115}e_t.$$

Results

We use a random walk Metropolis-Hastings algorithm to draw two chains of 200,000 draws from the posterior distribution of β and construct the estimates for each parameter using half the draws of each chain. The acceptance rates for each chain were 0.2778 and 0.2776. We use methods developed by Brooks and Gelman to monitor the convergence of the posterior draw estimates.²³ Table 1 presents the estimation results. In the appendix, we report the impulse response functions of all variables to each of the model's shocks (see figures A-1 to A-7).

The estimation generates several interesting results. First, there is a muted pass-through from nominal depreciation to inflation—the value of parameter a_1 is close to zero. The tightness of the posterior distribution shows that the data strongly support this observation. This is not a surprising result for at least three reasons: it is consistent with previous research by the central bank, which documents that the degree of pass-through has been low and declining over time;²⁴ Colombia is not a particularly open economy, where imports represent less than 20 percent of its GDP (versus 35 percent in Chile); and finally, as explained above, our model is estimated with high frequency data, so the result should be interpreted within this frequency.

Second, there is no direct impact of the real exchange rate on aggregate output. The estimated coefficient of the real exchange rate in the IS curve lies around zero, between -0.01 and 0.01 with 95 percent confidence. Unlike many models that assume that real depreciation is expansionary, the estimated results strongly support the notion that if there is any relationship between real exchange rate misalignments and unusual output growth, the relationship is weakly negative. This result is important because the unconventional block of the model is linked to the conventional one through the real exchange rate. Even if foreign exchange interventions were effective, in that they were able to explain a significant portion of exchange rate movements, the impact on economic activity would be small. Foreign exchange interventions could operate through other channels, for example through a change in the portfolio of private agents or through the potential impact of banks and pension funds

23. Brooks and Gelman (1998).

24. For example, Rowland (2004).

TABLE 1. Estimation Results

Parameter	Definition	Prior mean	Posterior mean	Confidence interval	Prior distribution	Posterior standard deviation
a_0	Forward-looking weight in Phillips curve	0.5700	0.6298	0.4960	Beta	0.2000
a_1	Pass-through coefficient	0.0000	0.0037	-0.0064	Normal	0.0100
a_2	Slope of Phillips curve	0.1750	0.6710	0.6362	Gamma	0.0500
b_0	Forward-looking weight in IS curve	1.0000	0.7112	0.5837	Normal	0.5000
b_1	Slope of IS curve	0.2000	0.6452	0.5905	Gamma	0.0500
b_2	Output response to real exchange rate	0.0000	-0.0037	-0.0129	Normal	0.0100
c_0	Backward-looking weight in Taylor rule	0.1700	0.2055	0.1723	Beta	0.0170
c_1	Taylor rule weight on inflation	1.6000	1.9101	1.7246	Gamma	0.1600
c_2	Taylor rule weight on output	0.2200	0.2334	0.1842	Gamma	0.0220
d_0	Capital flows inertia	0.2770	0.2542	0.1126	Beta	0.0880
d_1	Interest rate elasticity of capital flows	0.0030	0.0207	0.0121	Normal	0.0070
f_1	Current account elasticity to real exchange rate	0.0170	0.0325	0.0177	Gamma	0.0050
f_2	Current account elasticity to output	0.3820	0.1252	0.0270	Gamma	0.2000
g_0	Backward-looking weight in foreign exchange rule	0.2500	0.2176	0.1093	Beta	0.0800
g_1	Net foreign exchange purchases response to real exchange rate	0.1150	0.2661	0.2139	Gamma	0.0300
q	Probability of fixed exchange rate	0.0000	0.0114	0.0025	Uniform	0.2887
$\rho_{\downarrow\pi}$	Supply shock persistence	0.5000	0.9659	0.9394	Uniform	0.2887
$\rho_{\downarrow y}$	Demand shock persistence	0.5000	0.9758	0.9566	Uniform	0.2887
$\rho_{\downarrow k}$	Capital flow shock persistence	0.5000	0.2014	0.0000	Uniform	0.2887
$\rho_{\downarrow\uparrow}^*$	U.S. interest rate shock persistence	0.5000	0.7439	0.6509	Uniform	0.2887
$\rho_{\downarrow\uparrow}^*$	U.S. inflation shock persistence	0.5000	0.9225	0.8733	Uniform	0.2887
<i>Standard deviation of shocks</i>						
$\epsilon_{\uparrow\pi}$	Inflation shock	0.0200	0.0029	0.0025	Inverse gamma	Infinity
$\epsilon_{\uparrow y}$	IS curve shock	0.0200	0.0025	0.0024	Inverse gamma	Infinity
$\epsilon_{\uparrow i}$	Monetary policy shock	0.0100	0.0253	0.0221	Inverse gamma	Infinity
$\epsilon_{\uparrow k}$	Capital flows shock	0.0200	0.0190	0.0170	Inverse gamma	Infinity
u	Discretionary intervention shock	0.0200	0.0183	0.0061	Inverse gamma	Infinity
n	News intervention shock	0.0200	0.0220	0.0091	Inverse gamma	Infinity
$\epsilon_{\downarrow\uparrow}^*$	U.S. interest rate shock	0.1500	0.1544	0.1388	Inverse gamma	Infinity
$\epsilon_{\downarrow\uparrow}^*$	U.S. inflation shock	0.0300	0.0057	0.0051	Inverse gamma	Infinity

on saving and consumption decisions. In any case, the result does not claim that prolonged periods of real exchange rate appreciation have no impact on economic activity or other domestic variables. Rather, it implies that at a relatively high business cycle frequency, the link between the two is very weak.

Third, in the Phillips curve, we obtain a high estimated value of the forward-looking parameter, close to the priors, and a higher-than-expected response of inflation to economic growth. Inflation shocks, such as those that come from food or regulated prices, display a high degree of persistence and translate to observed inflation.

Fourth, the estimates of the Taylor rule coefficients are similar to those obtained in previous studies, although the estimated response to inflation deviations from target is higher in our figures.

Fifth, the credibility cost in the Taylor rule implied by the foreign exchange intervention is small. Interventions have not induced agents to assign a probability beyond 2 percent of being in a fixed exchange rate regime.

Sixth, capital flows are volatile, as their persistence is quite low, and there is a low degree of capital mobility in the economy in the sense that the reaction to the domestic-external interest rate differential is very small. In turn, the response of the current account to output and the real exchange rate is also small. In all cases, the posterior estimated coefficients are statistically significant.

Seventh, the data support the idea that the central bank has a foreign exchange reaction function. The response of foreign exchange sales/purchases to real exchange rate depreciation/appreciation is large and significant. This elasticity lies between 0.39 and 0.42 with 95 percent confidence. The data strongly favor the idea that the central bank responds to real exchange rate misalignments.

Finally, our model also has something to say about the effectiveness of interventions. Take, for instance, the impact of the “news” shock. Table 1 shows that the standard deviation of this shock is 2.2 percent. Given that the interventions are expressed in the model as a percentage of the stock of international reserves, this intervention corresponds to daily interventions of close to US\$40 million.²⁵ Figure A-6 reports the reaction of the endogenous variables to such a news shock. Again, we find that the domestic block of variables—output, inflation, interest rates—does not react. There is a short-

25. The stock of international reserves by the end of 2012 was US\$37.5 billion. One standard deviation of the news shock is 2.2 percent, so US\$37.5 billion times 2.2 percent is the monthly shock we study in the impulse response functions. If there are 20 weekdays in a month, the latter figure corresponds roughly to daily interventions of US\$40 million, close to the latest announcements by the central bank.

lived reaction to the real exchange rate, in which the pace of appreciation would be slowed by close to 6 percent in the first month. The impact evaporates by the second month, however. This result is within the ballpark estimates of Adler and Tovar.²⁶

Results 1 and 2—that is, the weak external channel in the Colombian economy—confirm the early findings in Gómez, Uribe, and Vargas.²⁷ Together these results imply that the domestic and external factors are quite disconnected in Colombia. The fact that inflation stays relatively immune to changes in the exchange rate implies that its joint dynamics, together with output and interest rates, would look a lot like those of a closed economy.

These results are confirmed by the impulse response functions. Impulse responses to foreign shocks, like capital flows, foreign exchange intervention, and external interest rates, have either small or no significant impact on inflation, the output growth gap, and domestic interest rates. The results reported in the appendix show that while these shocks affect capital flows, foreign exchange intervention, and the real exchange rate, the response of domestic variables is negligible. Also, the effects of domestic shocks (demand, supply, and monetary policy shocks), reported in the appendix, mainly affect output, inflation, and interest rates, while the response of other variables is either insignificant or small.

We performed a shock decomposition analysis to gauge the estimated contribution of the shocks on the observed movements of the variables in the model. The shock decomposition of inflation (in deviations from target) reveals that most of the movements of inflation are explained by demand and supply shocks and a small share by interest rate shocks (see figure 2). The share of foreign shocks is negligible. A similar pattern can be observed in the shock decomposition of the output growth gap (figure 3).

The shock decomposition of capital flows tells a different story, as they are mainly explained by their own shocks and shocks to external interest rates (figure 4). The contribution of domestic shocks on demand, supply, or local interest rates is very small. This domestic-external disconnect property of the economy may have had important implications for how the central bank has conducted exchange rate management and on the consequences of the latter.

Finally, we report the shock decomposition of the real exchange rate in figure 5. Real exchange rate movements (deviations from annual growth rate) are explained mainly by capital flow shocks, news about foreign exchange

26. Adler and Tovar (2011).

27. Gómez, Uribe, and Vargas (2002).

FIGURE 2. Shock Decomposition: Inflation



FIGURE 3. Shock Decomposition: Output Growth Gap

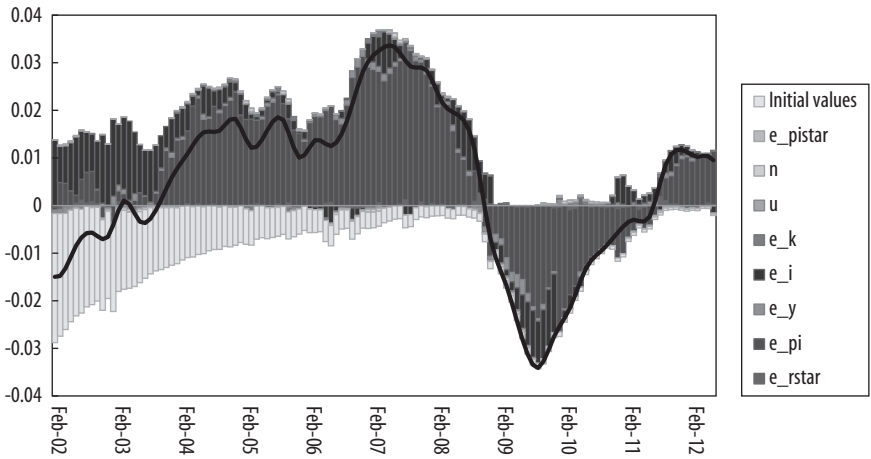


FIGURE 4. Shock Decomposition: Capital Flows

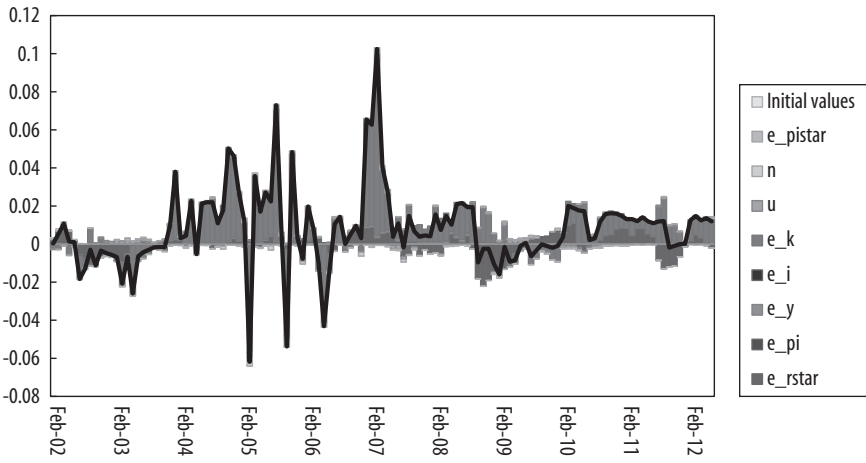


FIGURE 5. Shock Decomposition: Real Exchange Rate

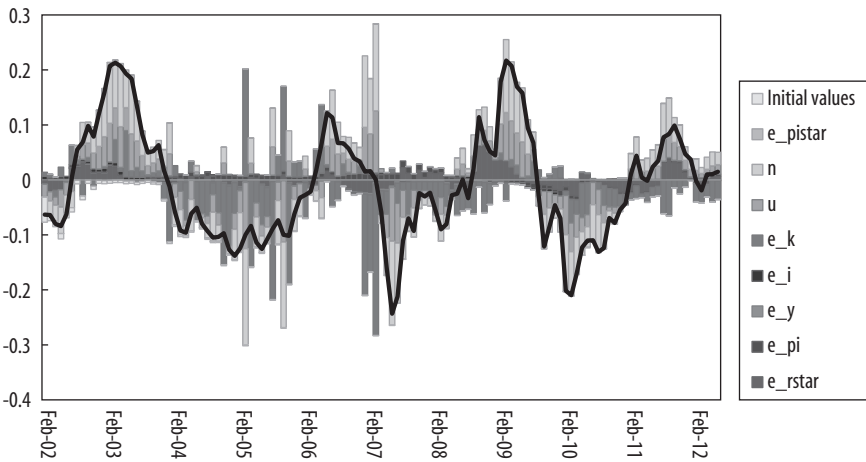
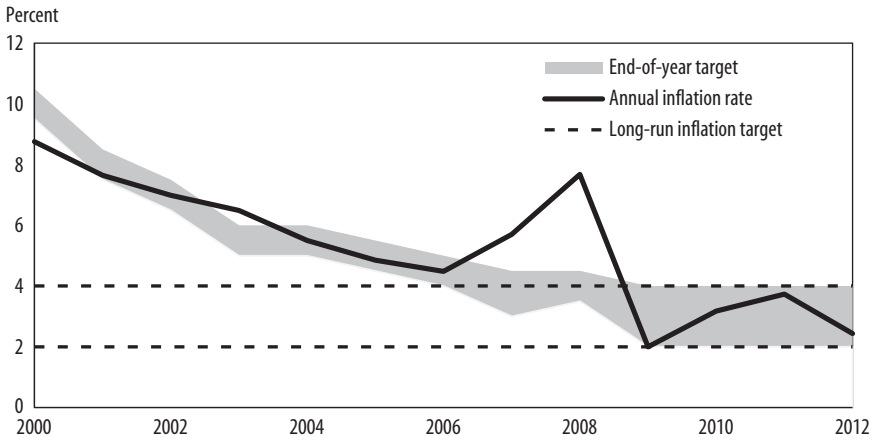


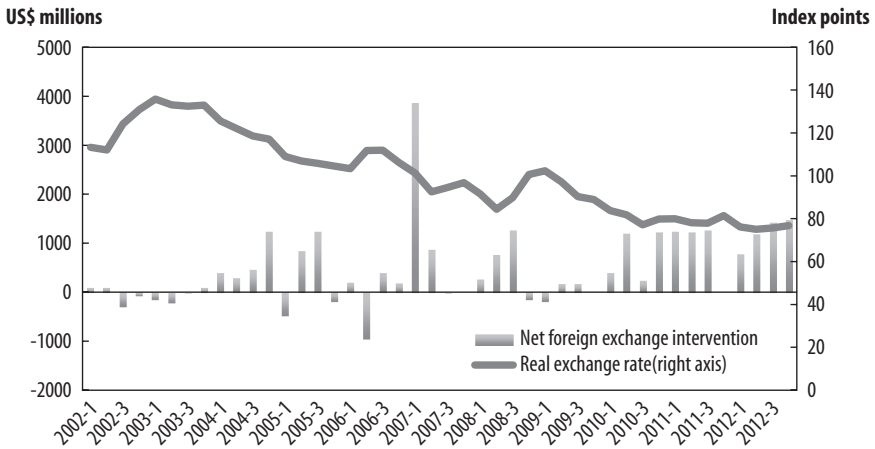
FIGURE 6. Colombia: Inflation Rate and Targets, 2000–12

intervention, and discretionary foreign exchange intervention shocks. The contribution of foreign interest rates is small. Both discretionary and news shocks explain a large portion of exchange rate fluctuations. We interpret this result to mean that the estimated intervention rule does not fully account for real exchange rate movements, but unanticipated shocks to foreign exchange intervention may have had more power, especially before the beginning of preannounced interventions in June 2008, as the contribution of both shocks has declined since then.

Consolidation of Inflation Targeting in Colombia: 2002–12

Figure 6 reports the inflation rate over the inflation-targeting era along with the announced annual and long-run targets, respectively. Colombia's central bank has been able to stabilize the inflation rate close to its long-run target of 3 percent. To achieve this, it has used a variety of instruments beyond the policy interest rates. We study them in this section with a particular emphasis on the most important one, foreign exchange interventions.

Foreign exchange interventions have taken place since the start of the regime, but they have been particularly severe since the middle of the decade. In 2012, the central bank purchased close to US\$5 billion. While most interventions have been purchases, the central bank has also sold nonnegligible amounts of reserves, mostly in the context of preannounced interventions

FIGURE 7. Net Foreign Exchange Interventions and the Real Exchange Rate, 2002–12

aimed at reducing exchange rate volatility. From January 2002 to December 2012, the net purchases of US\$27.2 billion hide total purchases of almost US\$31.9 billion and sales of US\$4.7 billion. Figure 7 reports the foreign exchange interventions for 2002–12.

Why does the central bank intervene in the foreign exchange market? On the one hand, it needs to keep an adequate level of international reserves. The central bank has published several documents explaining its strategy regarding the level and investment of international reserves.²⁸ These reports provide a detailed account of the criteria used to determine an adequate range of international reserves, based on the behavior of the current account, external debt, the world financial situation, the size of the economy, and the size of monetary aggregates.

On the other hand, interventions could also be related to implicit exchange rate targets in terms of the level of the exchange rate and its volatility. As figure 7 shows, foreign exchange purchases tend to be larger when the peso is stronger. This result is confirmed by our estimates in the previous section. Moreover, interventions have been justified as a means to mitigate exchange rate volatility or as an attempt to influence its trend. At times, the central bank has had explicit mechanisms that triggered sales or purchases when exchange rate volatility trespassed certain thresholds. While the bank has never stated

28. For example, *Informe sobre Reservas Internacionales* (Banco de la República, 2011); Gerencia Técnica (2012).

that it has an explicit exchange rate target, interventions have often been stepped up when there have been perceived or actual foreign exchange misalignments, suggesting that it might have been part of the policy reaction function. Our model does not allow for testing whether the central bank has had implicit exchange rate targets, but it does show that exchange rate misalignments triggered foreign exchange interventions.

Nevertheless, our results suggest a disconnect between the domestic and foreign variables.²⁹ While this disconnect does not necessarily mean that movements over the long run in foreign variables leave domestic variables unchanged, we do find that the two blocks operate with a strong independence from one another at a high business cycle frequency. If the foreign block of variables does not affect the domestic variables of interest for a central bank, and if the interventions have a small and short-lived effect on the exchange rate, then there must be alternative reasons explaining the intensive foreign exchange interventions of the last few years. In particular, the foreign exchange interventions should be studied in light of pressures exerted on the central bank by government officials, the press, and lobbies in response to actual or perceived exchange rate misalignments.

A first episode that illustrates the pressures that the central bank has faced took place in 2003 and 2004. At that time, President Álvaro Uribe made several public appeals claiming that the central bank should play a more active role in achieving the social goals of the government.³⁰ He publicly asked the bank to use part of its foreign exchange reserves to buy government external debt. Public opinion and part of the political establishment picked up on the proposal, and in a historic event, the Senate rejected the central bank's report to the Congress. As a former member of the central bank's board put it, this request constituted an act of political extortion to push the Bank to accept giving up part of the reserves.³¹ The IMF then entered the debate, arguing that there were no excess reserves in Colombia and that fiscal problems should be solved through fiscal policies, with international reserves acting solely as shock absorbers.³² President Uribe insisted that the central bank should estimate the amount of its excess reserves. The bank responded by issuing a

29. Our results are consistent with Gómez, Uribe, and Vargas (2002).

30. Moreno (2011).

31. Moreno (2011).

32. "FMI fija límites a Colombia para utilizar reservas internacionales," *Caracol*, 13 November 2003. Available online at www.caracol.com.co/noticias/actualidad/fmi-fija-limites-a-colombia-para-utilizar-reservas-internacionales/20031113/nota/117074.aspx (accessed 15 October 2012).

document concluding that at most the excess reserves were US\$500 million, or about 5 percent of international reserves at the time. While the amount is significant in relative terms, it was well below expectations: some senators had mentioned figures as high as US\$5 billion.³³ In the end, the central bank bought external debt for US\$500 million.

This first example of the political pressures on the central bank explains some of the movement in international reserves stocks. It also shows how the central bank was somewhat successful in using technical arguments, published in different series with varying technical depth, to partially refute strong political pressure, thereby mitigating its institutional and economic consequences. The better communication skills acquired in the context of the inflation-targeting strategy may have proven useful in that case.

The next example is paradoxical in comparison. In mid-2012, the Ministry of Finance produced a technical document claiming that the stock of international reserves was too low.³⁴ Based on a calibration of Jeanne and Rancière's model of optimal international reserves, the document argued that Colombia's international reserves were below optimal at close to US\$20 billion and proposed a fast track of daily foreign exchange acquisitions to close this gap.³⁵ The report was issued at a time of foreign exchange appreciation and could be read as a technical argument to support the claim that the central bank needed to intervene to depreciate the exchange rate. The central bank responded with a paper that disregarded the government's technical arguments by showing how sensitive the results were to the model's choice of parameters in the calibration.³⁶ The paper noted that rather than focusing on an optimal level of reserves, the central bank aims for what it calls an adequate level of reserves. It cited several criteria to estimate this level and showed that the current amount of international reserves was close to the desired figure according to these criteria. Compared with the 2003 debate, the exchange of ideas was kept at a more technical, and less political, level. Nevertheless, the central bank faced obvious pressure to change its international reserve goals or at least to increase its foreign exchange acquisitions in the short run. Shortly after the exchange of arguments, the central bank's board of directors stepped up the

33. "Pago de deuda externa con reservas evitaría reforma tributaria," *Caracol*, 7 July 2004. Available online at www.caracol.com.co/noticias/actualidad/pago-de-deuda-externa-con-reservas-evitaria-reforma-tributaria-senador-velez/20040707/nota/121390.aspx.

34. Mejía (2012).

35. Jeanne and Rancière (2011).

36. Gerencia Técnica (2012).

daily preannounced foreign exchange purchases (although by much less than the government's suggestion), amid claims by the finance minister that the peso was at least 8 percent overvalued.

A third example that illustrates this point is President Uribe's attempts to fix the exchange rate. In December 2004, after a period of exchange rate appreciation, Uribe asked his main legal adviser to write a decree that would fix the exchange rate.³⁷ On another occasion, the president phoned the governor of the central bank, who was at a board meeting at the Latin American Reserve Fund, to inform him that the next day he would announce that the country would go back to the crawling peg. The official announcements, however, never occurred. The institutions and the legal independence of the central bank have thus proved to be strong enough to withstand attempts by the government to intervene in spheres that the Constitution assigns to the central bank.

The preceding three examples illustrate scenarios in which the government has tried to influence the direction and intensity of the central bank's foreign exchange purchases and sales. The examples suggest that political pressure has been used to push for both an increase and a decrease in the level of international reserves. To a certain extent, the central bank has yielded to these pressures despite its *de jure* independence. As its deputy governor once said, maintaining independence implies a degree of compromise with public opinion or with the government.³⁸ The central bank has also used its strong research capabilities to make its case when the proposals or pressures are incompatible with its overall goals.

While the discussion thus far has focused on pressure from the government, there are also many examples of pressure from the private sector. Exporters, importers, manufacturers, agricultural producers, and coffee growers, among others, have all voiced their desired policies regarding the exchange rate in an attempt to influence the central bank's decisions directly or indirectly through government policy.

To sum up, the central bank has intervened in the foreign exchange market at least since 2003, either to build an adequate level of international reserves or to address exchange rate misalignments. The central bank's reserve decisions have been made amid strong media and political pressure, yet the bank has effectively used its communication skills, its technical staff, and its *de facto* and *de jure* independence to resist the pressure while upholding its constitutional mandate to keep prices stable. With the exception of 2007–08,

37. Moreno (2011).

38. Betancourt and Vargas (2008).

targets have been met or only missed by a narrow margin. As the model shows, the credibility of the regime has not been endangered.

Yields on International Reserves

Like many central banks, the Banco de la República takes a conservative approach to its investment strategies regarding international reserves. While a conservative strategy may be inherent to a central bank's character, in the case of Colombia, the conservative tactic has become increasingly important since the fall of Lehman Brothers in 2008. At that time, a popular and well-known left-wing congressman, Gustavo Petro, publicly accused the bank's board of directors of recklessly investing Colombia's foreign reserves. Petro stated that more than US\$2.5 billion was invested in high-risk assets and could be lost due to the crisis.³⁹ The central bank responded to Congressman Petro by showing that the majority of its foreign exchange reserves were invested in secure bonds, such as U.S. Treasury bonds. While it recognized that the crisis had an impact, the losses were less than 0.012 percent of total international reserves.⁴⁰ The figures Petro cited thus proved to be wrong, but a small part of the reserves have never been recovered. In its last report to Congress in 2012, the board of directors devoted a few pages to explaining the legal actions that had been taken to recover the fraction of the reserves that were lost during the financial crisis.⁴¹ That the amount lost was small relative to total reserves was irrelevant in terms of the consequences of that debate. Beyond the political pressure on the board members, there was a real threat that they would face legal actions as a result of the loss. The Office of the Attorney General (*Procuraduría*)—the entity in charge of investigating and judging public officials for actions related to their jobs—opened an investigation of the loss to evaluate whether board members and central bank officials should be sanctioned.

The central bank's reaction was to strengthen its investment standards, sacrificing potential returns in exchange for greater security. This strategy is behind the recent poor performance of Colombia's international reserves in terms of returns, shown in table 2. Indeed, the annual returns denominated

39. "Petro alerta sobre la necesidad de proteger reservas internacionales," *El Espectador*, 6 October 2008. Available online at www.elespectador.com/noticias/politica/articulo-petro-alerta-sobre-necesidad-de-proteger-reservas-internacionales (accessed 24 October 2012).

40. "Quiebra de Lehman Brothers sí afectó reservas internacionales de Colombia," *Caracol*, 30 September 2008. Available online at www.caracol.com.co/noticias/economia/quiebra-de-lehman-brothers-si-afecto-reservas-internacionales-de-colombia/20080930/nota/681195.aspx.

41. Banco de la República (2012).

TABLE 2. Annual Yield on International Reserves, 2002–12

<i>Year</i>	<i>Annual yield on international reserves (%)</i>	<i>Annual return on international reserves (US \$)</i>
2002	7.7	810.5
2003	4.2	464.8
2004	2.7	324.5
2005	0.6	81.4
2006	5.5	815.2
2007	7.4	1326.2
2008	4.5	1004.5
2009	1.3	321.4
2010	0.6	159.7
2011	0.4	136.0
2012	0.7	241.9

in dollars over the last three years have been below 1 percent. Although the stock of international reserves has more than tripled over the last ten years, its returns have declined from US\$810.5 million to an average of US\$180 million in the past three years. This reflects the low interest rates in the United States and the depreciation of the euro, but the bank's high risk aversion has also contributed to the low average returns. The country's current equilibrium leads to very low returns on its international reserves, and the board has no incentive to change the strategy.

In addition to the low returns on international reserves, the purchase of foreign exchange is costly, especially if it has to be sterilized. Given the pressure to buy more foreign exchange to attenuate the appreciation of the peso against the dollar, the central bank has estimated the cost of sterilizing interventions. According to the 2012 Report to the Congress, for each US\$100 million of foreign exchange purchases, the reserve balance is hit by more than US\$4.5 million. In 2012, the central bank ended the year with foreign exchange purchases of US\$4.844 billion; this intervention had a quasi-fiscal cost of more than US\$230 million.

The low returns on international reserves, the high cost of sterilized interventions, and the appreciation of the peso against the U.S. dollar have reduced the reserve balance. Since 2010, the central bank has reported large net losses at year-end, with obvious fiscal consequences. The sum of the losses over the last three years exceeded US\$500 million. The board has tried to carefully explain the causes of the losses to Congress. Absent budgetary independence, the actual policy independence of the central bank could be at risk. This could

also explain the central bank's resistance to more forcefully intervening in the foreign exchange market. Maintaining the appropriate level of policy independence in this context is a new challenge for the organization.

With respect to the investment of international reserves in Colombia, the central bank's strategy is currently focused on very secure and mostly liquid assets. This strategy makes sense as long as the amount of foreign exchange reserves remains close to the adequacy level dictated by potential short-run liquidity needs. As the stock of international reserves grows and the losses mount, explained mostly by the low return on investment, the threat to budgetary independence makes it imperative for the central bank to search for alternatives for investing in less liquid and more risky portfolios or projects that would enhance the long-run returns of its international reserves.

This task seems difficult for Colombia. While in principle the central bank could decide to invest part of its international reserves, or the excess, in long-term assets or in riskier and more profitable alternatives, the reality is that it has no incentive to do so. This reluctance is explained by the experience after the Lehman Brothers collapse, when the board faced threats of legal action for "endangering the country's reserves." We propose a way out of this bad equilibrium, which encompasses the creation of a separate investment fund inspired by the sovereign wealth funds that some Asian countries have established to invest part of their international reserves. According to this scheme, the central bank would put part of the stock (flow) of international reserves into a sovereign wealth fund, which would be an independent fund with a clear mandate to maximize revenues over longer terms (at least five years or more). The fund's returns and performance should be evaluated over the chosen horizon.

The fund's revenues would be redirected to the central bank and eventually to the government. As with most sovereign wealth funds, it would be managed by a third party, but its board would be controlled by government officials. The heads of the central bank, the Ministry of Finance, the national planning department, and possibly the Economic Commission of the Congress are obvious choices for serving on the fund's board, to enhance transparency and accountability and also to shield the fund from political manipulation.

The fund's success in establishing accountability while providing shields to allow for adequate investment strategies lies in the fine-tuning of its mandate. The experience of other countries and even Colombia's experience with a different sovereign wealth fund for saving oil revenues could be valuable inputs for designing its charter. In particular, China, Korea, and Singapore have all successfully built a separate investment fund for managing part of their international reserves.

Macprudential Policies

The international discussion of macroprudential policies intensified in the early 2000s. Colombia put in place marginal reserve requirements on financial intermediaries and non-interest-bearing deposit requirements on foreign credit to diminish dangerous credit growth rates. In 2006 and 2007 real credit growth rates reached 32 percent, and the transmission mechanism from policy interest rates to market rates showed delays. The central bank's board felt that over and above interest rate increases to decelerate credit growth, additional reserve requirements and a disincentive to foreign credit flows were warranted. Both of these measures were quickly reversed after the start of the global financial crisis in 2008.

Other prudential measures and regulatory decisions taken to meet Basel standards were implemented by the Superintendent of Banks (*Superintendencia Financiera*), a government agency independent from the central bank. In Colombia, the Bank Superintendent is in charge of supervising the financial sector and establishes the rules on credit provisions that financial institutions must follow. Accordingly, macroprudential policies regarding credit provisions are not directly set by the central bank. Nevertheless, the coordination between the central bank and the Superintendent of Banks has increased over time. For example, the superintendent recently increased bank provisions required for consumer loans, after repeated calls from the central bank suggesting that the growth rate of these loans was excessive.

Capital Controls

Capital controls are also in the toolkit used by the Colombian Central Bank to meet its goals in the inflation-targeting era. Over the last decade, the central bank and the government have used barriers to capital inflows at times of strong exchange rate appreciation. The strategy has been to impose Chilean-type restrictions based on unremunerated reserve requirements on foreign loans and portfolio investments to make them less attractive. For example, in May 2007, the central bank established a mandatory deposit on foreign debt, wherein those acquiring foreign debt had to deposit part of the loan without remuneration. These restrictions were abandoned in September 2008, when appreciation pressures receded in the midst of the global financial crisis.

Portfolio investments have also been targeted at times of exchange rate appreciation, although the government, rather than the central bank, is in charge of regulating portfolio investments. Short-term investments from abroad were prohibited in 2004–06. In May 2007, an unremunerated reserve

requirement was imposed, similar to the requirement on short-term debt, with a 40 percent deposit for a six-month period. A year later, the deposit requirement was increased to 50 percent.

However, the latest evidence suggests that capital controls have probably not been effective in containing exchange rate appreciation in Colombia. Rincón and Toro show mixed results: capital controls had some effect on the exchange rate in 2008, but only when combined with foreign exchange rate interventions.⁴² The rest of the recent evidence is skeptical regarding the usefulness of these restrictions. Clements and Kamil, for example, study the effects of capital controls implemented since 2007.⁴³ They show that while these mechanisms were successful in limiting external borrowing, they did not moderate the appreciation of the peso. Similarly, Concha, Galindo, and Vasquez study the effects of capital controls in Colombia over the period 1998–2008 and also find that they neither mitigated exchange rate appreciation nor reduced capital inflows.⁴⁴ The only statistically relevant effect is a reduction in financial volatility, but the economic significance of the effect is negligible. These results are in line with Forbes and Warnock, who find little association between capital controls and the probability of having surges or stops driven by foreign capital flows.⁴⁵

Conclusion

The estimations of our small-scale monetary policy model suggest that there is a weak link between domestic and external macroeconomic variables in Colombia at the monthly data frequency. First, the real exchange rate appears to have small effects on aggregate economic activity. Second, total inflation is relatively immune to changes in the nominal exchange rate. Third, the sensitivity of capital flows to the domestic-foreign interest rates differential is also small. Together, these results imply that foreign shocks hitting the economy tend to be adjusted by the balance-of-payments equilibrium conditions, so their effects on domestic economic variables are small. Likewise, domestic shocks tend to have their highest impact on local variables such as output, inflation, and domestic interest rates.

42. Rincón and Toro (2010).

43. Clements and Kamil (2009).

44. Concha, Galindo, and Vasquez (2011).

45. Forbes and Warnock (2012).

Our results should not be interpreted as claiming that the trends of the Colombian economy and those of the rest of the world are unrelated over the long run. Rather, our results show that at a business cycle frequency, movements in the exchange rate have little effect on domestic inflation and economic activity.

According to our estimated model, the Central Bank of Colombia has used at least two policy instruments—namely, a Taylor rule and a foreign exchange intervention rule—as part of its inflation-targeting strategy. The external-internal disconnect of the economy may have facilitated the implementation of both instruments, without generating significant economic policy trade-offs. In terms of credibility, we find that the determination of the domestic interest rate is consistent with a flexible exchange rate regime rather than a peg. Thus, the central bank may have had enough room to intervene in the foreign exchange market without putting the credibility of the inflation-targeting regime at risk. We also find the foreign exchange interventions have a short-lived impact on the exchange rate.

Our paper also shows that despite the strong political and media pressure on the central bank to implement policies that could come at the cost of not complying with its main objectives, the institution has used its technical strength and increasingly better communication skills to explain its actions and argue its position. It has therefore only had to bow to pressures inasmuch as they do not compromise its main goals.

One challenge the central bank faces is low yields on an increasingly large stock of international reserves. Over the last few years, the central bank has reported net losses by the end of the year. Policy independence depends to a certain extent on budgetary independence. Our paper suggests that to escape these constraints, the central bank should invest some of its international reserves more aggressively, and Colombia should thus consider forming a sovereign wealth fund. Beyond considering the choice of a better balance between risk and return, this fund could be pivotal to maintaining an appropriate level of central bank independence.

Overall, the balance of this decade of consolidation of inflation targeting is positive. By keeping its eye on inflation, economic activity, the exchange rate, credit variables, and financial stability, the central bank has effectively used a variety of instruments beyond the short-run interest rate. Foreign exchange interventions, macroprudential policies, reserve requirements, and, increasingly, the use of announcements are all now part of the toolkit of the monetary authority. For purists, this might not be labeled as textbook inflation targeting, but it is a strategy that is better suited to navigating the torrid waters

that developing countries have sailed through after the onset of the global financial crisis.

There are limits to our findings. The model presented here considers only a small subset of transmission channels, leaving out potentially important ones, and focuses on high-frequency data. The model does not consider longer horizons, since it is a monetary policy model that is naturally designed to be used at time horizons of one to two years. Nor does it consider balance-sheet effects or the role of stocks in the economy or financial and real linkages, which may have been important in Colombia in the last ten years. Introducing these linkages into the model is beyond the scope of this study, but we suspect that if they were included in a structural dynamic stochastic general equilibrium (DSGE) model, it would be difficult to reject our main findings based on the same monthly data. Given the internal-external disconnect that characterizes the Colombian economy, the financial and real linkages may have been dealt with by the authorities using other policy instruments, such as capital requirements, restrictions on the balance-sheet management of banks, and countercyclical provisioning requirements. This is an empirical question that needs to be addressed in future research.

Appendix: Bayesian Impulse Response Functions

FIGURE A - 1. Impulse Response Function to a Demand Shock

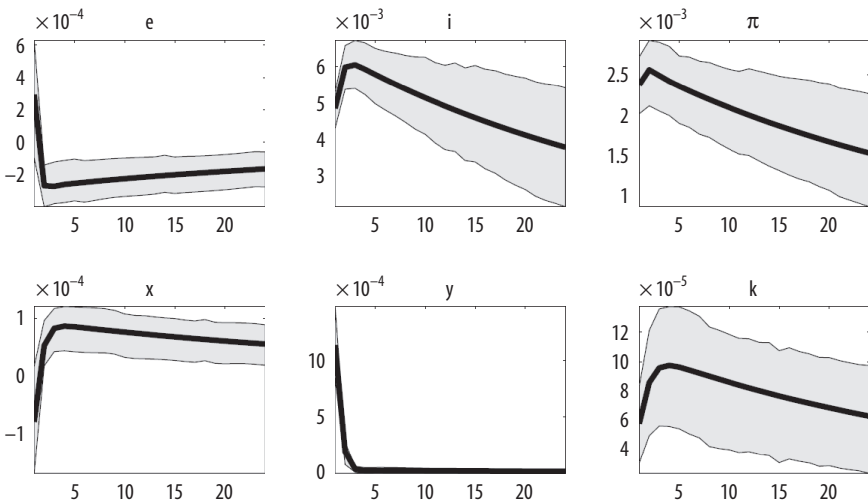


FIGURE A - 2 . Impulse Response Function to an Inflation Shock

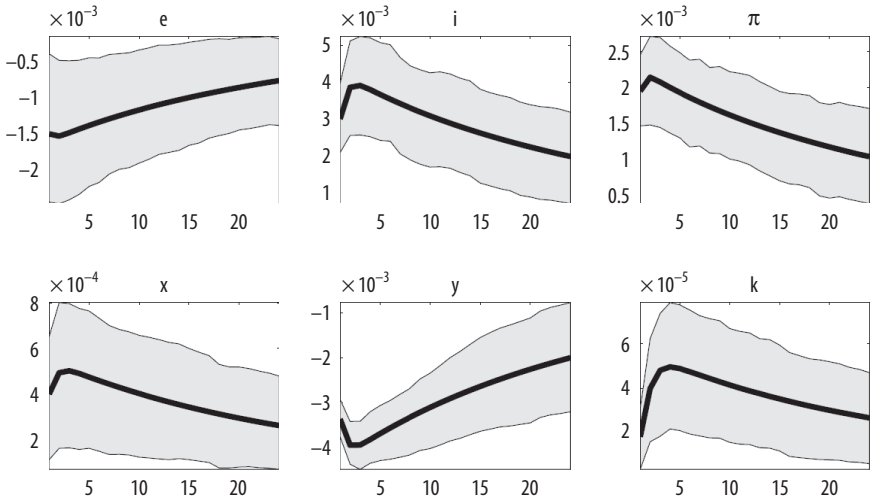


FIGURE A - 3 . Impulse Response Function to Monetary Policy Shock

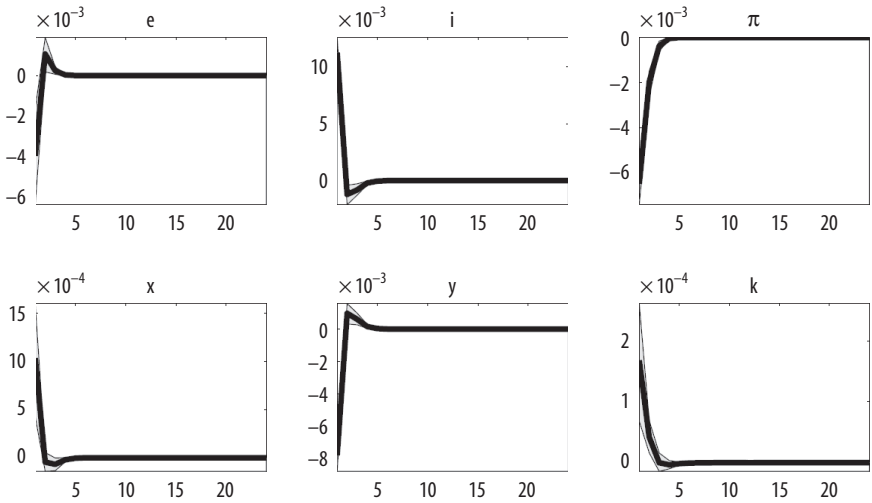


FIGURE A - 4. Impulse Response Function to Capital Flows Shock

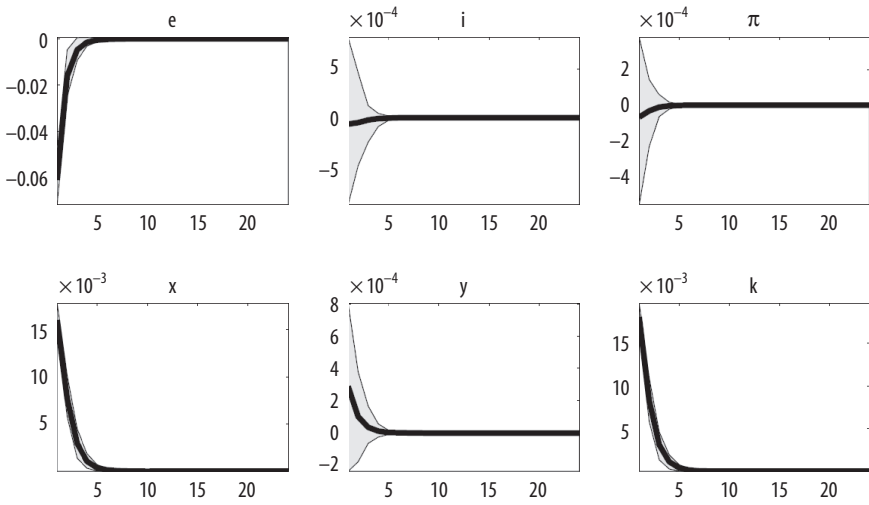


FIGURE A - 5. Impulse Response Function to FX Intervention Shock

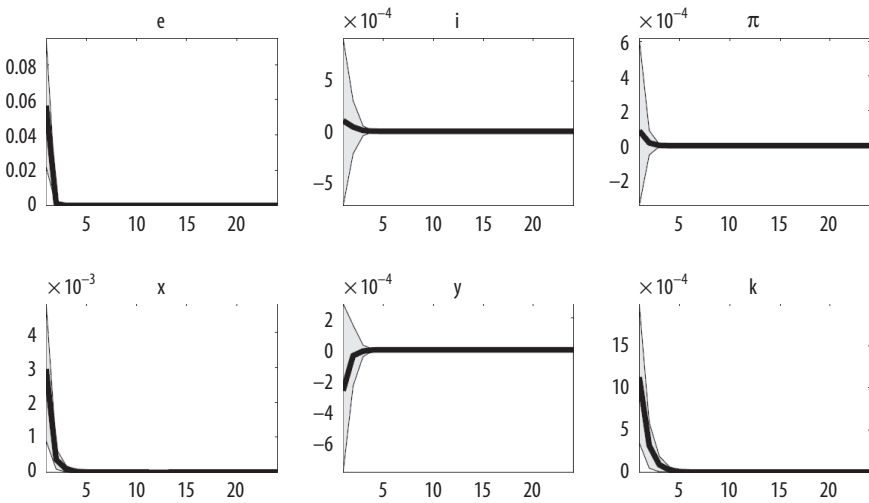


FIGURE A - 6 . Impulse Response Function to FX“News” Intervention Shock

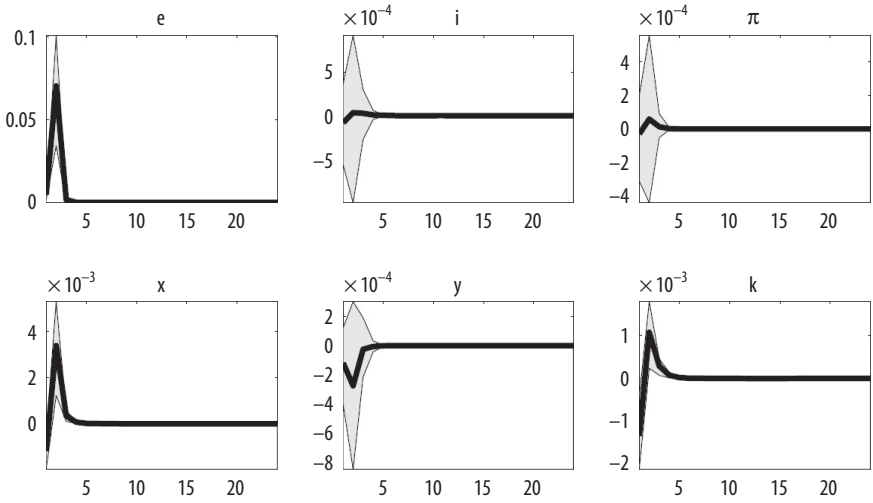
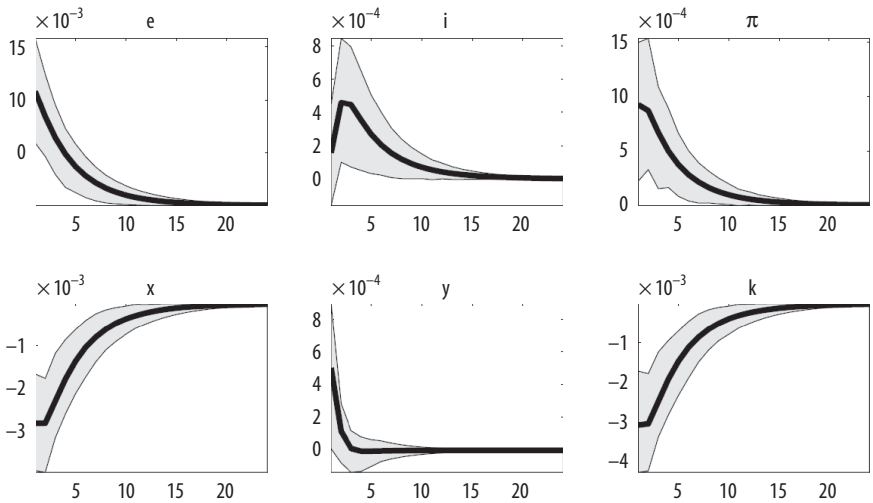


FIGURE A - 7 . Impulse Response Function to US Interest Rate Shock



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