

Two Models of FX Market Interventions: The Cases of Brazil and Mexico

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This paper compares empirically the implications of two distinct FX interventions models within the context of Inflation Targeting Regimes. To this purpose, it applies the VAR methodology developed by Kim (2003) to the cases of Mexico and Brazil. Our result can be readily summarized in three points. First, FX interventions have had a short-lived effect on the exchange rate in both Mexico and Brazil. Second, the Brazilian model of FX intervention entails higher inflation costs and this result cannot be entirely explained by differences in the level of pass-through. Third, each model yields interaction between exchange rate and conventional monetary policies (interest rate setting) of a different nature.

¹ The opinions expressed here are of the authors and do not necessarily represent those of CEMLA and or those of Banco de México. We would like to thank Alberto Ortiz Bolaños, Fabricio Orrego, Fernando Tenjo Galarza, Maria José Roa, Dalmir Louzada and other participants in the Meeting of the Central Bank Joint Research of the Americas. Please address e-mail correspondence to: renato.yslas@cemla.org and martin.tobal@banxico.org.mx.

I. Introduction

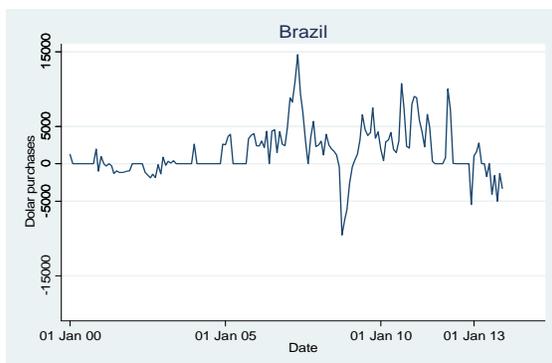
Historically, Latin America has seen a wide range of choices in terms of exchange rate and monetary policy regimes. Since the early 2000s a number of countries have opted for an Inflation Targeting Regime and devoted interest rate setting to meet the inflation target. Within this context, the main and almost exclusive goal of monetary policy has been to keep inflation under control. However, inflation targets and interest rate setting have come along with varying degrees of exchange rate flexibility. There is substantial heterogeneity in terms of exchange rate policies across countries and, therefore, different models of FX interventions coexist. This paper investigates whether a country's model of FX interventions conditions the effect of foreign currency purchases on the exchange rate, the country's performance in terms of inflation rates and the interaction between exchange rate and conventional monetary policies (interest rate setting). To this purpose, it uses the VAR model developed by Kim (2003) to compare the cases of Mexico and Brazil, two inflation target countries that represent distinct models of FX interventions.

When asked about the exchange rate policies followed by Mexico and Brazil, most economists would probably classify them as *managed floating* policies. However, as illustrated in Figures 1-2, using a single category for both countries would hide substantial differences across the two emerging markets. Figure 1 shows the majority of Brazilian interventions have involved net dollar purchases and, importantly, they have been performed on a regular basis. On the other hand, Mexico has intervened more sporadically (mostly in the aftermath of the 2008-2009 financial crisis) and by performing net dollar sales. Moreover, whereas Mexico has followed a pre-established rule, Brazil has primarily

used discretionary interventions. In summary, although both Mexico and Brazil are both inflation target countries, they represent two distinct models of FX interventions.

Foreign Exchange Intervention in Brazil and Mexico, 2000-2013 (Millions of dollars)

FIGURE 1

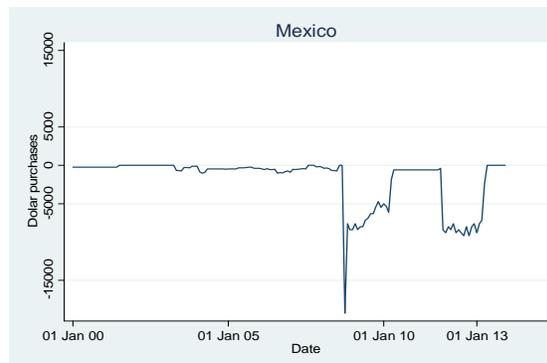


Source: Central Bank of Brazil.

*The Central Bank intervenes mainly by buying dollars.

**Foreign exchange intervention includes dollar purchases in the forward and spot markets, interventions through repo lines of credit and through foreign currency loans.

FIGURE 2



Source: Central Bank of Mexico.

*The Central Bank intervenes only by selling dollars.

**Foreign exchange intervention includes interventions through US dollar auctions, through the put options mechanism, through the mechanism to slow the pace of reserve accumulation and through the contingent dollar sales mechanism.

This paper compares the two models of FX interventions by employing the VAR structure setup with short run restrictions developed by Kim (2003). We adapt Kim's restrictions (2003) to the case of an emerging market and estimate his model with Mexican data on the one hand, and with Brazilian data on the other hand.² Our choice of Kim's (2003) methodology is driven by three facts. First, this method allows us to directly address the simultaneity bias present in the studies on the effects of intervention on the exchange rate. Second, we can use a single model to estimate the effects of FX interventions on a set of macroeconomic variables (and not solely the exchange rate). Third, this method provides

² As mentioned below, Kim (2003) examines the interaction between FX interventions and interest rate setting for the case of the U.S.

a unified framework to analyse the interaction between FX interventions, exchange rate and monetary policies (interest rate setting).

Our first result shows that FX interventions have had a short-lived effect on the exchange rate in both Mexico and Brazil: A positive one-standard deviation shock in FX interventions is associated with depreciations of the Reals and of the Mexican peso during one and two months, respectively. This result is consistent with findings in the literature that fully sterilized interventions have significant effects on the exchange rate in the short run (interventions are found to be sterilized in our model; see Tapia and Tokman, 2004; Rincón and Toro, 2010; Kamil, 2008; Echavarría et al., 2010; Echavarría et al., 2009; Kohlscheen and Andrade, 2013; Guimarães, 2004 and Section II for a review of this literature)

Our second result demonstrates that FX interventions have no inflation costs in Mexico but these interventions are costly in terms of inflation in Brazil. We inquire whether this result is driven by cross-country differences in exchange rate pass-through by studying the response of inflation to a shock in the exchange rate. Neither the timing nor the level of this response suggests that pass-through can entirely explain the higher inflation costs borne by Brazil. We then conclude that FX interventions are associated with higher inflation rates in Brazil, regardless of their effect on the exchange rate. To put it differently, the FX interventions model adopted by Brazil seems to be inherently related to higher inflation rates (relative to the Mexican model).

Our third result deals with the interaction between exchange rate and conventional monetary policies. We study the response of interest rate setting to the FX intervention shock in each country. The outcome shows this interaction is of a different nature in each FX intervention model. Whereas the Central of Mexico raises the interest rate immediately

after the shock, the response of the Central Bank of Brazil appears four months later. We conclude this result is linked to the fact that Brazil intervenes in the FX market on a regular basis. In particular, the relatively higher frequency with which the interventions are performed may make it more difficult to implement along with each intervention an increase in the interest rate. Moreover, the late response of the interest rate in Brazil partially explains our second result, according to which FX interventions have higher inflation costs in this country.

As more thoroughly explained in Section II, the paper make two main contributions to studies that investigate the effectiveness of FX interventions in Mexico and Brazil. First, we base our study on a single model for conventional monetary policy, FX interventions and exchange rate. From a methodological point of view, this contribution is relevant because FX interventions, monetary policy and exchange rate interact with each other and not account for this interaction may generate sizable bias (Kim, 2003). Second, we compare the two countries and, therefore, asses the implications of choosing different models of FX interventions.

The rest of the paper is organized as follows. Section II reviews related literature and highlights the contributions of the paper to this literature. Section III explains the data, the methodology and the identifying assumptions employed in the analysis. Section IV discusses the empirical results and Section V examines the robustness of the results. Finally, section VI concludes.

II. Related Literature

This paper relates to a set of studies investigating whether sterilized FX interventions are effective in affecting the level and volatility of the exchange rate. To investigate this issue,

the literature has primarily employed single equation econometric models such as GARCH specifications, cross-country studies and event study approaches. Overall, the literature is not conclusive on the effectiveness of FX interventions. Whereas some papers support the idea that FX are effective solely in the short run, others find no evidence of significant effects (see Sarno and Taylor (2001), Neely (2005) and Menkhoff (2012) for literature reviews).

For the particular case of Latin America, most studies show that FX interventions affect the level of the exchange rate in the short-run but are mixed about their effects on volatility (see Tapia and Tokman, 2004; Domaç and Mendoza, 2004; Kamil, 2008; Rincón and Toro, 2010; Adler and Tovar, 2011; Kohlscheen and Andrade, 2013; Broto, 2013; García-Verdú and Zerecero (2014) and García-Verdú and Ramos-Francia (2014)). For Brazil, Stone et al. (2009) show that measures aimed at providing liquidity to the FX market affect the level and volatility of the Reals/US dollar rate.³ Kohlscheen and Andrade (2013) use intraday data to demonstrate that a central bank's offer to buy currency swaps appreciates the exchange rate in Brazil.⁴ For Mexico, Domaç and Mendoza (2004) find that dollar sales by the Central Bank appreciate the peso and have a negative impact on its volatility, while dollar purchases are found to be not statistically significant. In contrast, Broto (2013) employs a larger period (July 21st 1996–June 6th 2011) to show that both foreign currency purchases and sales are associated with lower exchange rate volatility. García-Verdú and Zerecero (2014) find that auctions of dollars without a minimum price by the Central Bank of Mexico has been effective in providing liquidity and promoting orderly conditions in the

³ Stone et al. (2009) study measures taken in the aftermaths of the 2008-2009 financial crisis. They find that spot dollar sales and the announcements on futures market intervention appreciate the local currency.

⁴ Note that by selling a currency swap to the Central Bank, the financial institution receives the equivalent of the exchange rate variation plus a local onshore US interest rate. This reduces its demand for foreign currency, consequently appreciating the exchange rate.

FX market.⁵ Finally, García-Verdú and Ramos-Francia (2014) find little statistical effects of interventions on the exchange rate risk-neutral densities in Mexico.⁶

In contrast with the studies on the effectiveness of FX interventions mentioned above, this paper does not employ a uni-equational econometric model for the exchange rate. Instead, we analyse this issue in a unifying framework for FX interventions, monetary policy, exchange rate and inflation (among other variables). This is relevant because, as argued by Kim (2003), the two types of policies and the exchange rate interact with each other.

The paper also relates closely to a strand of this literature that estimates a rich set of macroeconomic relationships and interactions between FX interventions and conventional monetary policy (see Kim, 2003; Guimarães, 2004 and Echavarría et al, 2009). To estimate these relationships, the literature employs structural VAR frameworks with short run restrictions. For instance, Kim (2003) uses monthly data to show that net purchases of foreign currency substantially depreciates the exchange rate in the U.S. He also finds that, even if these purchases are sterilized, they have significant effects on monetary variables in the medium run. Following Kim's framework (2003), Echavarría et al. (2009) jointly analyse the effects of FX intervention and conventional monetary policy on the exchange rate, interest rate, and other macroeconomic variables for Colombia. They show that foreign currency purchases devalue the nominal exchange rate over 1 month.⁷

⁵ García-Verdú and Zerecero (2014) show that this modality of intervention is associated with a lower bid-ask spread of the peso/dollar exchange rate.

⁶ García-Verdú and Ramos-Francia (2014) use options data to estimate the exchange rate risk-neutral densities.

⁷ Guimarães (2004) finds that yen purchases by the Central Bank of Japan appreciate the nominal exchange rate but have no significant effects on neither money supply nor interest rates.

In line with the VAR literature on FX interventions outlined above, this paper estimates the effects of interventions on a broader set of macroeconomic variables (including inflation and interest rates). In contrast with Kim (2003), Guimarães (2004) and Echavarría et al. (2009), we estimate these effects for two countries (Brazil and Mexico) that follow different models of intervention and analyse the implications of such differences in terms of inflation costs and interactions between FX intervention and conventional monetary policies.

Finally, the paper relates to papers studying the existence of exchange rate pass through. A number of papers have documented a notable reduction in the level of pass through in both Mexico and Brazil since the early 2000's (e.g. Cortés, 2013; Capistrán et al., 2011; Nogueira Jr and León-Ledesma, 2009; Nogueira Jr., 2007; Mihaljek and Klau, 2006; Belaisch, 2003). For instance, Nogueira Jr. (2007) shows the adoption of inflation targeting regimes has reduced the level of pass-through in Mexico and Brazil (among other emerging economies). Notwithstanding its reduction, there still are references to exchange rate pass through in both countries (see Barbosa, 2008, for the case of Brazil and Banco de Mexico's Inflation Report from April-June 2011 for the case of Mexico). In this paper, we argue that this pass-through cannot entirely explain the inflation costs associated with FX interventions.

III. Data and Methodology

A. Variable Definition and Structural VAR with Short-run Restrictions

We opt for restrictions linking endogenous variables in the short run for two reasons. First, the literature that uses long run restrictions frequently assumes money neutrality to

identify effects of monetary policy shocks (see Lastrapes and Selgin, 1995; Fackler and Mcmillin, 1998 and Mcmillin, 2001). Money neutrality is reasonable when linking real variables, but most of the variables in our VAR system are nominal. Second, models with short-run restrictions perform better in terms of accurately identifying FX market intervention and conventional monetary policy shocks (see Kim, 2003, and Faust and Leeper, 1997).⁸

Let y_t be the 7×1 vector which includes first differences of the endogenous variables we consider. These variables and the corresponding data are summarized by the following list: the money market interest rate is used for the interest rate (i_t), the monetary base is employed for the monetary aggregate (m_t), the consumer price index is employed for consumer prices (cpi_t), industrial production is used as a proxy for output (ip_t), the local currency price of dollar is used for exchange rate (e_t), a commodity price index is employed for commodity prices (pc_t) and, finally, net purchases of dollars are used for foreign exchange interventions (fei_t).^{9,10} These endogenous variables and data are the same as those considered by Kim (2003) and follow very closely Echavarría et al.'s

⁸ The correct identification of structural shocks rests on the correct estimation of the structural parameters. In this line, Faust and Leeper (1997) show that inferences from VARs based on long-run assumptions might not be reliable because of data limitations. They argue that the long-run effects of shocks are not precisely estimated in small samples, and this inaccuracy transfers to impulse-response exercises. In other words, structural shocks might not be correctly identified when assuming long-run restrictions in finite samples.

⁹ All variables are in log terms (multiplied by 100), with the exception of foreign exchange intervention and interest rates that are in percentage terms. We normalize foreign exchange intervention by the quadratic trend of the monetary base.

¹⁰ For Brazil, foreign exchange interventions refer to interventions in the forward and spot markets and interventions through repo lines of credit and foreign currency loans. For Mexico, foreign exchange interventions concern interventions through US dollar auctions, though the put options and contingent dollar sales mechanisms and sales aimed at slowing the pace of reserve accumulation.

approach (2009). In contrast with these papers, we take first differences to ensure that all the variables are stationary.¹¹

The period under interest is defined to incorporate the “inflation targeting” period and we use monthly data (“high-frequency information”) to capture the impact of FX market interventions on the exchange rate; the sample period is thus defined as 2000M1-2013M12. The data come from different sources: The Central Bank of Brazil, the International Financial Statistics of the IMF, and the Central Bank of Mexico.

The dynamics of the Brazilian and the Mexican economies is defined by the following structural model

$$A_0 y_t = A(L) y_{t-1} + \varepsilon_t \quad (1)$$

where A_0 is a matrix of contemporaneous coefficients, $A(L)$ is a polynomial matrix in the lag operator L and ε_t is a 7×1 structural disturbance vector. The variance-covariance matrix of the structural disturbances is denoted by $\text{var}(\varepsilon_t) = \Sigma_\varepsilon$, in which the diagonal elements are the variances of structural disturbances and the non-diagonal elements are assumed to equal zero (so that the structural disturbances are assumed to be mutually uncorrelated).

The reduced form of the structural model is obtained by multiplying the inverse of A_0 on both sides of (1), and is written as follows

$$y_t = B(L) y_{t-1} + u_t \quad (2)$$

¹¹ According to the unit root tests for both Mexico and Brazil, all variables except foreign exchange interventions are integrated of order 1. Foreign exchange interventions are stationary in levels (see Appendix for further details).

where $B(L)$ is 7×7 polynomial matrix in the lag operator L and u_t is the 7×1 vector of reduced form (estimated) residuals with $\text{var}(u_t) = \Sigma_u$. By estimating Equation (2), we will obtain estimates of $\text{var}(u_t) = \Sigma_u$ that will allow us to recover the structural parameters of the model defined in Equation (1).

In order to recover the structural parameters, it is important to note that the residuals of the structural and of the reduced form are related by $\varepsilon_t = A_0 u_t$. This implies $\Sigma_\varepsilon = A_0 \Sigma_u A_0'$; and yields a system of 49 equations. Thus, to recover the structural parameters, we need to impose at least 28 restrictions on A_0 and Σ_ε because 28 of the system's equations are independent and, by plugging the sample estimates of $\text{var}(u_t) = \Sigma_u$, we are left with 56 unknowns.^{12,13} As explained below, we will impose 35 parameters' restrictions and over identify the system (see the next subsection for further details).

When imposing restrictions on A_0 , the structural VAR literature with short run restrictions frequently employs the conventional normalization of the simultaneous equation literature. That is, it assumes that the 7 diagonal elements of A_0 are equal to 1. Also very frequently, the additional 21 restrictions arise from the assumption that A_0 is

¹² In general, there are $n(n+1)/2$ independent equations, where n equals the number of endogenous variables: all the $n(n-1)/2$ off-diagonal elements of $A_0 \Sigma_u A_0'$ are equal to zero, and the n diagonal elements of $A_0 \Sigma_u A_0'$ are equal to the structural error variances. Furthermore, there are $n(n+1)$ structural parameters: the n^2 elements of A_0 plus the n diagonal elements of Σ_ε . Thus, once we assume the diagonal elements of A_0 or Σ_ε are equal to 1, we need to impose at least $n(n-1)/2$ additional restrictions.

However, imposing those $n(n+1)/2$ restrictions is a necessary but not a sufficient condition to identify the structural system. For a necessary and sufficient condition see propositions 9.1 and/or 9.3 of Lütkepohl (2005).

¹³ Imposing only 28 restrictions is a necessary but not a sufficient condition to identify the structural system.

lower triangular (this assumption is referred to as the Cholesky decomposition in this literature).

An issue with the Cholesky decomposition is that it imposes a recursive structure on the contemporaneous relationships among the variables given by A_0 , i.e. each variable is contemporaneously affected by those variables above it in the vector of endogenous variables y_t , but it does not contemporaneously affect them.¹⁴ From a practical perspective, the problem with the recursive structure is that outcomes are frequently sensitive to changes in the variable ordering. In other words, each ordering might imply a different system of equations and, thus, yield different results.

B. Defining Contemporaneous Restrictions

In contrast with the common practice in the VAR literature that assumes that the 7 diagonal elements of A_0 are equal to 1, we follow Cushman and Zha's (1997) and Sims and Zha's approach (2006) and restrict the main diagonal elements in Σ_ε to equal 1. This approach has the advantage of simplifying some formulas used in the inference and does not alter the economic substance of the system (Sims and Zha, 2006).¹⁵

With regards to the remaining 28 restrictions, we depart from the standard Cholesky decomposition by using the generalized method proposed by Blanchard and Watson (1986), Bernanke (1986) and Sims (1986). This approach allows for a broader set of contemporaneous relationships among the variables so that A_0 can have any structure,

¹⁴ Note that when A_0 is assumed to have a recursive structure, the assumption that the elements of its main diagonal equal 1 provides the additional restrictions to exactly identify the structural parameters.

¹⁵ Sims and Zha' (2006) argue that this method "compels the reader to remain aware that the choice of "left-hand-side" variable in the equations of models with the more usual normalization is purely a matter of notational convention, not economic substance" (page 248).

whether recursive or not. In particular, we impose the 28 short-run restrictions on A_0 listed in Table 1.¹⁶ Each row in this table can be interpreted as a contemporaneous equation; for instance, the first row tells us how foreign exchange interventions react contemporaneously to movements in the remaining variables (the interest rate, etc.).

Table 1. A_0 Matrix and Contemporaneous Restrictions

	Δfei_t	Δi_t	Δm_t	Δcpi_t	Δip_t	Δe_t	Δpc_t
Δfei_t	g_{11}	0	0	0	0	g_{16}	0
Δi_t	g_{21}	g_{22}	g_{23}	0	0	0	0
Δm_t	0	g_{32}	g_{33}	g_{34}	g_{35}	0	0
Δcpi_t	0	0	0	g_{44}	g_{45}	g_{46}	0
Δip_t	0	0	0	0	g_{66}	0	0
Δe_t	g_{61}	g_{62}	g_{63}	g_{64}	g_{65}	g_{66}	g_{67}
Δpc_t	0	0	0	0	0	0	g_{77}

Note in the first row of Table 1 we assume that foreign exchange interventions react contemporaneously solely to the exchange rate. This assumption is consistent with the evidence provided by the *leaning against the wind* literature and follows closely Kim (2003) and Echavarría et al. (2009)'s approach for the cases of the U.S. and Colombia, respectively.¹⁷

The second row introduces the contemporaneous responses of Δi_t . The g_{21} and g_{23} parameters are left free to allow for the possibility that interventions are not fully sterilized and, interestingly, to capture their contemporaneous interaction with monetary policy. The

¹⁶ The over-identification is not rejected by the likelihood ratio test at any conventional level. In particular, the statistic $\chi^2(7)$ equals 11.34 in the case of Brazil and 3.15 in the case of Mexico, with significance levels of 0.125 and 0.871 respectively (see Table A2 in the Appendix Section).

¹⁷ See, for instance, Adler and Tovar (2011) for a reference in this literature in which the main goal of interventions is to stabilize the exchange rate.

contemporaneous response of Δi_t to output and prices are assumed to be null (g_{24} and $g_{25} = 0$, which is based on Kim's argument that information on output and prices is not available within a month).¹⁸ The response to the exchange rate is set to 0 because both Mexico and Brazil (formally) conduct monetary policy under inflation targets. Furthermore, in line with Echavarría et al. (2009) but in contrast with Kim (2003), g_{27} is assumed to equal 0. Kim (2003) assumes otherwise to solve the standard "price puzzle" that characterizes the U.S. economy. The Appendix Section shows this puzzle appears only for Brazil and, to tackle this issue, Section IV shows that allowing for g_{27} to be different from 0 does not alter any of our qualitative results.

The third row in Table 2 denotes the conventional money demand equation and the fourth and fifth rows determine price and output (see Sims and Zha (2006), Kim (1999), Kim and Roubini (2000), Kim (2003) and Echavarría et al. (2009) for other papers using the same money demand specification). The g_{41} , g_{42} , g_{43} , g_{47} , g_{51} , g_{52} , g_{53} , g_{54} , g_{56} , g_{57} parameters are set to 0 because, as argued by Kim (2003), inertia, adjustment costs and planning delays preclude firms from changing either prices or output immediately in response to monetary policy. On the other hand, we take an agnostic approach with regards to contemporaneous "exchange rate pass-through." That is, we let prices contemporaneously respond to the exchange rate and thus leave the g_{46} parameter free (Section IV shows that changing this assumption does not alter our qualitative results; see Section II for comments about pass-through in Cortés (2013), Capistrán et al. (2011), Nogueira Jr and León-Ledesma (2009), Barbosa (2008), Nogueira Jr. (2007), Mihaljek and Klau (2006) and Belaisch (2003)).

¹⁸ This assumption has been widely used in the monetary literature of the business cycles. See Gordon and Leeper (1994); Kim and Roubini (2000) and Sims and Zha (2006) for references.

In the sixth row, we let the exchange rate to respond contemporaneously to all of the variables. These assumptions are in line with Echavarría et al. (2009) but contrast with Kim (2003). Our argument and Echavarría et al. (2009)'s for the case of Colombia is that commodity prices are more relevant in determining the local currency in developing countries than in determining the U.S. Dollar.

Finally, in the seventh row, we assume that commodity prices are contemporaneously exogenous. This assumption arises from the fact that the economic conditions of Brazil and Mexico do not have such a strong impact on the IMF's price index of commodities as the economic conditions of the U.S. Brazil, for instance, is a large exporter of sugar, coffee, beef, poultry meat, soybeans, soybean meal and iron ore. However, these products represent only 0.16 per cent of non-fuel commodities, which in turn represent only an average of 0.37 of the commodity price index used in this paper. Along the same lines, Mexico produces a small world share of its main export commodity: crude petroleum.¹⁹

IV. Results

We add a constant, 4 lags, the U.S. federal funds rate and a dummy variable for 2008:10-2009:6 to the reduced-form in Equation (2) and estimate the resulting model.²⁰

A. Impulse Responses to FEI Shocks

¹⁹ This data refers to the IMF's Commodity Price Index calculated between 2004 and 2013 (<http://www.imf.org/external/np/res/commod/index.aspx>).

²⁰ The dummy variable is included to account for the recent financial crisis. The resulting reduced form of the model is written as follows: $y_t = B_0 + B(L)y_{t-1} + Fx_t + u_t$, where B_0 is the vector of constants, $B(L)$ is a polynomial matrix in the lag operator L , F is the matrix of coefficients associated to the exogenous variables, x_t is the vector of exogenous variables, and u_t is the vector of reduced form residuals.

Figures 3-8 and 11-18 report the responses of the endogenous variables to a one standard deviation shock in FX interventions. The figures that appear on the right refer to the impulse responses for Mexico and those that appear on the left refer to the case of Brazil. In order to facilitate the comparison we use the same scale in all figures.

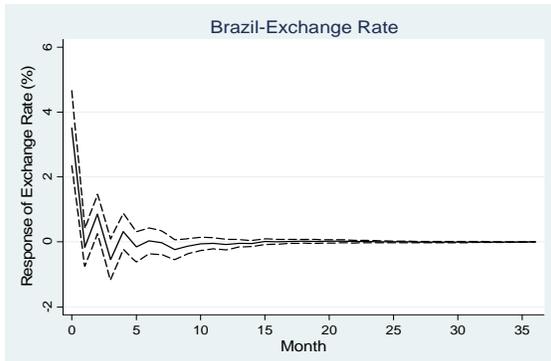
Figures 3-4 are informative on the effectiveness of FX market interventions. These figures show that net dollar purchases are associated with a significant impact on the exchange rate. In both Brazil and Mexico the sign of the response is as expected since a positive FX interventions shock generates a depreciation of the Reals and of the Peso (Figures 3 and 4, respectively). In both countries the effect is short-lived: Whereas in Mexico this effect lasts two months, it dies out one month after the intervention in Brazil.

Figures 5-6 refer to the reaction of monetary bases to the positive FX intervention shock. Note that there are some fluctuations right after the shock in Brazil. However, the contemporaneous response of the monetary base is not significant in either Mexico or Brazil. This result, along with the evidence displayed in Figures 11-12, shows that FX interventions are not associated with an immediate expansion in the monetary conditions (i.e. an increase in the monetary base and a fall in the interest rate). Hence, we conclude that the interventions are fully sterilized in both Mexico and Brazil.

Putting together Figures 3-6 allows us to link our results with the empirical literature. In particular, the result presented in this paper are consistent with the findings that fully sterilized interventions have significant effects on the exchange rate in the short run (see Tapia and Tokman, 2004; Rincón and Toro, 2010; Kamil, 2008; Echavarría et al., 2010; Echavarría et al., 2009; Kohlscheen and Andrade, 2013; Guimarães, 2004 and Section II for a review of this literature). This consistency with the empirical literature provides external validity to the identification strategy we have pursued.

Impulse Responses to FX Intervention Shocks

FIGURE 3



Sources: Central Bank of Brazil and authors' calculations.

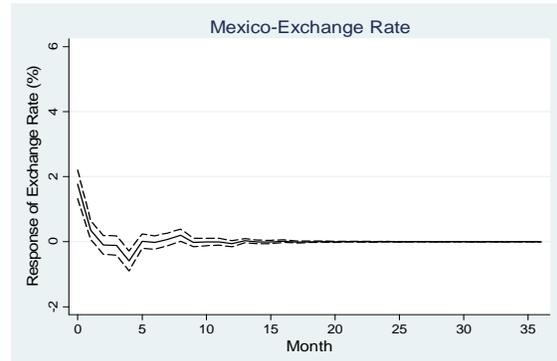
*The figure depicts the response to a positive FX intervention shock in $t=0$.

**The dashed lines are 90% confidence bounds.

***Exchange rate depreciates on impact and goes up further 2 months later.

****Exchange rate is defined as national currency per US dollar.

FIGURE 4



Sources: Central Bank of Mexico and authors' calculations.

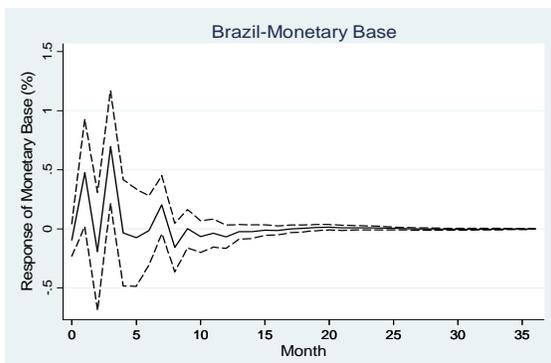
*The figure depicts the response to a positive FX intervention shock in $t=0$.

**The dashed lines are 90% confidence bounds.

***Exchange rate depreciates on impact and goes up further one month later. Four months after the shock, it appreciates a bit.

****Exchange rate is defined as national currency per US dollar.

FIGURE 5



Sources: Central Bank of Brazil and authors' calculations.

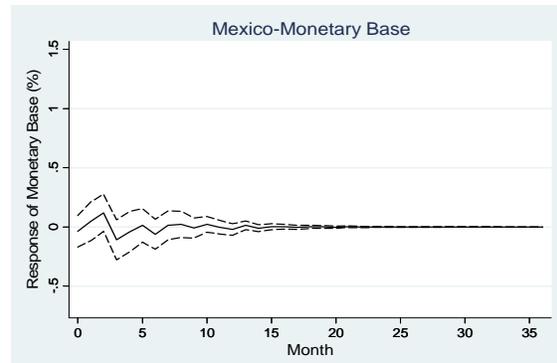
*The figure depicts the response to a positive FX intervention shock in $t=0$.

**The dashed lines are 90 % confidence bounds.

***Monetary base fluctuates a bit in response: It increases 1 and 3 months after the shock.

****Monetary base is defined as the sum of the currency issued by the Central Bank and the banking reserves.

FIGURE 6



Sources: Central Bank of Mexico and authors' calculations.

*The figure depicts the response to a positive FX intervention shock in $t=0$.

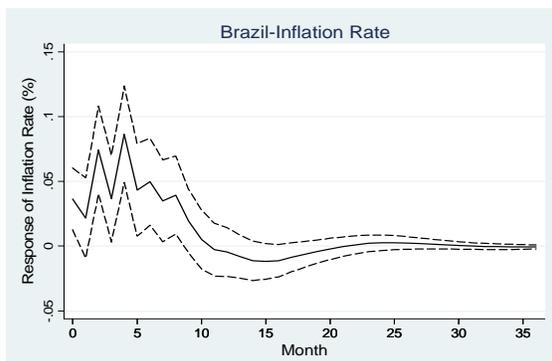
**The dashed lines are 90 % confidence bounds.

***Monetary base does not respond significantly to intervention shocks.

****Monetary base is defined as the sum of the currency issued by the Central Bank and the banking reserves.

Impulse Responses to FX Intervention Shocks (Continuation)

FIGURE 7



Sources: Central Bank of Brazil and authors' calculations.

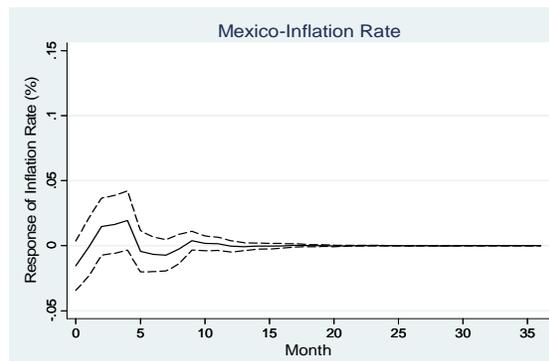
*The figure depicts the response to a positive FX intervention shock in $t=0$.

**The dashed lines are 90 % confidence bounds.

***Inflation goes up on impact and then continues increasing from 2 to 8 months after the shock.

****Inflation is defined as the percentage change in the consumer price index.

FIGURE 8



Sources: Central Bank of Mexico and authors' calculations.

*The figure depicts the response to a positive FX intervention shock in $t=0$.

**The dashed lines are 90 % confidence bounds.

***Inflation does not respond significantly to intervention shocks.

****Inflation is defined as the percentage change in the consumer price index.

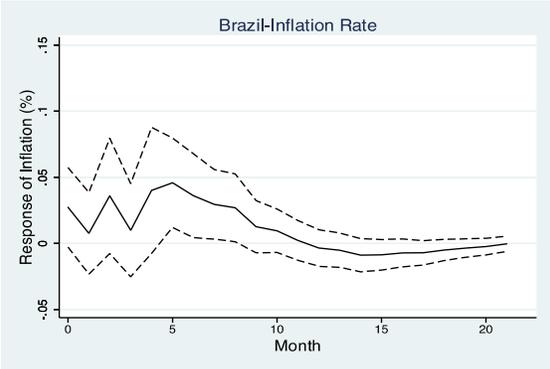
Figures 7- 8 provide information on the inflation costs of FX interventions; they show the response of the inflation rate to a positive FX interventions shock in Mexico and Brazil, respectively. Note in these figures that the response of the inflation rate differs significantly across countries. In Brazil, a positive FX intervention shock is associated with significant increases in the inflation rate. This rate increases on impact and remains significantly high in Brazil until the eight month (the effect is not statistically significant in the first month). The response of the inflation rate peaks at months 2 and 4, with significant increases of 0.074 and 0.086, respectively. Note in Figure 8 that the shock, on the other hand, does not have a significant impact on inflation in Mexico at any period of time. Hence, whereas FX market interventions are costless in Mexico, they are costly in terms of inflation in Brazil.

The differential response of the inflation rate in Mexico and Brazil may refer to cross-country differences in pass-through. If the inflation rate responded more quickly and to a

significantly greater extent in Brazil, the inflation costs borne by this country would be entirely explained by differences in the level and timing of pass-through. To further investigate this issue, we examine the responses of the inflation rate to a shock in the exchange rate and display the results in Figures 9-10.

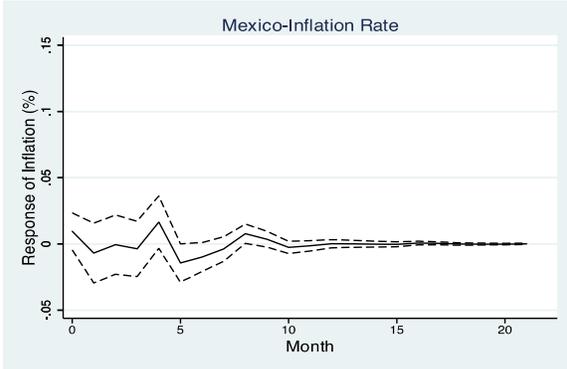
Response of Inflation Rate to Exchange Rate Shocks

FIGURE 9



Sources: Central Bank of Brazil and authors' calculations.
 *The figure depicts the response to a positive exchange rate shock in $t=0$.
 **The dashed lines are 90 % confidence bounds.
 ***Inflation goes up in response five months after the shock and keeps rising until the eight month.
 ****Inflation is defined as the percentage change in the consumer price index.
 *****In order to facilitate visualization, we plot the response only over a 22 month horizon. The effect is, however, not significant after month 22.

FIGURE 10



Sources: Central Bank of Mexico and authors' calculations.
 *The figure depicts the response to a positive exchange rate shock in $t=0$.
 **The dashed lines are 90 % confidence bounds.
 ***Inflation goes up in response eight months after the shock.
 ****Inflation is defined as the percentage change in the consumer price index.
 *****In order to facilitate visualization, we plot the response only over a 22 month horizon. The effect is, however, not significant after month 22.

Figure 10 shows that, in line with the evidence provided by Cortés (2013), Capistrán et al. (2011) and Nogueira Jr. (2007), the response of the inflation rate is statistically non-significant in Mexico (except for a tiny increase in the eight month). Figure 9 shows the response is significant in Brazil but its timing and extent suggests that pass-through cannot entirely explain the results observed in Figure 7: The inflation increases on impact and peaks in the fourth month in response to the FX interventions shock (Figure 7), but it only begins to increase significantly in the fifth month in response to the shock in the exchange

rate (Figure 9). Furthermore, the maximum response of the inflation rate to this shock equals 0.046 percentage points, which suggests a relatively small pass-through in Brazil. This result is consistent with the evidence presented in Section II, according to which this country has seen a significant reduction in the response of inflation to variations in the exchange rate (Nogueira Jr. and León-Ledesma (2009), Nogueira Jr. (2007), Mihaljek and Klau (2006) and Belaisch (2003)).

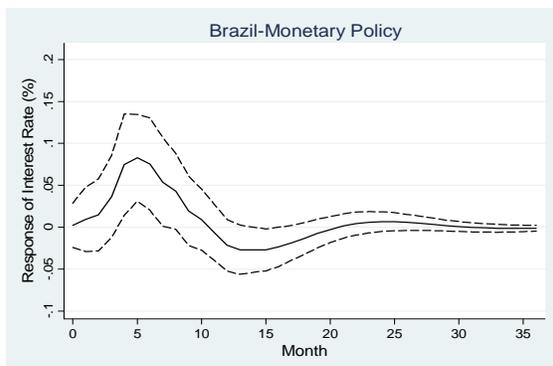
The fact that pass-through cannot entirely explain the differential inflation costs of FX interventions in Mexico and Brazil suggests the Brazilian model is inherently associated with higher inflation rates. To put it differently, FX interventions are associated with higher inflation in Brazil, regardless of their impact on the exchange rate. Thus, these interventions must cause an inflation increase through alternative mechanisms. A probable mechanism refers to the discretionary nature of the net dollar purchases performed by the central bank. Because one would expect expectations on inflation to be more unstable in a discretionary model, FX interventions may increase these expectations thereby actually increasing the inflation rate.

Before proceeding to the next subsection, we compare the interaction between exchange rate and conventional monetary policies across the two FX interventions models. Figures 11 and 12 display the responses of the interest rate to the FX interventions shock in Brazil and Mexico, respectively. Note in these figures that the nature of the interaction between the policies is of a different nature in each country. Whereas the interest rate increases immediately in response to the shock in Mexico, the Central Bank of Brazil raise this rate only four months after the shock. In other words, we observe a “late” response of interest rate setting in Brazil relative to Mexico. This result is not surprising given that the Brazilian model entails FX interventions that are performed on a more regular basis. The relatively

higher frequency with which the interventions are performed may make it more difficult to implement along with each intervention an increases in the interest rate. Thus, we observe in Figure 12 a late response of the interest rate to the FX interventions shock.

Impulse Responses to FX Intervention Shocks (Continuation)

FIGURE 11



Sources: Central Bank of Brazil and authors' calculations.

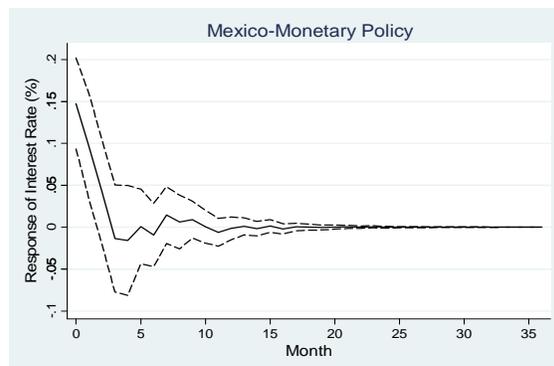
*The figure depicts the response to a positive FX intervention shock in $t=0$.

**The dashed lines are 90 % confidence bounds.

***Interest rate increases four months after the shock and remains increasing until the 7th month.

****Money market interest rate is used for the interest rate.

FIGURE 12



Sources: Central Bank of Mexico and authors' calculations.

*The figure depicts the response to a positive FX intervention shock in $t=0$.

**The dashed lines are 90 % confidence bounds.

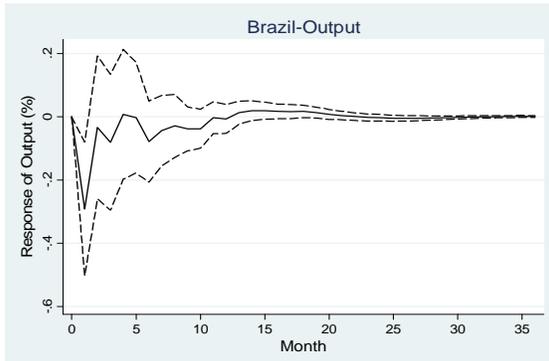
***Interest rate goes up on impact and increases again the next month.

****Money market interest rate is used for the interest rate.

The fact that interest rate setting responds later in Brazil may partially explain the results observed in Figures 7-8. Whatever the mechanism through which the Brazilian inflation increases is, the late response of monetary policy does not help reduce the differential response of the inflation rate to the FX interventions shock.

Impulse Responses to FX Intervention Shocks (Continuation)

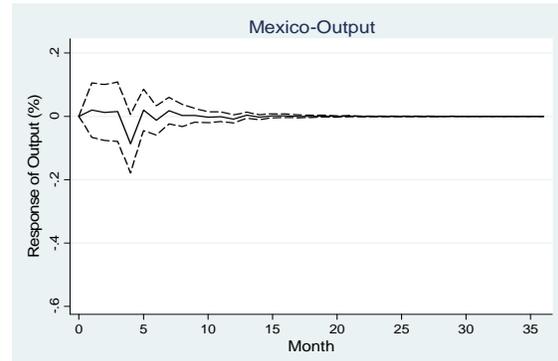
FIGURE 13



Sources: Central Bank of Brazil and authors' calculations.

- *The figure depicts the response to a positive FX intervention shock in $t=0$.
- **The dashed lines are 90 % confidence bounds.
- ***Output falls in response 1 month after the shock.
- ****Industrial production is used as a proxy for output.

FIGURE 14



Sources: Central Bank of Mexico and authors' calculations.

- *The figure depicts the response to a positive FX intervention shock in $t=0$.
- **The dashed lines are 90 % confidence bounds.
- ***Output does not significantly respond to intervention shocks.
- ****Industrial production is used as a proxy for output.

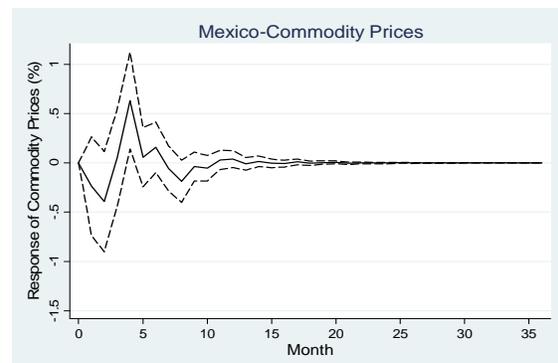
FIGURE 15



Sources: Central Bank of Brazil and authors' calculations.

- *The figure depicts the response to a positive FX intervention shock in $t=0$.
- **The dashed lines are 90 % confidence bounds.
- ***Commodity prices fall in response 1 month after the shock, and goes down further 7 months later.
- ****IMF's commodity price index is used for commodity prices.

FIGURE 16

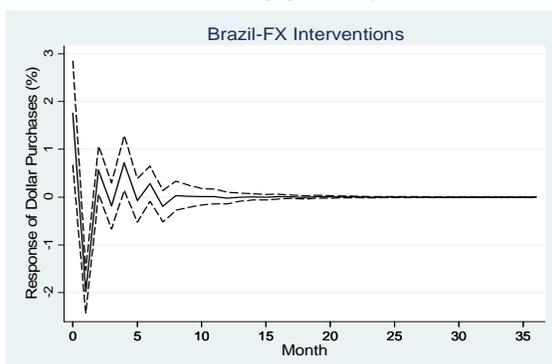


Sources: Central Bank of Mexico and authors' calculations.

- *The figure depicts the response to a positive FX intervention shock in $t=0$.
- **The dashed lines are 90 % confidence bounds.
- ***Commodity prices go up in response 4 months after the shock.
- ****IMF's commodity price index is used for commodity prices.

Impulse Responses to FX Intervention Shocks (Continuation)

FIGURE 17



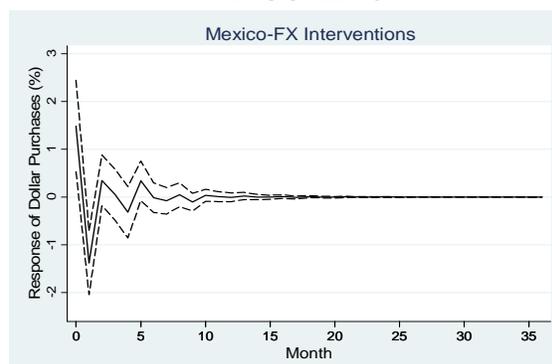
Sources: Central Bank of Brazil and authors' calculations.

*The figure depicts the response to a positive FX intervention shock in $t=0$.

**The dashed lines are 90 % confidence bounds.

***Dollar purchases increase on impact and then fluctuate in the next four months.

FIGURE 18



Sources: Central Bank of Mexico and authors' calculations.

*The figure depicts the response to a positive FX intervention shock in $t=0$.

**The dashed lines are 90 % confidence bounds.

***Dollar purchases increase on impact and reduce in the next month.

B. Variance Decomposition

Tables 2-3 display the forecast error variance decomposition of inflation for Brazil and Mexico, respectively. Each row in these tables refers to one of the seven shocks and shows the proportion of the variance in the inflation rate that is explained by the corresponding shock. Let us first focus on how the proportions associated with FX interventions and exchange rate shocks vary over time. The first row in Table 2 shows that in Brazil the proportion of the variance in the inflation rate explained by FX intervention shocks increases over time and stabilizes by the 24th month. The seventh row shows that a similar conclusion can be drawn with regards to exchange rate shocks. This behaviour is also observed for Mexico in Table 3, with the only difference being that the proportions stabilize earlier in this country, i.e. by the 12th month.

Table 2. Forecast Error Variance Decomposition of Inflation in Brazil

Months	Shocks						
	FX Intervention	Interest Rate	Money Demand	Consumer Price	Output	Exchange Rate	Commodity Price
1 month	0.037 (0.028)*	0.000 (0.000)*	0.000 (0.000)*	0.936 (0.054)*	0.004 (0.010)*	0.021 (0.027)*	0.002 (0.003)*
6 month	0.175 (0.075)*	0.030 (0.035)*	0.036 (0.037)*	0.559 (0.083)*	0.061 (0.044)*	0.058 (0.063)*	0.081 (0.045)*
12 month	0.206 (0.089)*	0.032 (0.033)*	0.040 (0.038)*	0.506 (0.088)*	0.059 (0.042)*	0.079 (0.075)*	0.078 (0.041)*
24 month	0.208 (0.090)*	0.034 (0.035)*	0.042 (0.040)*	0.499 (0.090)*	0.060 (0.042)*	0.081 (0.077)*	0.078 (0.042)*
36 month	0.208 (0.090)*	0.034 (0.035)*	0.042 (0.040)*	0.499 (0.090)*	0.060 (0.042)*	0.081 (0.077)*	0.078 (0.042)*

Sources: Central Bank of Brazil and authors' calculations.

*Standard error in parentheses.

Table 3. Forecast Error Variance Decomposition of Inflation in Mexico

Months	Shocks						
	FX Intervention	Interest Rate	Money Demand	Consumer Price	Output	Exchange Rate	Commodity Price
1 month	0.008 (0.012)*	0.002 (0.004)*	0.000 (0.000)*	0.959 (0.032)*	0.027 (0.025)*	0.003 (0.005)*	0.000 (0.001)*
6 month	0.029 (0.026)*	0.023 (0.017)*	0.074 (0.039)*	0.810 (0.054)*	0.033 (0.024)*	0.016 (0.012)*	0.015 (0.019)*
12 month	0.032 (0.029)*	0.025 (0.017)*	0.074 (0.038)*	0.799 (0.056)*	0.033 (0.024)*	0.021 (0.014)*	0.017 (0.019)*
24 month	0.032 (0.029)*	0.025 (0.017)*	0.074 (0.038)*	0.799 (0.056)*	0.033 (0.024)*	0.021 (0.014)*	0.017 (0.020)*
36 month	0.032 (0.029)*	0.025 (0.017)*	0.074 (0.038)*	0.799 (0.056)*	0.033 (0.024)*	0.021 (0.014)*	0.017 (0.020)*

Sources: Central Bank of Mexico and authors' calculations.

*Standard error in parentheses.

There are substantial differences, however, in the magnitude of the proportions across countries. FX interventions shocks explain 3.7 percent of the variance in the Brazilian inflation rate one month after the shock and 20.8 percent from two years on. These figures are substantially higher than the corresponding 0.8 and 3.2 percent observed in the first and

seventh rows in Table 3 for the case of Mexico. Although the forecast error variance decomposition analysis does not aim at establishing a causal relationship between exchange policy and inflation rate, it supports the result that FX interventions are further more costly in Brazil than in Mexico (as mentioned in the previous subsection).

As for the proportions explained by shocks in the exchange rate, the figures are notably small in both countries. For Brazil, these proportions equal 2.1 and 8.1 percent at 1 and at 24 months, respectively. For Mexico, the proportions equal 0.3 and 2.1. These numbers support the idea that the level of pass-through is small in both economies.

Certainly, the level of pass-through is greater for Brazil than it is for Mexico in absolute terms. However, the proportion explained by exchange rate shocks is smaller relative to the corresponding proportion associated with FX interventions shocks for the case of Brazil. For instance, the difference between the figures that appear in the seventh and first rows equal 1.6 and 12.7 percent at 1 and 24 months for Brazil and 0.5 and 1.1 percent for Mexico. This result supports the result that differences in the level of pass-through cannot entirely explain the fact that FX interventions have higher inflation costs in Brazil than in Mexico.

V. Robustness

This subsection examines the robustness of our results by changing identifying restrictions. We focus on two cases: The contemporaneous response of the interest rate to commodity prices and the response of consumer prices to exchange rate shocks (concerned with the g_{27} and g_{46} parameters, respectively). Three reasons motivate this analysis. First, by imposing these restrictions, our model departs from either Kim's (2003) setup and/or Echavarría et al.'s (2009) approach. Second, the restriction on g_{27} is connected to the

empirical finding that some economies present a “price puzzle”, i.e. prices do not respond in the expected direction to conventional monetary policy. This finding is relevant to our study because the original set of contemporaneous restrictions we have imposed generates a “price puzzle” for the case of Brazil. Third, the restriction on g_{46} response is connected to contemporaneous pass-through and, therefore, is at the core of our main results.

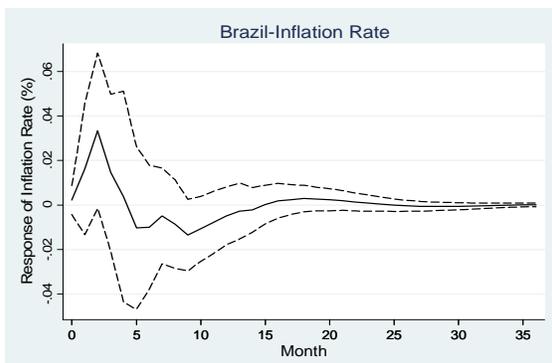
The review of the two identifying restrictions yields the three alternative models that are described by the following conditions: $g_{27} \neq 0$; $g_{46} = 0$; and $g_{46} = 0$ and $g_{27} \neq 0$. For the sake of brevity, we present solely the response of Δip_t to a shock in Δi_t for the first case and the responses of Δe_t , Δip_t and Δi_t to the FX interventions shock for the three cases. Presenting these responses allows us to show that the price puzzle disappears when $g_{27} \neq 0$ and to examine the robustness of the model to changes in the two identifying restrictions. Figures 19-38 show the responses for the three alternative models.

Note in Figure 19 that when $g_{27} \neq 0$, the price puzzle disappears in Brazil; a rise in the interest rate is not associated with an increase in the inflation rate²¹. In both this model and in the remaining two setups, the consideration of alternative identifying restrictions modifies neither the qualitative results nor the significance of the responses. In particular, in the three alternatives we observe that (i) FX interventions are effective in both countries and their effects on the exchange rate are short-lived; (ii) the inflation rises in response to the shock in Brazil but it does not respond in Mexico and (iii) the central bank increases the interest rate immediately after the shock in Mexico but it does not in Brazil.

²¹ However, leaving the parameter g_{27} free do not solve completely the puzzle; we do not observe a fall in the inflation rate in response to contractionary monetary policy shock as would be predicted by standard economic theory.

Response of Inflation Rate to Interest Rate Shocks under $g_{27} \neq 0$

FIGURE 19



Sources: Central Bank of Brazil and authors' calculations.

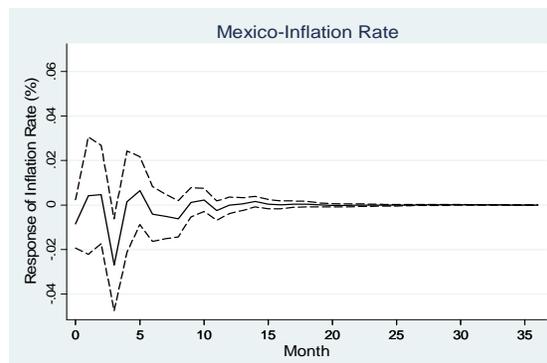
*The figure depicts the response to a positive interest rate shock in $t=0$.

**The dashed lines are 90 % confidence bounds.

***We do not find evidence of the *price puzzle*; i.e. inflation rate does not rise significantly in response to interest rate shocks.

****Inflation is defined as the percentage change in the consumer price index.

FIGURE 20



Sources: Central Bank of Mexico and authors' calculations.

*The figure depicts the response to a positive interest rate shock in $t=0$.

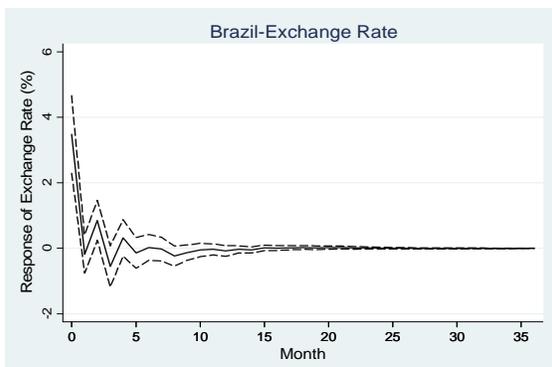
**The dashed lines are 90 % confidence bounds.

***Inflation rate goes down in response 3 months after the shock

****Inflation is defined as the percentage change in the consumer price index.

Impulse Responses to Foreign Exchange Intervention Shocks under Alternative Identifying Assumptions: $g_{27} \neq 0$

FIGURE 21



Sources: Central Bank of Brazil and authors' calculations.

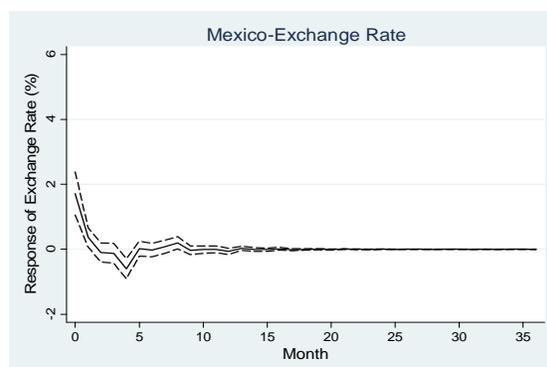
*The figure depicts the response to a positive FX intervention shock in $t=0$.

**The dashed lines are 90% confidence bounds.

***Exchange rate depreciates on impact and goes up further 2 months later.

****Exchange rate is defined as national currency per US dollar.

FIGURE 22



Sources: Central Bank of Mexico and authors' calculations.

*The figure depicts the response to a positive FX intervention shock in $t=0$.

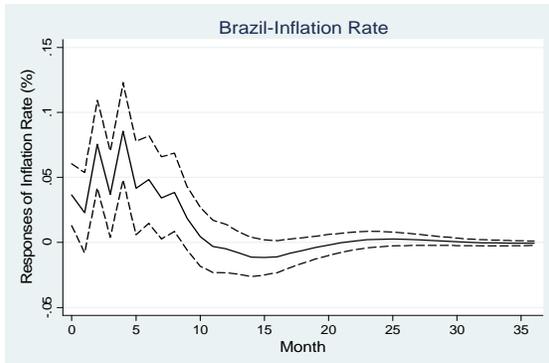
**The dashed lines are 90% confidence bounds.

***Exchange rate depreciates on impact and goes up further one month later. Four months after the shock, it appreciates a bit.

****Exchange rate is defined as national currency per US dollar.

**Impulse Responses to Foreign Exchange Intervention Shocks under
Alternative Identifying Assumptions: $g_{27} \neq 0$ (Continuation)**

FIGURE 23



Sources: Central Bank of Brazil and authors' calculations.

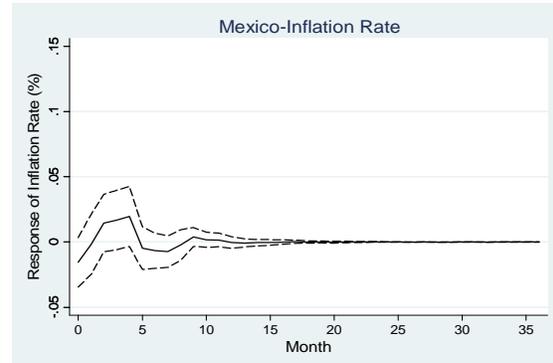
*The figure depicts the response to a positive FX intervention shock in $t=0$.

**The dashed lines are 90 % confidence bounds.

***Inflation goes up on impact and then continues increasing from 2 to 8 months after the shock.

****Inflation is defined as the percentage change in the consumer price index.

FIGURE 24



Sources: Central Bank of Mexico and authors' calculations.

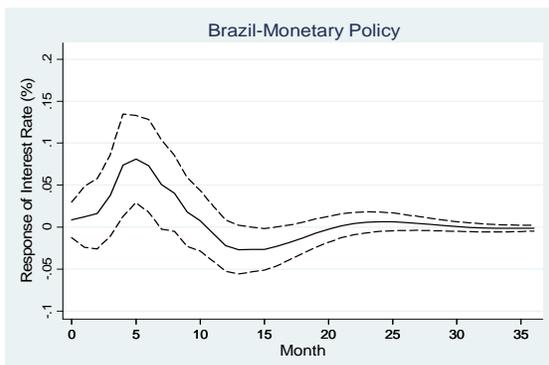
*The figure depicts the response to a positive FX intervention shock in $t=0$.

**The dashed lines are 90 % confidence bounds.

***Inflation does not respond significantly to intervention shocks.

****Inflation is defined as the percentage change in the consumer price index.

FIGURE 25



Sources: Central Bank of Brazil and authors' calculations.

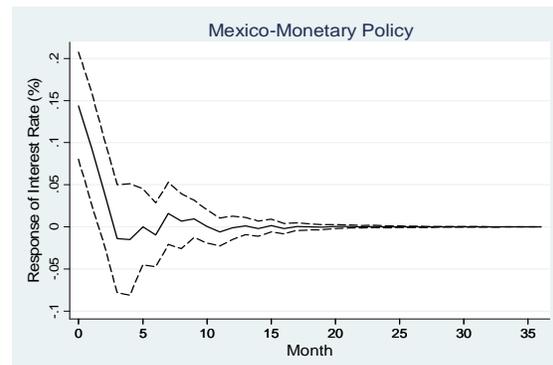
*The figure depicts the response to a positive FX intervention shock in $t=0$.

**The dashed lines are 90 % confidence bounds.

***Interest rate increases four months after the shock and remains increasing until the 6th month.

****Money market interest rate is used for the interest rate.

FIGURE 26



Sources: Central Bank of Mexico and authors' calculations.

*The figure depicts the response to a positive FX intervention shock in $t=0$.

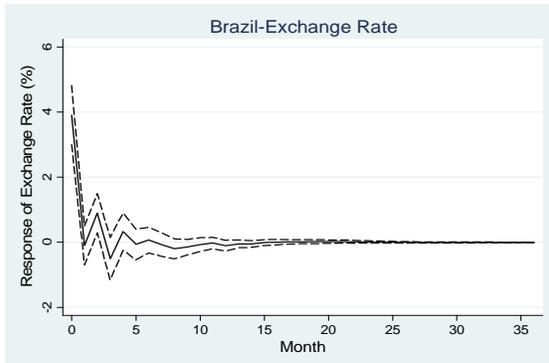
**The dashed lines are 90 % confidence bounds.

***Interest rate goes up on impact and increases again the next month.

****Money market interest rate is used for the interest rate.

Impulse Responses to Foreign Exchange Intervention Shocks under Alternative Identifying Assumptions: $g_{46} = 0$

FIGURE 27



Sources: Central Bank of Brazil and authors' calculations.

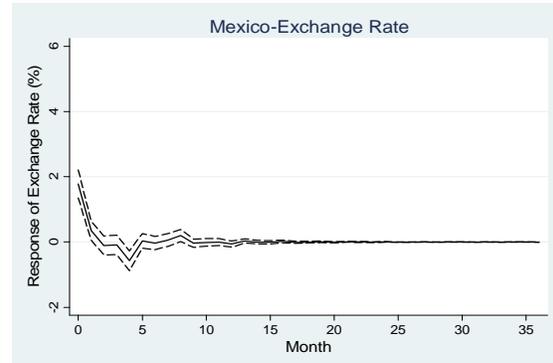
*The figure depicts the response to a positive FX intervention shock in $t=0$.

**The dashed lines are 90% confidence bounds.

***Exchange rate depreciates on impact and goes up further 2 months later.

****Exchange rate is defined as national currency per US dollar.

FIGURE 28



Sources: Central Bank of Mexico and authors' calculations.

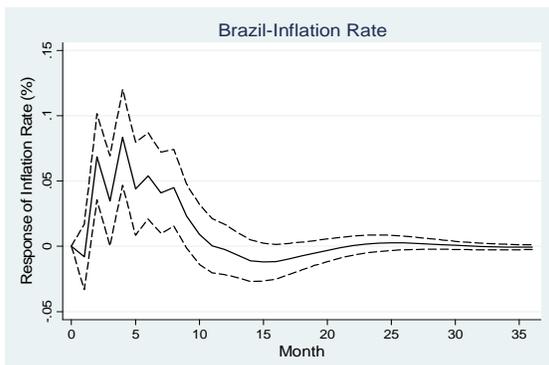
*The figure depicts the response to a positive FX intervention shock in $t=0$.

**The dashed lines are 90% confidence bounds.

***Exchange rate depreciates on impact and goes up further one month later. Four months after the shock, it appreciates a bit.

****Exchange rate is defined as national currency per US dollar.

FIGURE 29



Sources: Central Bank of Brazil and authors' calculations.

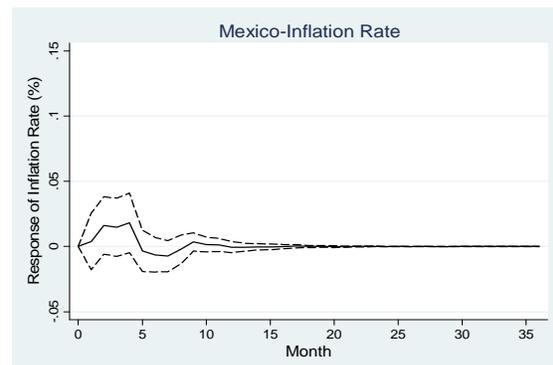
*The figure depicts the response to a positive FX intervention shock in $t=0$.

**The dashed lines are 90 % confidence bounds.

***Inflation goes up 2 months after the shock and keeps rising until the 8th month.

****Inflation is defined as the percentage change in the consumer price index.

FIGURE 30



Sources: Central Bank of Mexico and authors' calculations.

*The figure depicts the response to a positive FX intervention shock in $t=0$.

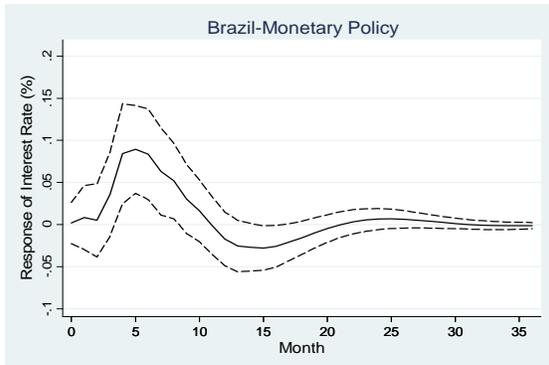
**The dashed lines are 90 % confidence bounds.

***Inflation does not respond significantly to intervention shocks.

****Inflation is defined as the percentage change in the consumer price index.

**Impulse Responses to Foreign Exchange Intervention Shocks under Alternative
Identifying Assumptions: $g_{46} = 0$ (Continuation)**

FIGURE 31



Sources: Central Bank of Brazil and authors' calculations.

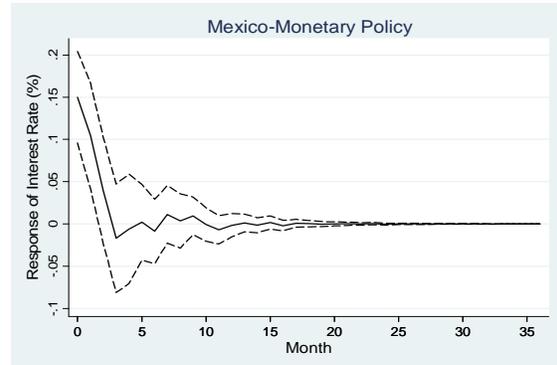
*The figure depicts the response to a positive FX intervention shock in $t=0$.

**The dashed lines are 90 % confidence bounds.

***Interest rate increases four months after the shock and remains increasing until the 8th month.

****Money market interest rate is used for the interest rate.

FIGURE 32



Sources: Central Bank of Mexico and authors' calculations.

*The figure depicts the response to a positive FX intervention shock in $t=0$.

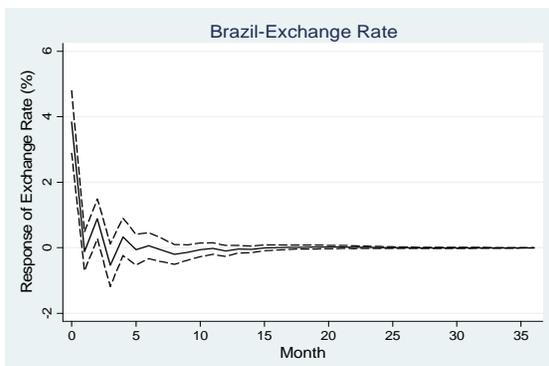
**The dashed lines are 90 % confidence bounds.

***Interest rate goes up on impact and increases again the next month.

****Money market interest rate is used for the interest rate.

**Impulse Responses to Foreign Exchange Intervention Shocks under Alternative
Identifying Assumptions: $g_{46} = 0$ and $g_{27} \neq 0$**

FIGURE 33



Sources: Central Bank of Brazil and authors' calculations.

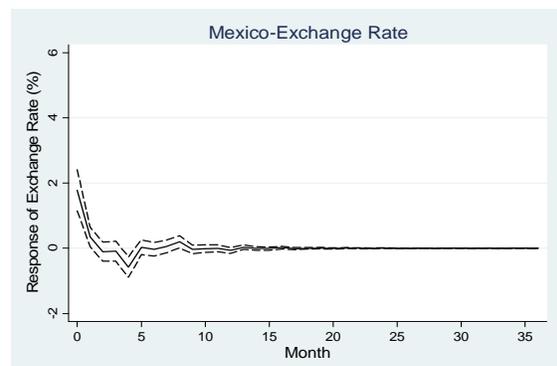
*The figure depicts the response to a positive FX intervention shock in $t=0$.

**The dashed lines are 90% confidence bounds.

***Exchange rate depreciates on impact and goes up further 2 months later.

****Exchange rate is defined as national currency per US dollar.

FIGURE 34



Sources: Central Bank of Mexico and authors' calculations.

*The figure depicts the response to a positive FX intervention shock in $t=0$.

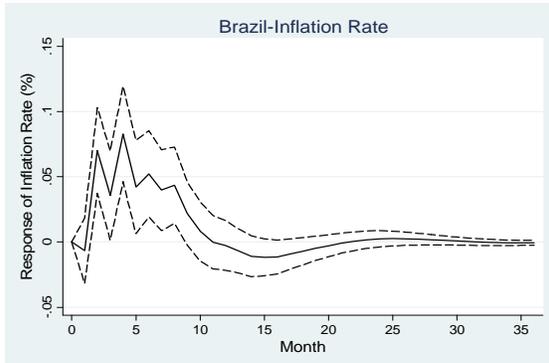
**The dashed lines are 90% confidence bounds.

***Exchange rate depreciates on impact and goes up further one month later.

****Exchange rate is defined as national currency per US dollar.

**Impulse Responses to Foreign Exchange Intervention Shocks under
Alternative Identifying Assumptions: $g_{46} = 0$ and $g_{27} \neq 0$ (Continuation)**

FIGURE 35



Sources: Central Bank of Brazil and authors' calculations.

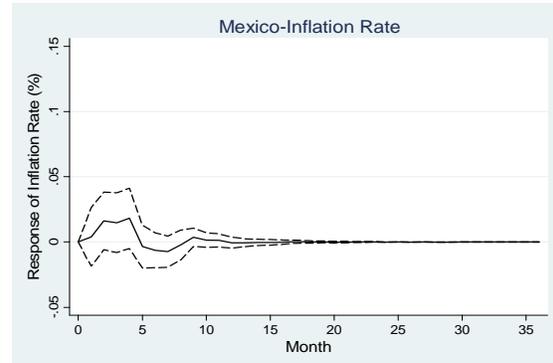
*The figure depicts the response to a positive FX intervention shock in $t=0$.

**The dashed lines are 90 % confidence bounds.

***Inflation goes up 2 months after the shock and keeps rising until the 8th month.

****Inflation is defined as the percentage change in the consumer price index.

FIGURE 36



Sources: Central Bank of Mexico and authors' calculations.

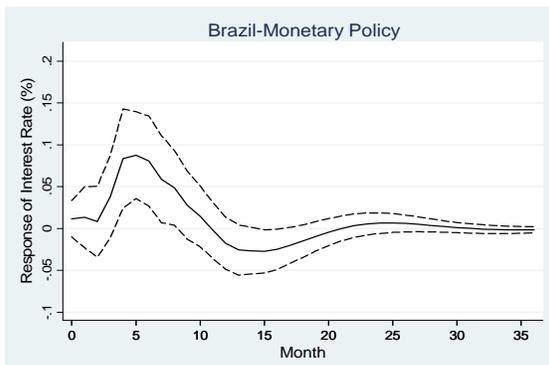
*The figure depicts the response to a positive FX intervention shock in $t=0$.

**The dashed lines are 90 % confidence bounds.

***Inflation does not respond significantly to intervention shocks.

****Inflation is defined as the percentage change in the consumer price index.

FIGURE 37



Sources: Central Bank of Brazil and authors' calculations.

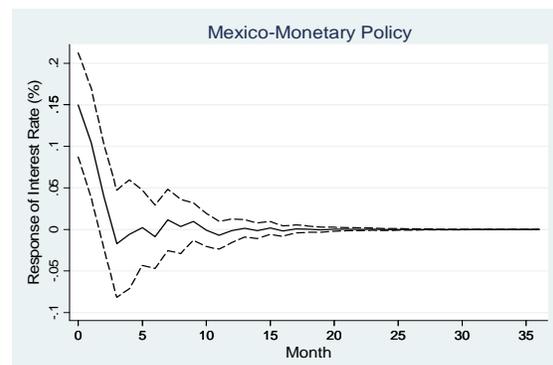
*The figure depicts the response to a positive FX intervention shock in $t=0$.

**The dashed lines are 90 % confidence bounds.

***Interest rate increases four months after the shock and remains increasing until the 8th month.

****Money market interest rate is used for the interest rate.

FIGURE 38



Sources: Central Bank of Mexico and authors' calculations.

*The figure depicts the response to a positive FX intervention shock in $t=0$.

**The dashed lines are 90 % confidence bounds.

***Interest rate goes up on impact and increases again the next month.

****Money market interest rate is used for the interest rate.

VI. Conclusions

This paper has provided evidence on three results. First, in both Brazil and Mexico net dollars purchases significantly depreciate the local currency in the short run.

Second, different FX intervention models imply different costs in terms of inflation.

Third, this result does not seem to be entirely driven by cross-country differences in exchange rate pass through. We provide evidence the result the result is at least partially linked to the interactions between FX interventions and interest rate setting policy. In particular, having a FX interventions model that involves net dollar purchases on a regular basis seems to make it more difficult to compensate these interventions with increases in the interest rate.

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Appendix

Table A1. Unit Root Test Statistics

Variable	Augmented Dickey-Fuller			Phillips-Perron		
	Brazil	Mexico	95 % Critical value	Brazil	Mexico	95 % Critical value
A. In Levels						
<i>fei</i>	-3.57**	-2.46**	-1.94	-4.91**	-3.01**	-1.94
<i>i</i>	-3.31*	-3.53**	-3.44	-2.78*	-3.01*	-3.44
<i>m</i>	-1.47*	-1.40*	-3.44	-5.25**	-2.06*	-3.44
<i>cpi</i>	-2.02*	-1.40*	-3.44	-1.52*	-4.17**	-3.44
<i>ip</i>	-2.78*	-2.41*	-3.44	-2.50*	-2.18*	-3.44
<i>e</i>	-2.26*	-3.38*	-3.44	-2.37*	-3.24*	-3.44
<i>pc</i>	-3.25*	-3.25*	-3.44	-2.68*	-2.68*	-3.44
B. In First Differences						
Δfei	----	----	----	----	----	----
Δi	-5.11**	-4.08**	-1.94	-4.18**	-10.81**	-1.94
Δm	-3.90**	-7.57**	-2.88	-21.72**	-19.90**	-2.88
Δcpi	-5.79**	-3.75**	-2.88	-5.83**	-9.72**	-2.88
Δip	-11.77**	-4.88**	-2.88	-11.73**	-15.03**	-2.88
Δe	-8.41**	-11.54**	-1.94	-8.40**	-11.54**	-1.94
Δpc	-4.37**	-4.37**	-1.94	-8.84**	-8.84**	-1.94

Sources: Central Bank of Brazil, Central Bank of Mexico and authors' calculations.

Notes: The tests for variables in levels (panel A) include a constant and a liner trend, except for *fei*. The tests for Δm , Δcpi and Δip (in panel B) include only a constant, and for *fei* (in panel A), Δi , Δe , Δpc (in panel B) include neither a constant nor a liner trend. The lag lengths were chosen based on the AIC.

*The null hypothesis of a unit root cannot be rejected at 95% confidence level.

**The null hypothesis of a unit root is rejected at 95% percent confidence level.

Table A2. Likelihood Ratio Test for Over-Identifying Restrictions (Baseline Model)

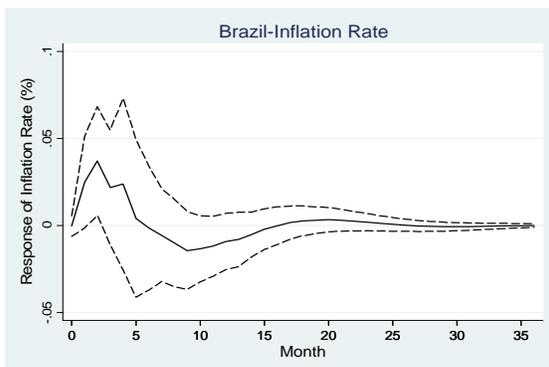
	Likelihood ratio statistic ($\chi(7)$)	P-Value
VAR model for Brazil	11.34	0.125*
VAR model for Mexico	3.15	0.871*

Sources: Central Bank of Brazil, Central Bank of Mexico and authors' calculations.

*Over-identifying restrictions are not rejected at 1, 5 and 10 percent levels.

Response of Inflation Rate to Interest Rate Shocks (Baseline Model)

FIGURE A1



Sources: Central Bank of Brazil and authors' calculations.

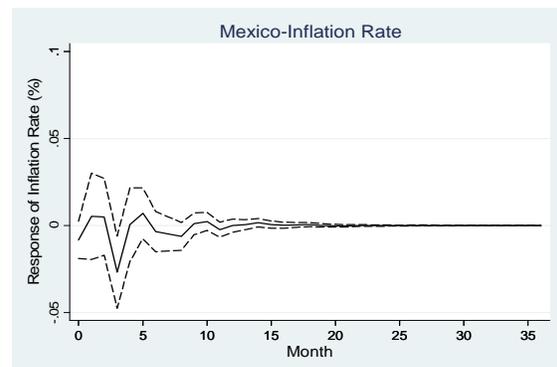
*The figure depicts the response to a positive interest rate shock in $t=0$.

**The dashed lines are 90 % confidence bounds.

***We find the *price puzzle*: Inflation rate increases in response two months after the shock.

****Money market interest rate is used for the interest rate.

FIGURE A2



Sources: Central Bank of Mexico and authors' calculations.

*The figure depicts the response to a positive interest rate shock in $t=0$.

**The dashed lines are 90 % confidence bounds.

***We do not find the *price puzzle*: Inflation rate falls in response three months after the shock.

****Money market interest rate is used for the interest rate.