Foreign Exchange Interventions and Foreign Shocks: The case of Uruguay*

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Abstract

We study the effects of exchange rate interventions in Uruguay on relevant macroeconomic variables such as the exchange rate, inflation, activity, and interest rates. Instead of attempting to identify exogenous variations in the intervention policy (a frequent strategy in the related literature, but that raises many endogeneity concerns), we investigate the effect of interventions in dampening the impact of external shocks that are relevant determinants of exchange rate movements. This estimation is carried out through a novel econometric tool called constrained impulse response functions, which allow to construct counterfactual scenarios that are locally valid (i.e. marginal effects around average responses). We find that interventions can help dampen exchange rate effects, and may have non-trivial effects inflation as well, but generally no consequences in terms of activity. Importantly, these effects depend on the type and sign of the external shock under consideration.

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1 Introduction

This paper studies the macroeconomic effect of foreign exchange rate interventions (FXI) in Uruguay. Most of the related literature attempts to answer this question by identifying exogenous shocks to FXI, using different approaches. This strategy is, however, controversial in countries with flexible but managed exchange rates; for FXI are clearly implemented in a state contingent fashion, responding to different shocks that affect the economy and that, at the same time, influence the nominal exchange rate. In other words, endogeneity issues are almost impossible to circumvent in this context. Against this background, we propose a novel econometric strategy to study how the dynamics triggered by well identified (external) shocks varies depending on the intensity of FXI implemented by the Central Bank.

The role of exchange rate policy in emerging economies has a long history of debate. In essence, the exchange rate dilemma that most Latin American economies have faced deals with the difficulty to reconcile flexibility, on the one hand, with external competitiveness and financial and macroeconomic stability, on the other. In addition, because exchange rate swings have amplified financial and real effects in dollarized economies, exchange rate management has been a hot topic in many emerging countries, and Uruguay in particular.

The rationale for exchange rate interventions rests on avoiding potentially damage exchange rate deviations either from a (explicit or implicit) target or from its "equilibrium" level. In the first case, the intervention tries to maintain an explicit or implicit rigidity in the exchange rate conceived as a nominal anchor or as a policy instrument to promote international competitiveness. In the second one, the intervention is a corrective measure that tries to push the exchange rate closer to its moving fundamentals, smoothing cyclical deviations and misalignments. It is worth mentioning that not all interventions are exchange rate driven, though. In some cases, interventions may seek to restore reserve stocks after a currency crisis (Aizenman and Lee (2007)), or to keep precautionary reserves to back the national currency in case of potential speculative attacks (Obstfeld *et al.* (2010)).

Open economies are exposed to external shocks whose effects can be seen in the exchange rate and other macroeconomic variables. The substantial increase in the volatility of capital flows since the 2008 global financial crisis led policymakers to rely on foreign exchange interventions, together with other policy tools, to stabilize their economies (IMF, 2012). Adler and Mora (2011), and Daude *et al.* (2016) document that interventions correlate negatively with exchange rate pressures -leaning against the wind- and positively with foreign financial conditions and capital flows.

Foreign exchange intervention has become an Uruguayan trademark after the currency was allowed to float following the 2002 crisis and until mid 2021 when the Central Bank abandoned this intervention policy. (Bucacos *et al.* (2019))[1]. Significant levels of intervention are registered under its inflation-targeting regime regardless of the instrument used (i.e., monetary aggregates in 2002-2007 and in 2013-2020 and the policy rate in 2007-2013 and since 2020 on wards). In addition, Uruguay is one of the most highly dollarized economies in the region,[2] potentially leading to dangerous currency mismatches and makes it vulnerable to significant income losses. In effect, the impact of the exchange rate band system abandonment in the 2002 triple crisis -i.e. balance of payments, banking, and fiscal– was significant: inflation rose to 14.0

[1]This rule has changed, the Central Bank has not intervened in the exchange market since August 2021

[2]72 percent of total deposits and 46 percent of total loans in the banking system are denominated in foreign currency as of April 2023.

percent, real output fell by 7.7 percent and total unemployment rose to 16.6 percent. Unfortunately, dollarization weakens the power of monetary policy to deal with the macroeconomic volatility caused by external shocks.

Assessing the effectiveness of interventions is controversial (Daude *et al.* (2016)). The evidence suggesting that they have statistically significant and lasting influence on the exchange rate behavior, both on its level and on its volatility, is not conclusive. The main reason for that is the two-way causality between interventions and exchange rate variations. In fact, central banks purchase (sell) dollars to partially offset appreciations (depreciations) that are happening contemporaneously (Dominguez (1993), Dominguez (1998); Dominguez *et al.* (1990); Dominguez *et al.* (1990); Ghosh (1992); Tapia *et al.* (2004); Guimarães and Karacadag (2004); Domaç and Mendoza (2004); Humala and Rodríguez (2010); Kamil (2008); Toro and Rincón (2011); Dominguez *et al.* (2013)). Unaddressed, the endogeneity bias tends to hide the effect of interventions on the exchange rate. Usually, to overcome this endogeneity problem two methods are used: either an instrumental variable approach (i.e. trying to identify exogenous variations in interventions) or high-frequency data. Unfortunately, high-frequency estimates cannot account for the persistence of the effects over time nor the cumulative effects of interventions (Blanchard *et al.* (2015)).

In this context, here we apply a novel econometric tool called constrained impulse response functions. In essence, we investigate the effect of interventions in dampening the impact of external shocks that are relevant determinants of exchange rate movements in Uruguay. We find that interventions can help dampen exchange rate effects and their impact on prices, but not on activity, although the result depends on the type and sign of the external shock considered. In particular we focus on two external shocks that seems to be the main external drivers of NER fluctuations: changes in global risk (associated with the VIX index) and the global strength of the US dollar (determined by the Broad dollar index).

Traditional impulse response analysis seek to estimate the average dynamics of the variables of interest after a given shock, relative to those dynamics that we could expect without conditioning on a given shock. In our case, the identified shocks are disturbance in external variables that, by a small and open economy argument, are strictly exogenous for Uruguay, and the variables of interest are domestic series such as the nominal exchange rate (NER), FXI, activity, prices, etc. In turn, a constrained impulse response conditions not only on the presence of a given shock but also on the behaviour of some domestic variable; FXI in our case. This tool thus allows us to produce counterfactual exercises to characterize what happens if the intensity of the FXI following a given shock is different relative to its average response.

The paper is structured as follows: Section 2 presents the relevant literature to this investigation; Section 3 describes the econometric approach and the data (including a discussion about the measure of foreign exchange interventions in Uruguay), while Section 4 presents the results. Finally, Section 5 presents the main conclusions.

2 Literature Review

This section briefly reviews several strands of research related to the topic of this investigation. We begin with studies that analyze the theoretical ways FX interventions influence the exchange rate, followed by papers that focus on how global financial conditions affect emerging economies. We then highlight papers discussing the effectiveness of interventions in terms of smoothing the path and in stabilizing the exchange rate, and finally, studies that focus on the same issues in Uruguay.

Channels The theoretical literature points to several channels through which interventions are expected to affect exchange rates: a signaling, a portfolio balance, a coordination, and a noise-trading channel. When sterilized interventions provide information on central bank's monetary policy intentions, exchange rates may be affected through the signaling channel (Mussa (1981); Kaminsky and Lewis (1996)). The portfolio balance channel (Henderson and Rogoff (1982); Kouri (1983); Branson and Henderson (1985); Kumhof (2010); Gabaix and Maggiori (2015)) refers to the idea that, under imperfect markets, sterilized interventions changes the relative supply of domestic assets and exerts pressures on the exchange rate. The coordination channel (Lyons *et al.* (2001); Reitz and Taylor (2008)) tells about frictions at a micro level affecting the information that markets participants get from central bank operations. Finally, the noise-trading channel (Hung (1997)) occurs when the central bank uses interventions to modify the exchange rate in the hope of changing noise-traders' behavior.

Global financial conditions The effects of global financial conditions on emerging market economies have been the focus of empirical research for a long time. Some works study the role of push factors – i.e., changes in international real interest rates – in driving inflows to Latin American countries (Calvo *et al.* (1993); Calvo (2001)) and provide evidence of an exchange rate channel from US monetary policy shocks, according to which foreign central banks face a trade-off between narrowing MP rate differentials or experiencing currency movements against the US dollar (Albagli *et al.* (2019)). Oher researchers show how exogenous portfolio equity inflows cause exchange rate appreciation in the receiving countries (Hau *et al.* (2010)). And still others analyze the transmission of global financial conditions to financially integrated economies irrespective of their exchange rate regime (Rey (2015)). The collateral effects of large capital flows – i.e,, from asset price inflation, to credit booms, to overheating, to real exchange rate appreciation, and to the buildup of financial vulnerabilities – particularly challenge emerging economies and the evidence suggests that intervention is effective in stemming appreciation pressures arising from global flow shocks (Blanchard *et al.* (2015)). Liability dollarization amplifies the effects of fluctuations in capital flows and foreign exchange intervention can reduce macroeconomic volatility and improve welfare (Castillo *et al.* (2021)).

Some papers attempt to characterize the optimal foreign exchange intervention policy (Cavallino (2019)) where monetary policy and foreign exchange intervention seem to be complementary rather than substitute tools. More recently, capital controls and interventions are recognized as prudential measures. However, there is no one-size-fits-all recipe because while for a significant number of countries, FX interventions and capital controls are combined to tame the effects of international financial shocks as countries open up financially, FX interventions replace capital controls (Cezar and Monnet (2021)).

Effectiveness The evidence on the effectiveness of interventions on the level of the exchange rates is mixed. Early literature focused on developed countries in the nineties (Dominguez (1998); Dominguez *et al.* (1990); Ghosh (1992); Kaminsky and Lewis (1996)) report limited evidence of that, unless interventions were coordinated across major central banks. Those results are also found more recently (Kearns and Rigobon (2005); Naranjo and Nimalendran (2000), and Chen *et al.* (2012) among others). Recent evidence points that intervention is a successful tool in muting the impact of the Global Financial Cycle (Rodnyansky *et al.* (2022)).

In emerging markets some backing evidence is found although it cannot be generalized because most of it rests on country specific studies (see a comprehensive review in Menkhoff (2013)). Fratzscher *et al.* (2019), using daily data covering 33 countries from 1995 to 2011, find that intervention is widely used and an effective policy tool, with a success rate in excess of 80 percent under some criteria. They point out that the best results are found in countries with narrow band regimes while in countries with flexible regimes the effectiveness requires the use of large volumes and that intervention is made public and supported via communication.

In fact, in many cases the endogeneity of intervention decisions may be the one to blame for the low rate of robust results. In order to overcome reverse causality several researchers have relied on high-frequency data (Domaç and Mendoza (2004); Humala and Rodríguez (2010); Dominguez *et al.* (2013), among others). This approach, exploiting the fact that interventions are normally taken at a lower frequency than exchange rate movements, has found evidence of the effects of intervention on the exchange-rate in the short-run. Nevertheless, because it is not conclusive on the persistence beyond a few days after the intervention, the evidence is not enough to imply relevant macroeconomic consequences. Daude *et al.* (2016) rely on low frequency data and a panel approach to study the effect of FXI on exchanges rates, and find evidence broadly consistent to Adler *et al.* (2019), who focus on monthly data and explore both contemporaneous and dynamic effects.

Uruguay Regarding the Uruguayan case, there is significant research on the effects of regional factors on Uruguayan performance. Researchers use several methodological approaches to study the transmission mechanisms of regional shocks to Uruguay: VAR (Favaro and Sapelli (1986)), nearVAR (Masoller (1998)), together with VAR with exogeneity restrictions models (Sosa (2010)) and models capturing Dutch-disease-related channels (Bergara *et al.* (1994)). The main findings refer to a large impact of regional variables especially bilateral real exchange rates (Favaro and Sapelli (1986)), an important role played by Argentina (Talvi (1994); Voelker (2004); Eble (2006); Sosa (2010)) affecting Uruguayan output, relative prices and growth, and the vulnerability of Argentina, Paraguay, and Uruguay –i.e., the rest of the MERCOSUR members- to a real devaluation in Brazil (Bevilaqua *et al.* (2001)). Other studies concentrate on the correlation between the Uruguayan business cycle and the cyclical component of some key regional macroeconomic variables, finding that the Uruguayan business cycle is strongly influenced by regional factors (Kamil (1998)). In particular, the strong effect of shocks from Argentina is explained by the existence of idiosyncratic real and financial linkages between Uruguay and Argentina, which also explain the very high correlation between their business cycles (Sosa (2010)).

The vulnerability of the Uruguayan economy to changes in US monetary policy have not offered much statistically significant evidence for Uruguay using usual approaches - i.e., panel data analysis, correlation analysis and even case studies. Instead, FAVAR (Bucacos (2015)) models by incorporating more information without adding more variables and allowing a better identification of structural shocks, show the expected results. In cases when shocks come from very specific foreign countries instead of "the rest of the world", GVAR models are used (Noya *et al.* (2015)).

The high dollarization of the Uruguayan economy amplifies the consequences of foreign shocks and gives the monetary authority more reasons to intervene. In effect, as both firms' and families' balance sheets have currency mismatches sudden movements in the exchange rate provoke undesired income changes that increase the vulnerability of the financial system. Probit models used to help identifing likely motives for central bank interventions, point to the fulfillment of its monetary policy objectives and the diminishing of exchange rate volatility. In some occasions - e.g., in 2003 - exchange rate purchases seek to recompose Central Bank´s reserve position (Aboal *et al.* (2006)).

Empirical results suggest that the use of foreign exchange intervention in Uruguay, together with other monetary and financial tools, helped dampen the adverse effect of large swings in capital flows and related domestic portfolio changes in terms of the economic fundamentals, and excessive volatility in relative prices, currency markets, and interest rates (Bucacos *et al.* (2019)). Although sterilized interventions affect the level of the exchange rate, its effect is short-lived – i.e., a week. Those results coincide with the findings from an event study approach performed for the 2004-2006 period (Puppo Sanchez and Gari Etchavarria (2009)) that reports effectiveness of interventions in affecting both the level of the exchange rate in the short run and its weekly volatility.

It follows that the Uruguayan economy, characterized by high dollarization, frequent foreign shocks, and usual interventions, appears to be an interesting case to study the role of interventions in cushioning real losses. Our goal is to provide new evidence on the consequences of FX interventions as a policy tool for macroeconomic management.

3 Methodology and Data

The methodology relies on local-projections to compute both traditional and constrained impulse responses following shocks to external variables. Let Z_t denote a vector with the relevant external variables, driven by shocks denoted by ϵ_t, while Y_t is a vector of domestic variables, driven by both external shocks ϵ_t as well as other domestic shocks collected in the vector u_t. Crucially, by an small and open economy assumption domestic shocks u_t have no role in explaining the dynamics of external variables Z_t. In addition FXI_t, the foreign exchange interventions measure, is one of the elements in Y_t. Finally, let X_{t-1} collect the relevant lags of Z_t, Y_t, while y_t and z_t denote, respectively, a generic element of Y_t and Z_t.

The first goal is to estimate the effect of a given external shock ϵ_t^z (corresponding to the external variable z_t) on y_{t+h}, what is generally known as an impulse response. Formally, this is defined as

$$IRF_z(y_{t+h}) \equiv E(y_{t+h}|\epsilon_t^z = \boldsymbol{s}, X_{t-1}) - E(y_{t+h}|X_{t-1}), \quad \text{for } h = 0, ..., H.$$

This is a counterfactual expected path for y_{t+h} given the observed shock and the initial conditions, relative to the expected path conditioning only on initial conditions.

Following Jordà (2005), Chang and Sakata (2007) and Plagborg-Møller and Wolf (2021), among others, this IRF can be estimated by local projections. In particular, Chang and Sakata (2007) suggests a two-steps procedure:

1. Assuming a contemporaneous Cholesky order for the external variables, let H_t denote the variables in Z_t appearing before z_t in that order. Estimate the following regression

$$z_t = \alpha_0 + \alpha_1 H_t + \alpha_2(L) Z_{t-1} + \epsilon_t^z, \tag{1}$$

where α_0, α_1 are parameters and $\alpha_2(L)$ is a polynomial in the lag operator L. Compute the residuals $\widehat{\epsilon}_t^z$, which are estimates of the shock of interest according to the imposed Cholesky order. Notice that Y_t is not relevant in this regression, as implied by the small and open economy assumption.

2. Estimate the following local-projection regression for each $h = 0, ..., H$

$$y_{t+h} = \beta_h \widehat{\epsilon}_t^z + \phi_h + \gamma_h(L)X_{t-1} + v_{t+h}. \tag{2}$$

The estimator $\widehat{\beta}_h$ consistently estimates $IRF_z(y_{t+h})$. In this equation, the inclusion of the lags X_{t-1} is not required for consistency of the estimation but it might improve efficiency.

We also want to estimate the impulse response distinguishing between positive and negative shocks. Let B_t be a dummy variable which is equal to $= 1$ if $\widehat{\epsilon}_t^z > 0$, and zero otherwise. Then, the local-projection regression (2) in step 2 is replaced by:

$$y_{t+h} = \beta_{1,h} B_t \widehat{\epsilon}_t^z + \beta_{2,h}(1 - B_t)\widehat{\epsilon}_t^z + \phi_{1,h} B_t + \phi_{2,h}(1 - B_t) + \gamma_h(L)X_{t-1} + v_{t+h}. \tag{3}$$

Here, $\widehat{\beta}_{1,h}$ estimates the response to a positive shock, while $\widehat{\beta}_{2,h}$ is that to a negative shock.

Let w_t be another element in Y_t (different from y_t) and let $w_{t,t+h} \equiv [w_t', w_{t+1}', ..., w_{t+h}']'$. A constrained impulse response is defined as,

$$CIRF_z\left(y_{t+h}|w_{t,t+h}\right) \equiv E\left(y_{t+h}|f(w_{t,t+h}) = \mathcal{C}_h, \epsilon_t^z = \boldsymbol{s}, X_{t-1}\right) - E\left(y_{t+h}|X_{t-1}\right) \quad \text{for } h = 0, ..., H.$$

where $f(\cdot)$ is a generic function and $\mathcal{C}_h$ is a scalar. In other words, here the counterfactual path contemplates not only the particular shock but also the behaviour of the endogenous variables w following the shock. In our implementation, $w_t = FXI_t$ and $f(w_{t,t+h}) = w_t^h \equiv \sum_{i=0}^{h} FXI_{t+i}$ (i.e. the cumulative intervention between t and $t + h$). Additionally, notice that

$$\begin{aligned} CIRF_z\left(y_{t+h}|w_{t,t+h}\right) &= E\left(y_{t+h}|f(w_{t,t+h}) = \mathcal{C}_h, \epsilon_t^z = \boldsymbol{s}, X_{t-1}\right) - E\left(y_{t+h}|\epsilon_t^z = \boldsymbol{s}, X_{t-1}\right) \\ &\quad + E\left(y_{t+h}|\epsilon_t^z = \boldsymbol{s}, X_{t-1}\right) - E\left(y_{t+h}|X_{t-1}\right) = CE_z\left(y_{t+h}|w_{t,t+h}\right) + IRF_z(y_{t+h}) \end{aligned}$$

where $CE_z\left(y_{t+h}|w_{t,t+h}\right) \equiv E\left(y_{t+h}|f(w_{t,t+h}) = \mathcal{C}_h, \epsilon_t^z = \boldsymbol{s}, X_{t-1}\right) - E\left(y_{t+h}|\epsilon_t^z = \boldsymbol{s}, X_{t-1}\right)$ is the constraining effect: how the original impulse response changes if the constraint to w_t is imposed.

To implement this in the case of symmetric responses, consider replacing (2) by

$$y_{t+h} = \beta_h \widehat{\epsilon}_t^z + \delta_h(w_t^h - \overline{w}^h)\widehat{\epsilon}_t^z + \phi_h + \gamma_h(L)X_{t-1} + v_{t+h}. \tag{4}$$

where $\overline{w}^h$ is the sample-average of w_t^h. Clearly, $(w_t^h - \overline{w}^h)\epsilon_t^z$ is endogenous in (4). But as ϵ_t^z is strictly exogenous given our assumption, $\widehat{\epsilon}_t^z$ is a valid instrument for $(w_{t,h} - \overline{w}_h)$. Thus, using instrumental variables in (4), $\widehat{\beta}_h$ estimates $IRF_z(y_{t+h})$ while $\widehat{\delta}_h(\mathcal{C}_h - \overline{w}_h)$ estimates $CE_z\left(y_{t+h}|w_{t,t+h}\right)$.

A similar procedure can be implemented to modify the local-projection regression for asymmetric responses (3). In particular, the estimated regression is

$$y_{t+h} = \beta_{1,h} B_t \widehat{\epsilon}_t^z + \delta_{1,h}(w_t^h - \overline{w}^h) B_t \widehat{\epsilon}_t^z + \beta_{2,h}(1 - B_t)\widehat{\epsilon}_t^z + \delta_{2,h}(w_t^h - \overline{w}^h)(1 - B_t)\widehat{\epsilon}_t^z + ...$$
$$\phi_{1,h} B_t + \phi_{2,h}(1 - B_t) + \gamma_h(L) X_{t-1} + v_{t+h}, \quad (5)$$

where the dummy B_t is defined as before. Here, $\widehat{\beta}_{1,h}$ and $\widehat{\beta}_{2,h}$ are estimates the IRF, respectively, to a positive and a negative shock, while $\widehat{\delta}_{1,h}(\mathcal{C}_h - \overline{w}_h)$ and $\widehat{\delta}_{2,h}(\mathcal{C}_h - \overline{w}_h)$ captures the constraining effect following, respectively, positive and negative shocks. As before, this is estimated by an instrumental variable approach where $B_t(w_{t,h} - \overline{w}_h)$ and $(1 - B_t)(w_{t,h} - \overline{w}_h)$ are instrumented with $B_t \widehat{\epsilon}_t^z$ and $(1 - B_t)\widehat{\epsilon}_t^z$.

3.1 Data and identification of foreign shocks

Our data set includes both external and domestic variables. For external variables we use (in parenthesis are the names appearing in the figures):

- US Federal Reserve's "pure" monetary policy shocks (FF shock), as defined by Jarociński and Karadi (2020).
- The VIX index (VIX), a measure of global risk.
- US Federal funds rate (FFR).
- The Broad Dollar index (USD), capturing the global strength of the US dollar.
- Commodities terms of trade for Uruguay (ToT).
- EMBI index for Latinamerica (EMBI-LA), capturing regional risk.
- Argentina's nominal exchange rate (NER-Ar), a relevant trading partner with occasionally large FX jumps.

Shocks to each of this variables are identified by short-run strategy, using a Cholesky order following the list above. As we will see, of those included, shocks to the VIX and the Broad-dollar index together explain between 20 and 35% of the volatility in Uruguay nominal exchange rate.

We analyze the effect of these shocks in the following variables for Uruguay:

- FX interventions (FXI), described below.
- The nominal exchange rate (NER).
- The IMAE monthly index of economic activity (GDP), a proxy for GDP.
- The monetary policy rate (i^{MP}).
- The EMBI index for Uruguay (EMBI-Uy).
- PCI indices: Core (P^X), Core tradables (P^{XT}), Core non-tradable (P^{XN}).
- The multilateral real exchange rate (REER).

The sample is monthly, from 2007.M1 to 2022.M6.

3.2 Foreign Exchange Interventions in Uruguay

Uruguay presents the peculiarity of intervening continuously in the foreign exchange market for most of the period under review, between 2007 and 2022[3], but without a publicly specified rule. The official explanation for intervening in the exchange market, during the period 2007 to 2020, was to avoid sudden fluctuations in the exchange rate, that is, to reduce volatility. Therefore, the correlation between daily interventions is high. Beginning in 2020, FX interventions are absent.

The time series of foreign exchange interventions used in this paper is unique and superior to that alternatives used in the applied literature on the subject. We used the daily series of operations of the BCU in the foreign exchange market, from which operations that do not strictly correspond to an intervention in the foreign exchange market were filtered, in particular operations related to exchanges of financial assets between the BCU and the Ministry of Economy were removed, as well as exchange rate forwards used by the oil company ANCAP. Once the daily series has been cleaned of these items, we construct a monthly variable, simply adding the operations in the month. The monthly average of intervention in the exchange market was USD 38 million, with a maximum of USD 624 million of net purchases and USD 668 millions of maximum of net sales.

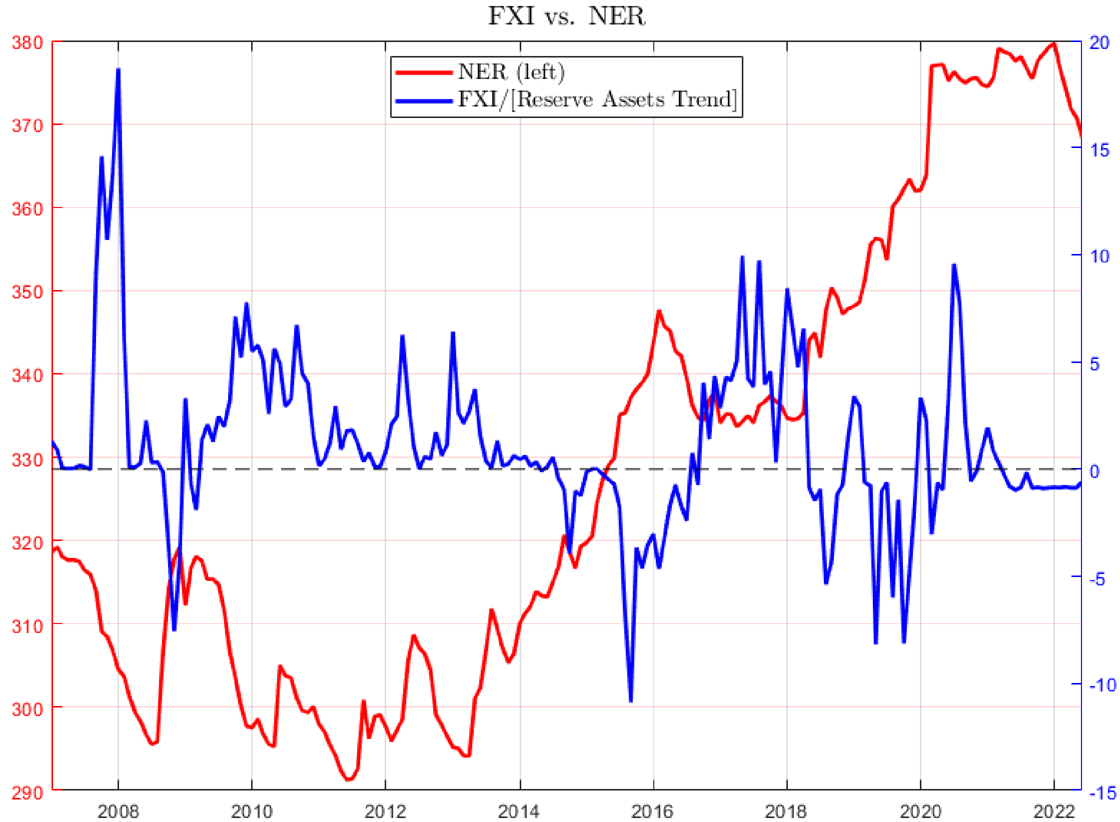
Given that over the analyzed period the BCU has accumulated reserves on average, there is a potential concern related to the fact that a purchase or sale of a given amount of USD at the beginning of the sample (with relatively low total reserves) has a higher impact that a similar operation, by the same amount, at the end of the sample (when total reserves where relatively larger). Therefore, in the regression we scale the FXI intervention series by the HP trend of total reserve assets in the BCU balance sheet.[4]

Figure 1 shows the nominal exchange rate (in logs, left vertical axis) and the BCU scaled interventions in the exchange rate market (in %, right vertical axis). As can be seen there is a clear asymmetry in terms of net purchases of USD (positive values) compared to net sales (negative values). Moreover, it is quite evident that the relationship between interventions and the NER has not been linear (i.e. periods of similar movements in the NER do not necessarily display equivalent interventions). This, in turn, opens the door to analyze potential conditional effect depending on the intervention policies

[3]The last FX intervention of the BCU in the spot FX market was in August 2021.

[4]We use the trend in total assets to isolate the scaled series from short-term valuation changes in the total reserves.

Figure 1: FX interventions and nominal exchange rate



4 Results

We begin by characterizing the relative importance of external shocks in explaining Uruguay's NER volatility on average. We then analyze the impulse response (both symmetric and asymmetric) of domestic variables to selected foreign shocks, following the approach outlined in equations (1)-(3). We conclude investigating the constrained impulse responses depending on the path of FX interventions.

4.1 Foreign Shocks and NER Fluctuations

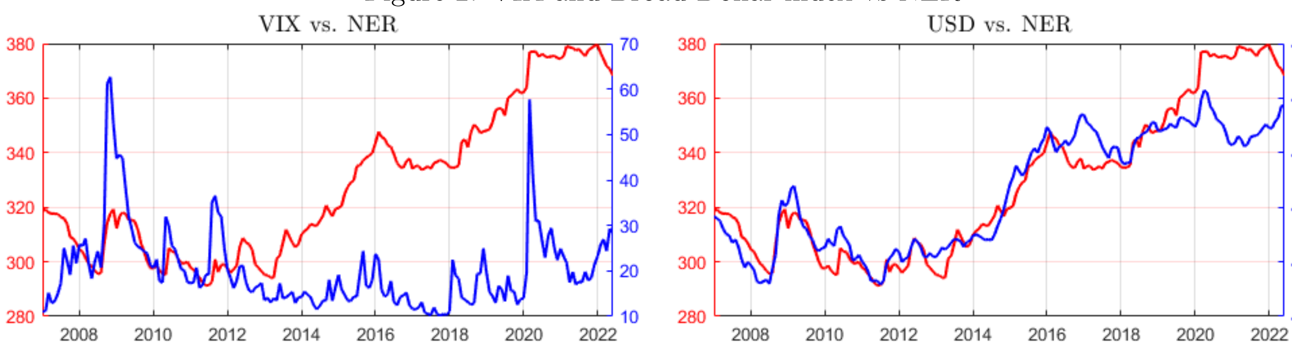
As a preliminary analysis, we use a VAR model (in differences) including the foreign variables plus the NER. The goal is to compute the forecast error variance decomposition of the NER, to obtain a measure of the relative importance (on average) of external shocks in explaining exchange rate fluctuations in Uruguay. Results are displayed in 1, for horizons 0, 2, and 11 (respectively, the month of the shock, and 3 and 12 months since the shock). As can be seen, taken together shocks to foreign variables explain between 30 and 45% of the NER's volatility. Among those, the shocks to VIX and Broad indices are the most important, the former is relatively more relevant in the very short run and the later in the medium run. Given these results, below we focus the analysis on the responses to these two shocks.

Table 1: NER forecast error variance decomposition

Horizon	MP	VIX	Broad	TOT	EMBI-LA	NER-Ar	Sum
0	4	12	10	0.2	0.5	5	32
2	1	15	25	0.1	0.2	2	42
11	1	6	30	0.1	3	0.5	45

Figure 2 plots the evolution of these two variables in tandem with the NER. We can see that the dollar price in Uruguay closely follows the global values of the dollar,[5] except for a period between 2016 and 2018, and after the pandemic. In turn, the co-movement between the VIX and the NER is mostly related to episodes of large swings in the VIX.

Figure 2: VIX and Broad Dollar index vs NER



Note: in both figures the NER (in logs) is plotted on the right vertical axis in red. Blue lines (left axis) are the VIX index and the Broad dollar index (in logs)

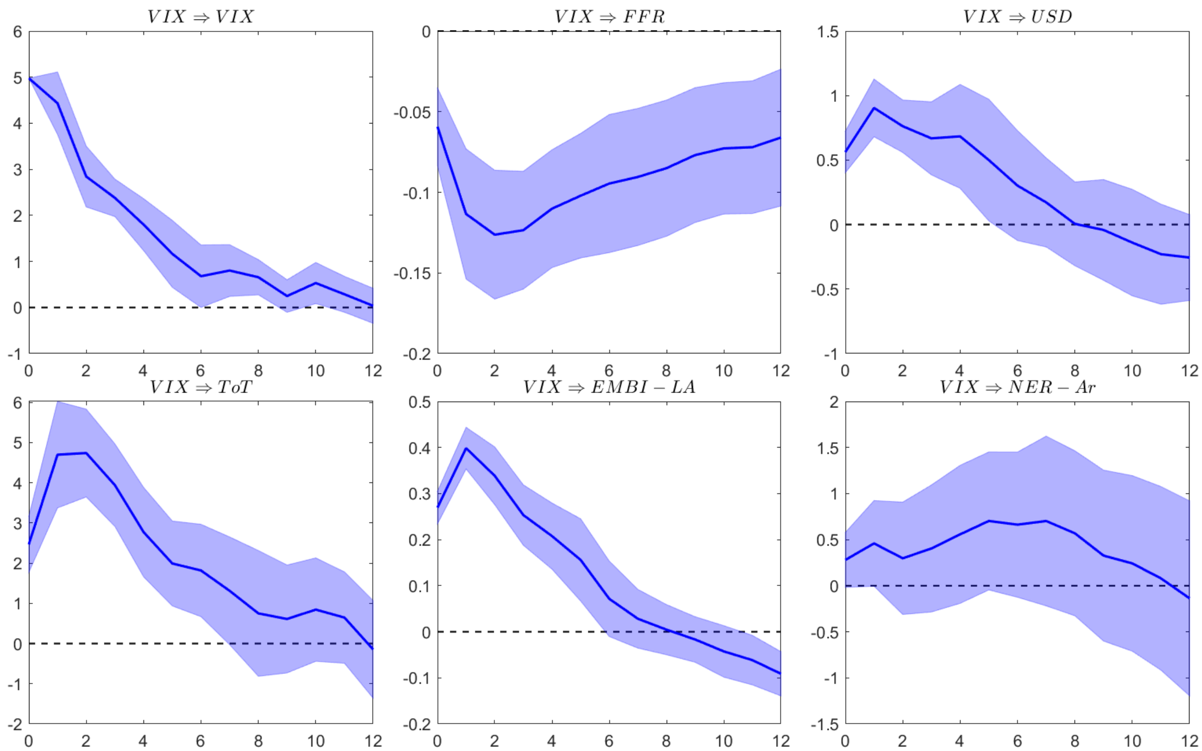
4.2 Impulse Responses to a VIX Shock

We begin by analyzing the effects after a VIX shock, normalized to represent an increase in the index equivalent to a one standard deviation of the identified shock. Figure 3 display the response of the other foreign variables to a VIX shock. This increase in global risk strengthens the US dollar (as people seek US safe assets) and increases default risk in emerging countries, Latinamerican in particular. These effects create depreciation pressures for small economies like Uruguay. At the same time, we see that the Fed reduced its interest rate on average after this shock, plus the increase in the Broad dollar index improve commodities terms of trade in Uruguay. These two should dampen the depreciation pressures, but as we will see this offsetting effect is less important than the direct effects.

The response of domestic variables to the VIX shock is displayed in Figure 4. The NER depreciates in Uruguay on average and the central bank responds by selling FX reserves (recall a negative value for FXI denotes net sales), attempting to dampen the effect on the NER. The shock generates a contraction in the economy, that is somehow delayed relative to the shock. The monetary policy rate does not seem to move significantly initially, but after six months we see a mild decrease (which might be explained as an attempt to to smooth the delayed effect on activity). In addition, the EMBI index for Uruguay increases

[5] Recall that the Broad dollar index is measured such that an increase means the US dollar is appreciating (in nominal terms) relative to the US main trading partners, while the NER in Uruguay is such that an increase means a depreciation of the Peso against the US dollar. Thus, a positive correlation is expected.

Figure 3: IRF to VIX Shocks, external variables



Note: Solid blue lines display the estimated IRF, while the light blue areas corresponds to 95% confidence bands. Values in the horizontal axis are months after the shock, while vertical axis are expressed in percentage terms. These are estimated from equation (2).

(in line to those in other Latinamerican countries) which is likely one of the channels through which the shock generates a contraction in activity.

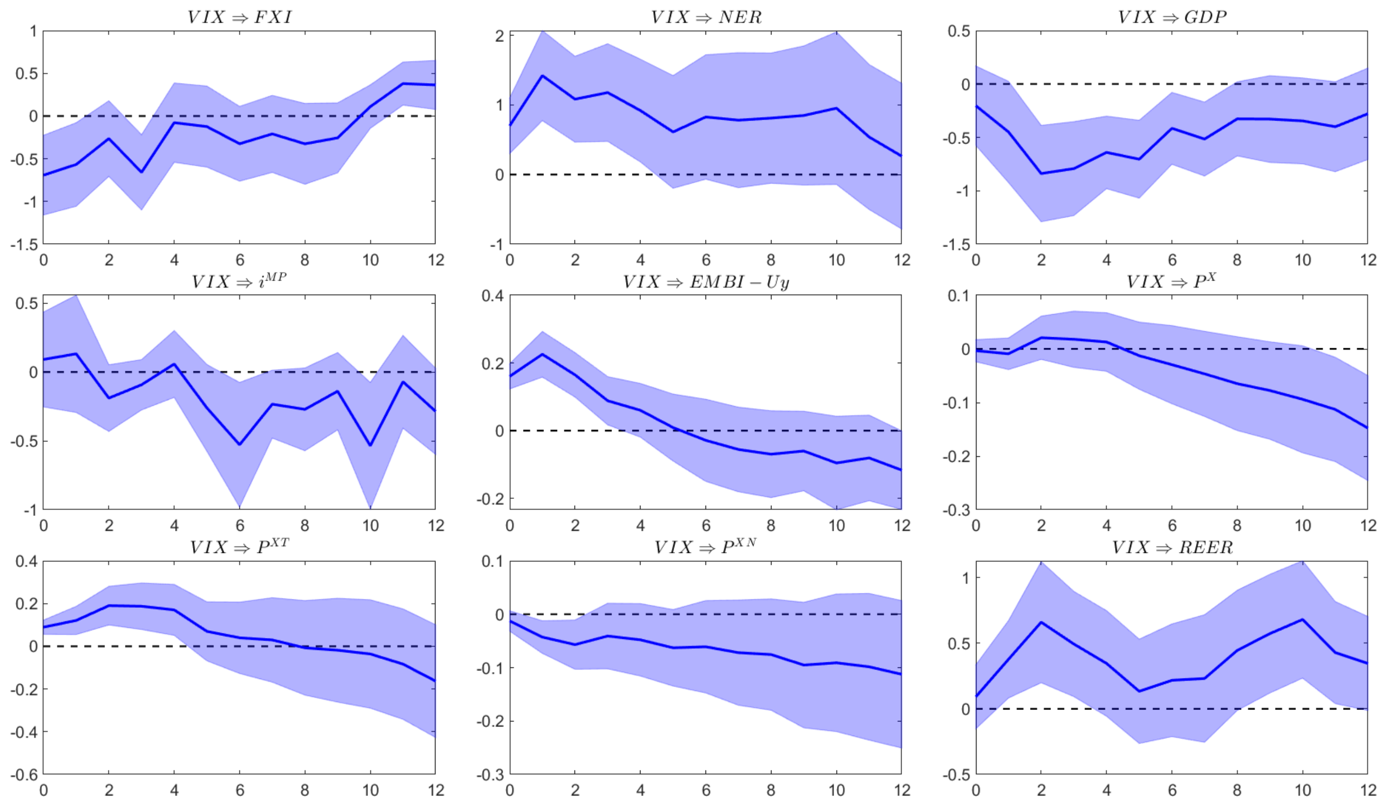
In terms of inflation, we see that tradable prices (P^{XT} in the figure) increase initially, in line with the nominal depreciation.[6] Comparing this to the response of the NER, the implied pass-through for tradables lies between 0.1 and 0.2.[7] On the contrary, nontradable prices (P^{XN} in the figure) are negatively affected, consistent with the relative-price adjustment in aggregate demand this shock should induce. However, while the IRF is always negative, after a few initial months the response is no longer statistically significant. Overall, the Core CPI (P^X in the figure) does not seem to show a significant effect after this shock, except for the last few months when a significant reduction is observed. Moreover, we also observe a real depreciation on average.

Figure 5 considers the possibility of responses that are different for increases (blue) than for decreases in the VIX index (green). These are normalized so that responses represent a one-standard-deviation shock conditional on being positive (an increase of 8 units in the VIX index) and the other of being negative (a drop of 2 units in the VIX). Starting from the NER response we clearly see that a positive VIX shock depreciates the domestic currency, while a surprise drop in the VIX generates an appreciation.

[6]Recall that IRF are counterfactual scenarios, so this is the expected response of the price level relative to the the trend that prices have on average (given by average inflation).

[7]In the terminology introduced by García-Cicco and García-Schmidt (2020), this corresponds to pass-through *conditional* on the given shock.

Figure 4: IRF to VIX Shocks, domestic variables



Note: See figure 3 for additional details.

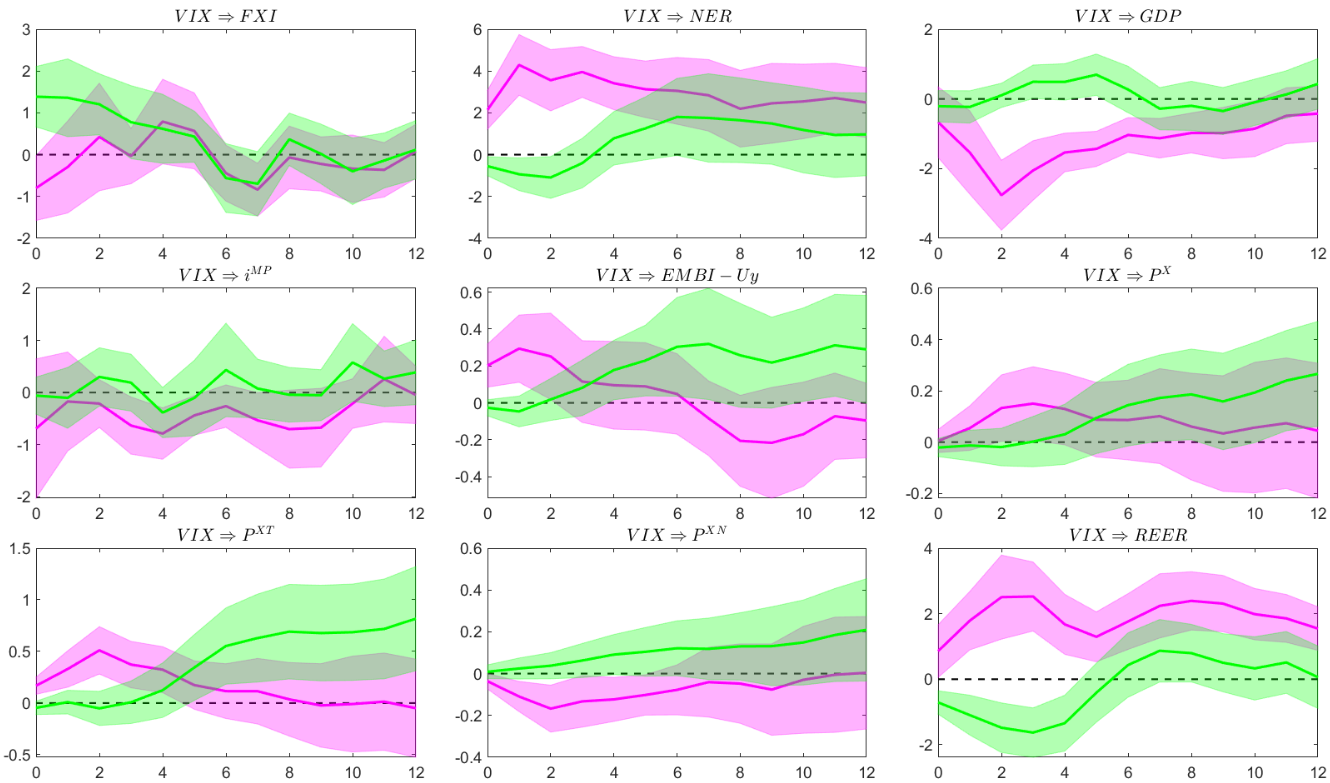
While the different in size reflect the fact that the average positive shock is larger that the absolute value of the average negative shock, the dynamics are different. For a positive shock, it induces a persistent depreciation, while the appreciation in the negative is relatively short lived, and after a few months the response seems to be positive (although not significant).

The dynamics of FXI are also different. In particular, while the depreciatory shock induces FX reserves sales on impact, these are only marginally significant and last only one period. In contrast, after an appreciatory shock to the VIX, FXI increases (i.e. the central bank is buying reserves). This implies that the FXI responses described in Figure 4 assuming symmetry, which are weighted averages of the asymmetric responses in Figure 5, are not driven by the BCU selling in response to VIX shocks that induce a depreciation, but instead are driven by purchases in periods of favorable VIX shock.

In terms of the impact on activity, we see that GDP drops after an increase in the VIX, but a drop in has almost no impact). The EMBI index for Uruguay rises in the short run after a positive VIX shock, while the initial response to a drop in the VIX is not significantly.

Based on these responses received we can try to produce a narrative about how FXI might affect the dynamics depending on whether the VIX shock is positive or negative. An increase in global uncertainty (positive VIX shock) produces a nominal depreciation and the central bank sales FX reserves (although the response is not significant). As those minor sales fail to prevent the nominal depreciation, prices increases and there is a contraction in economic activity. On the other hand, the large and significant

Figure 5: IRF to VIX Shocks, domestic variables, asymmetric responses



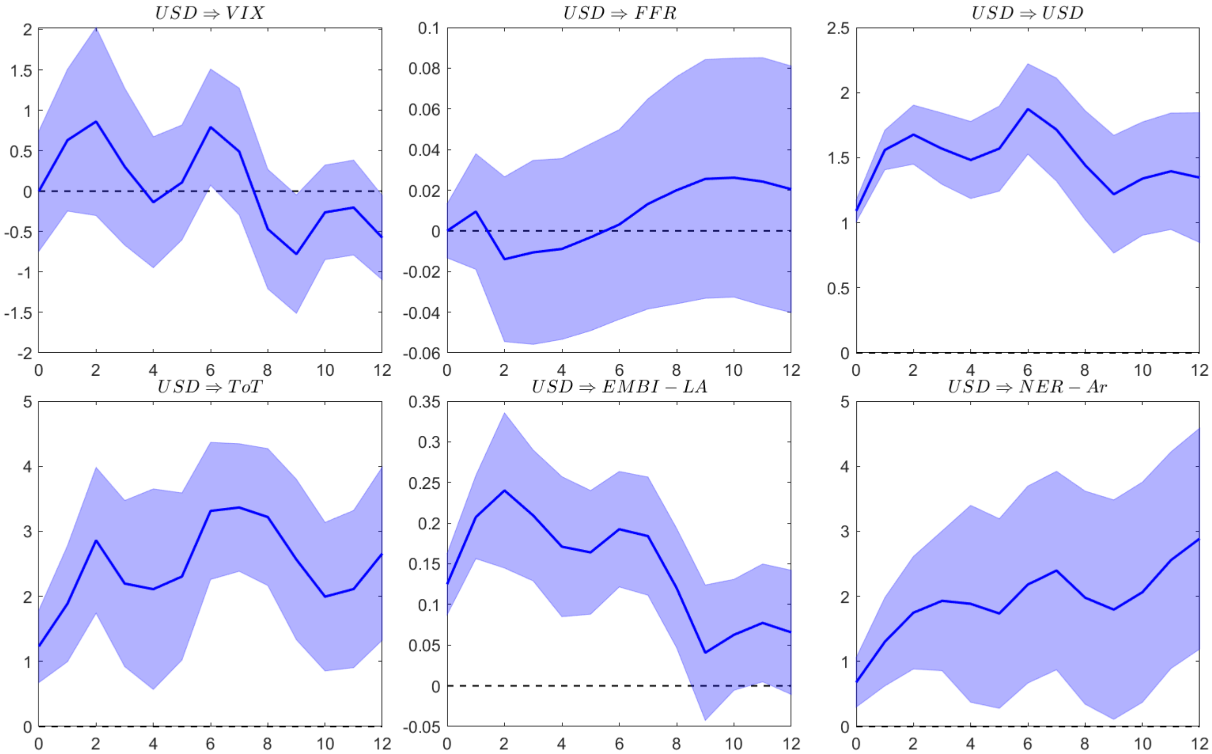
Note: Solid blue lines and light blue areas corresponds the IRF and to 95% confidence band after a positive shock, while solid green lines and light green areas correspond to negative shocks. These are obtained from $\widehat{\beta}_{1,h}$ and $\widehat{\beta}_{2,h}$ (and their standard errors) in equation (5).

net FX purchases after a negative VIX shock mitigates the nominal appreciation. However, this action prevent prices (particularly tradables) to fall, while activity mildly increase a few months after the shock. The constrained IRFs conducted below allows to formally test this line of argument.

4.3 Impulse Responses to a Broad-Dollar Index Shock

Following similar steps as in the previous subsections, Figure 6 displays the response of the other foreign variables to a Broad-Dollar index shock, normalized to positive increase equivalent to a one standard deviation of the identified shock. As can be seen, this global appreciation of the dollar produces insignificant responses in the VIX index and on the Federal Funds rate. The shock induces an increase in the EMBI index for Latin American countries, as well as a depreciation in Uruguay's trading partners, such as Argentina. Terms of trade for Uruguay increase after the shock, providing some offsetting effect after this shock.

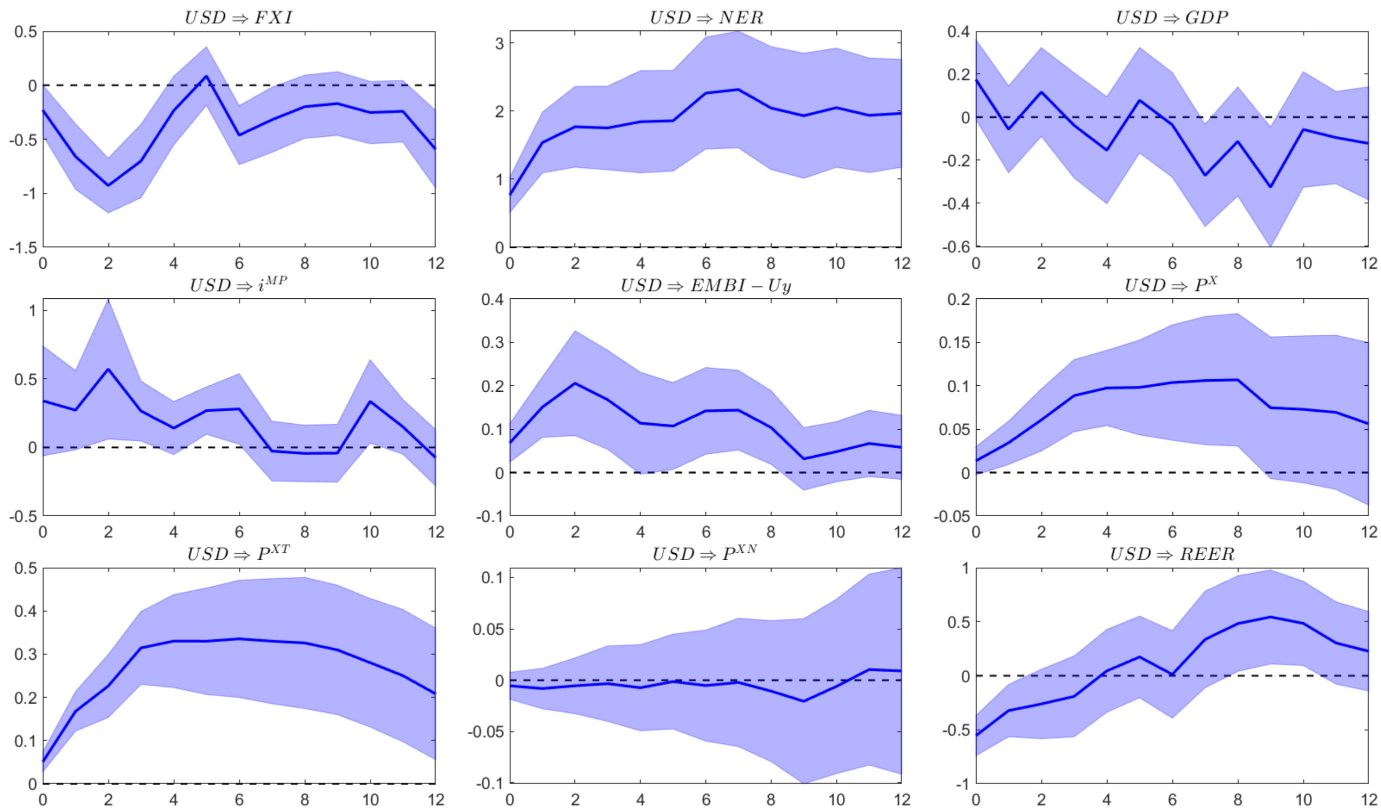
Figure 6: IRF to USD Shocks, external variables



Note: See figure 3 for details.

In Figure 7 the responses to domestic variables are displayed. The NER depreciates in Uruguay after this shock, with dynamics closely following the evolution of the Broad-dollar index after the shock. We can also see significant net FX sales in the first month after the shock, amounting to almost 1% of trend reserves. In addition, similar to the behaviour of the EMBI-LA index discussed before, the EMBI for Uruguay also increases.

Figure 7: IRF to USD Shocks, domestic variables

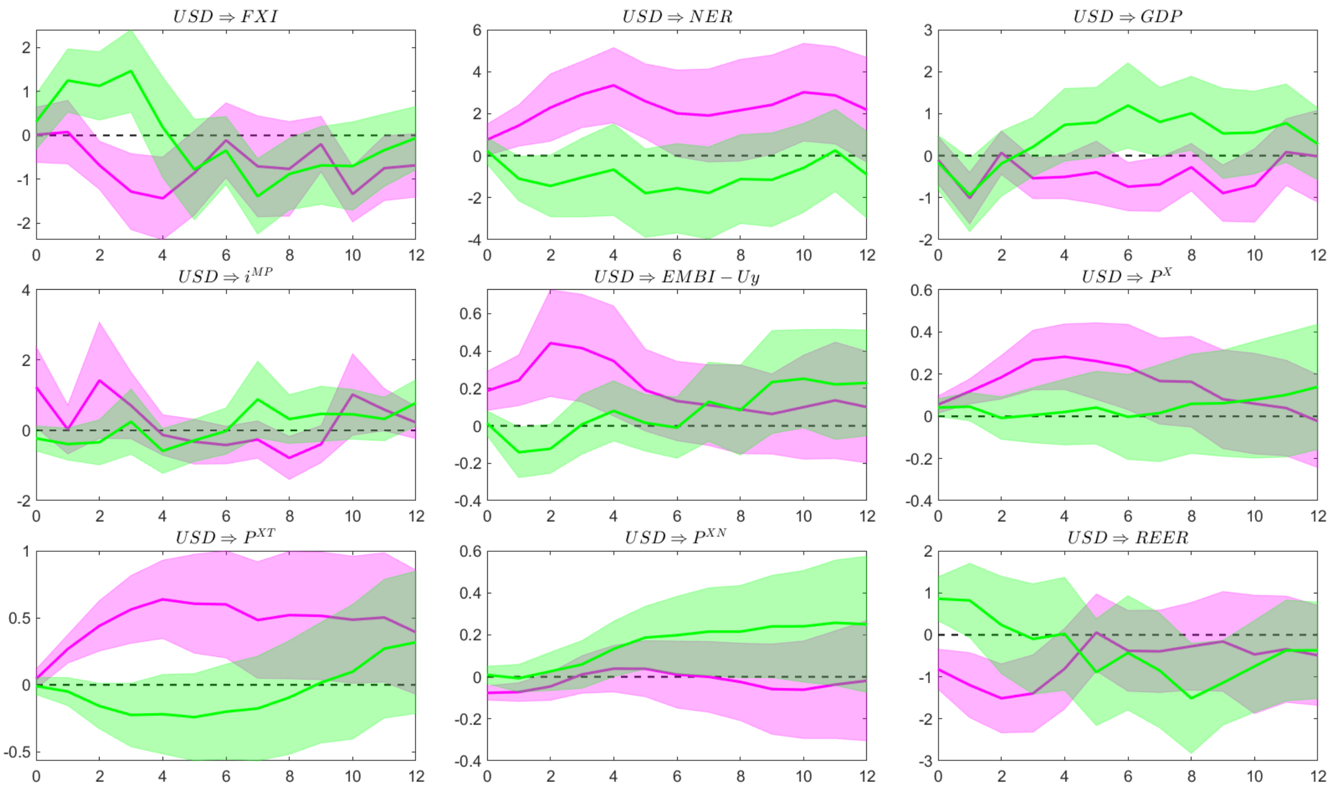


Note: See figure 4 for details.

The effect on activity of this shock is much noisier (and not statistically significant) compared to what we observed after a VIX shock. Tradable prices rise significantly, those for nontradables are not significantly altered, core CPI increases, and the multilateral real exchange rate initially appreciates (i.e. while Uruguay is depreciating against the US dollar, it is overall appreciating relative to its trading partners, at least in the short run). We can also see an increase in the monetary policy rate, which could be justified by the fact that, since the shock has almost no effect on activity, the rate is used to offset the effects in prices.

In Figure 8 we compare the responses allowing to differ by the sign of the shock. We can see that a positive shock induces a relatively larger and statistically more significant increase in the NER relative to the appreciation produced after a negative shock. The pattern of FXI is also different: while after a depreciatory shock the central bank begins to sell reserves only after a few months, following an appreciatory shock the purchases increase right away. The EMBI-Uy increases significantly after a depreciatory shock, particularly during the first five months, while the reduction is not significant after a shock of the opposite sign.

Figure 8: IRF to USD Shocks, domestic variables, asymmetric responses



Note: Solid blue lines and light blue areas corresponds the IRF and to 95% confidence band after a positive shock, while solid green lines and light green areas correspond to negative shocks. These are obtained from $\widehat{\beta}_{1,h}$ and $\widehat{\beta}_{2,h}$ (and their standard errors) in equation (5).

Activity seems to contract after a global rise in the US dollar value, while after a surprise global weakening of the dollar an expansion is observed but only after five months. In terms of prices, following a depreciatory shock tradables increase and non-tradables mildly fall (leading to an overall rise in core inflation). However, following a shock that induces an appreciation in Uruguay, tradable prices are reduced only slightly (although not statistically significant) while non-tradable prices increase significantly with a delay. Consistent with these results, Core CPI does not significantly move after an appreciatory shock.

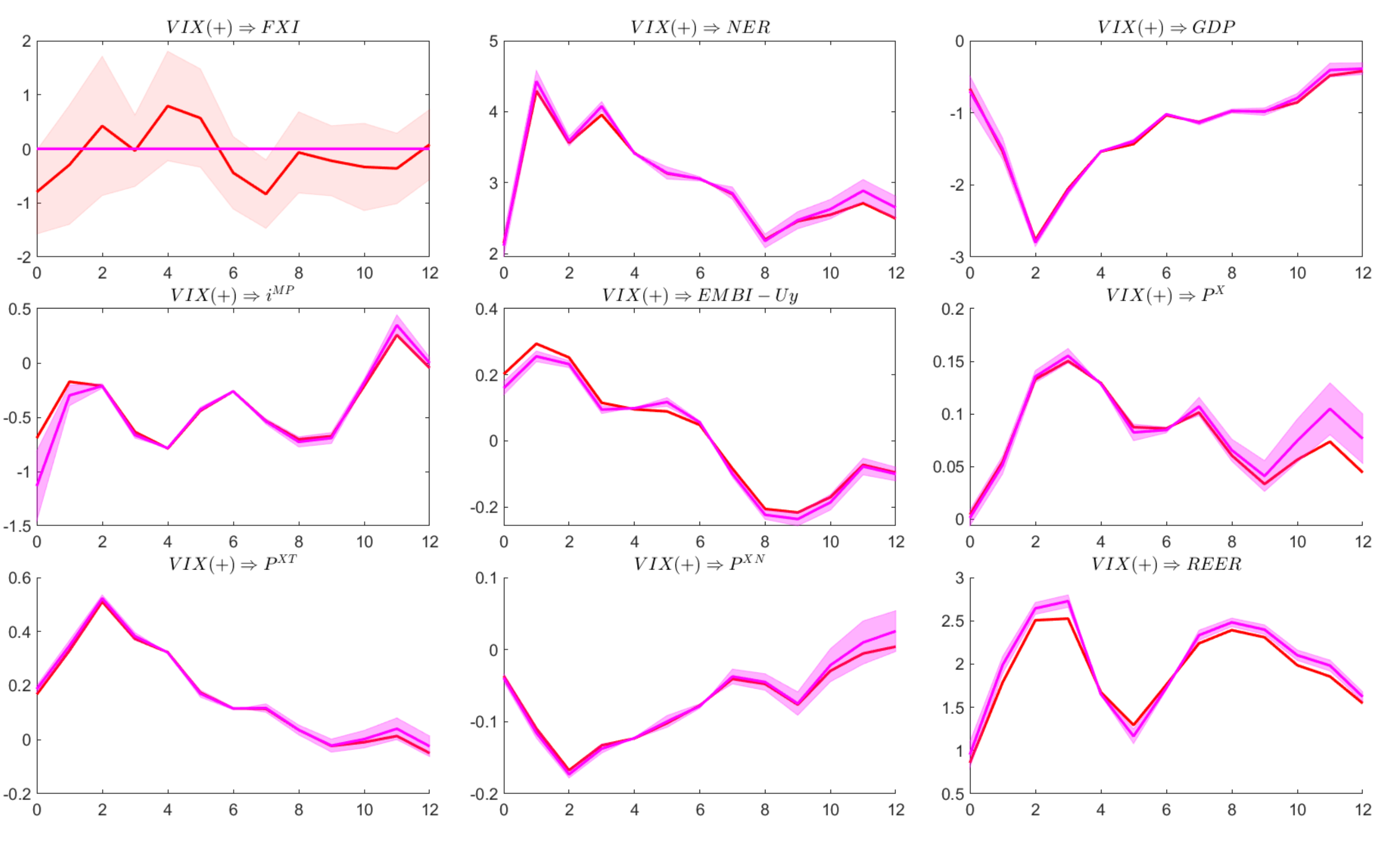
These responses suggest the following interpretation of the interaction between FXI and macro variables after a shock to the global value of the US dollar. Following a global strengthening of the US dollar, despite selling FX reserves (which is produced after a few months after the shock), the central bank is not able to prevent the nominal depreciation, in turn leading to a rise in inflation and a contraction in activity. In contrast, the FXI net purchases (which materializes immediately after the shock hits) are able to dampen the NER appreciation somehow. However, this prevents inflation from falling (boosting activity with a delay). The analysis based on constrained IRFs below will help to formally test this narrative.

4.4 Conditional Impulse Response Analysis

Given the marked differences in the observed dynamics depending on the sign of the shock, as analyzed in the previous subsections, we implement a CIRF analysis that distinguishes between positive and negative shocks. The counterfactual path for FXI that we study assumes that the central bank does not change FXI following the shock. Figures 9 to 12 display the results, and can we read as follows. The upper-right panel shows in red the estimated IRF, given by either $\widehat{\beta}_{1,h}$ or $\widehat{\beta}_{2,h}$ (depending on the sign of the shock) in equation (5), its respective confidence band, and in blue or green (depending on whether the shock is positive or negative) the counterfactual path assumed (simply zero in this case). In the rest of the panels, the red line is the point estimate of the IRF for a given domestic variable, the blue or green lines correspond to the point estimate of the CIRF (i.e. the IRF plus the constraining effect, $\widehat{\beta}_{1,h}+\widehat{\delta}_{1,h}(\mathcal{C}_h-\overline{w}_h)$ or $\widehat{\beta}_{2,h}+\widehat{\delta}_{2,h}(\mathcal{C}_h-\overline{w}_h)$ in equation (5)), and the light blue or green areas are confidence bands related **only** to the constraining effect. In this way, whenever the red line lies outside the confidence bands means the constraining effect is statistically significant.

Figure 9 analyzes the case of a positive VIX shock, which recall induces, in particular, a nominal depreciation and FXI sales in the short run (although not significant). We can see that, in the counterfactual in which the central bank does not sell FX reserves, the NER would rise even further, although the difference is only significant in a few periods (the largest difference in the point estimate is 0.3, a value almost 10% larger relative to the IRF). Thus, FXI sales seem to dampen somehow the effect induced nominal depreciation after this shock.

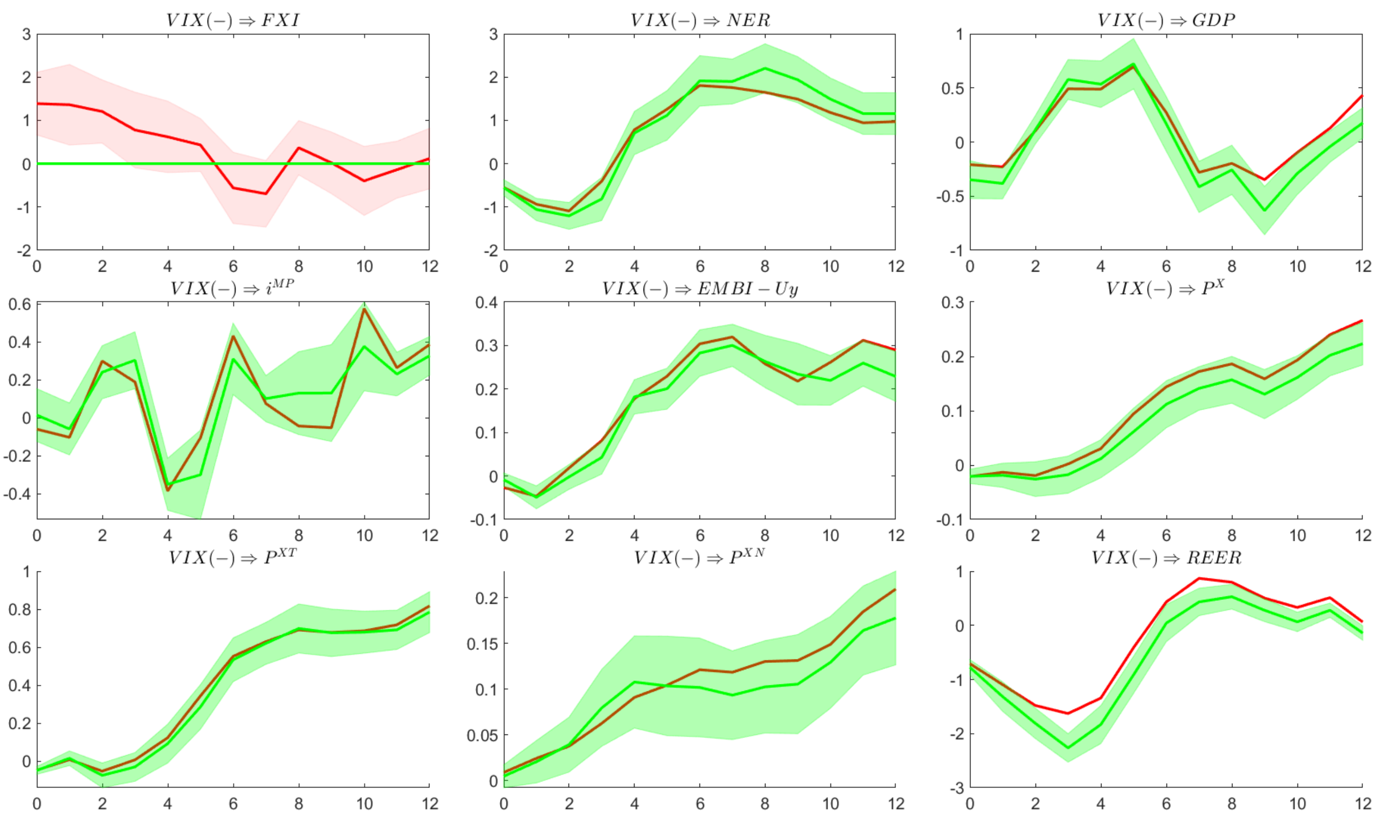
Figure 9: Constraining effect of interventions after a positive VIX shock



We can also see that in the counterfactual of no-intervention the monetary policy rate and EMBI-Uy increases are relatively smaller, while GDP behaviour is not significantly different. In terms of inflation, results shows that the absence of FXI would induce a larger path for tradable prices initially (consistent with the relatively larger depreciation in this counterfactual scenario) but also an additional, albeit mild, reduction in the price of non-tradables. These two opposite effects produce almost no difference between scenarios in the path of Core inflation. Finally, without the intervention, the REER depreciation is significantly larger in the short run (with a largest difference close to 15% larger than in the IRF).

Figure 10 shows the CIRF analysis for the case of a negative shock to the VIX. The counterfactual scenario with no FXI displays a somehow larger initial appreciation after this shock, although not statistically significant. Core CPI displays a relatively milder increase (not statistically significant), while the constraining effect in the REER appreciation is significant, implying a relatively larger real appreciation without the FX intervention. No other relevant difference arisein this case.

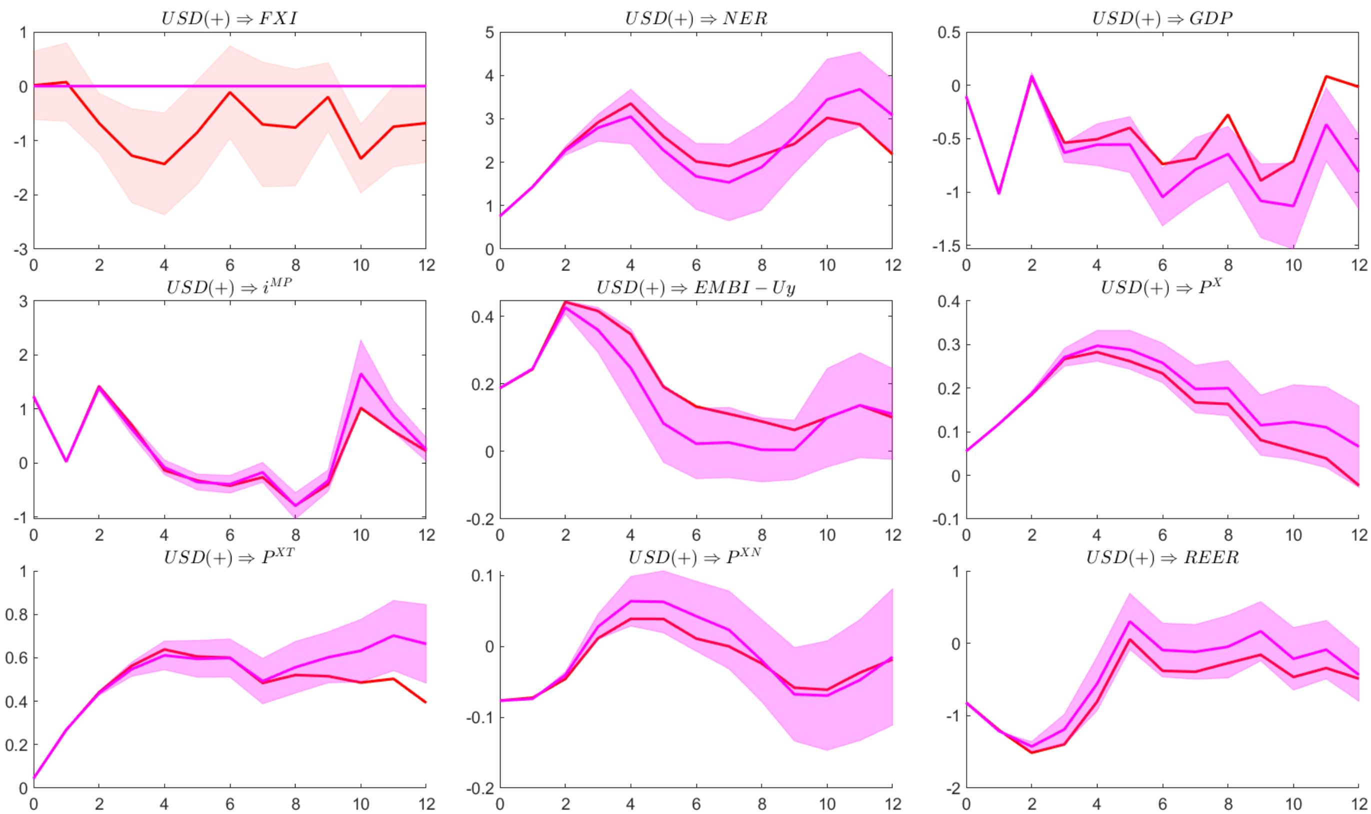
Figure 10: Constraining effect of interventions after a negative VIX shock



In Figure 11 the case of a positive shock to the Broad dollar index is displayed. As previously analyzed in the IRF analysis, the central bank responds to this shock with significant FX sales that are somehow delayed relative to the moment the shock occurs. The path for the NER in the counterfactual scenario is generally not significantly, except at the end of the horizon displayed in the figure in which the counterfactual nominal depreciation without interventions seems to be larger. Thus, if the intervention has any significant effect on the NER, it is materialized several month following the shock.

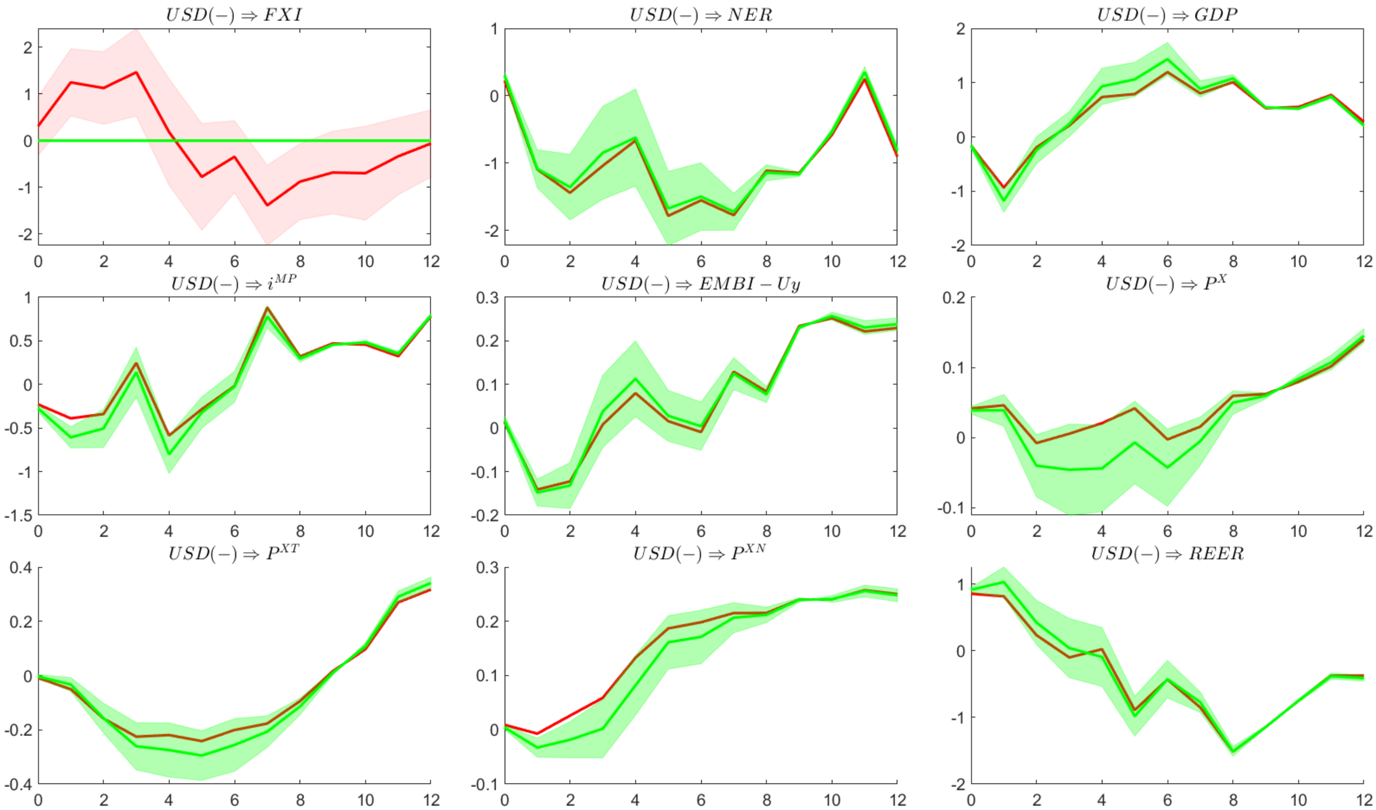
A similar pattern can be observed in the behaviour of tradable prices, while non-tradable as well as the Core CPI index are mildly above (but not significantly) in the counterfactual scenario. In term of the effect on activity, it seems that the contraction is activity is somehow larger in the counterfactual of no intervention, although not significant.

Figure 11: Constraining effect of interventions after a positive USD shock



Finally, Figure 12 show the CIRF analysis for the case a shock that weakens the global value of the dollar, which tend to appreciate the domestic currency and that, according to the IRF analysis above, leads to initial purchases of FX reserves. In the counterfactual of no interventions, the path of the NER is almost identical than under the IRF. Consistently, the path for tradable prices is similar between scenarios also.

Figure 12: Constraining effect of interventions after a negative USD shock



In contrast, non-tradable prices increase by less in the counterfactual case of no intervention, which also leads to a more an additional reduction in overall Core inflation. In addition, the path for the monetary policy rate is relatively more expansionary in the case with no FX intervention.

Overall, the analysis indicates that the influence of FX intervention in the economy varies depending the type and sign of the shock. Following shocks that induce a depreciation, FXI help to dampen the NER increase only after VIX shocks but not after shocks to the Broad Dollar index. When it has that dampening effect, the intervention is able to reduce the impact on tradable inflation, but at the same time the absence of intervention would have led to a somehow larger reduction in non-tradable inflation.

In contrast, when external shock are such are those that induce appreciations, it is less clear that the FX intervention allows to smooth the impact on the exchange rate (and thus on tradable inflation) but at the same time non-tradable price seem to display a relatively higher inflationary path, specially after a weakening the the global value of the dollar, and on the REER after a reducing in the VIX. Thus, FX interventions in a favorable global scenario seem to have a cost in terms of inflation, but not due so much related to the behaviour of tradable prices but of non-tradables instead.

5 Conclusions

In this paper, we seek to understand the role played by FXI in smoothing the effect of external shocks in Uruguay, a small and open economy under an inflation-targeting regime that also features significant

FXI. Instead of trying to identify exogenous variations in FXI –a strategy followed by most of the related literature but that is generally hard to defend– we leverage a novel econometric technique called constrained impulse responses that allows producing counterfactual scenarios depending on the intensity of the FXI following an external shock. Moreover, we can construct a series of FXI for the case of Uruguay reflecting "pure" interventions, in the sense that it is cleaned from valuation effects in foreign reserves that cloud the more usual measures of FXI used in the literature.

Results indicate that the role of FXI depends on the shock hitting the economy and its sign. It also highlights that FXI has been more heavily used in Uruguay to increase reserves in favorable global scenarios. This, in turn, has a cost in terms of inflation that is not directly related to the evolution of the nominal exchange rate (and thus tradable prices) but instead to the behaviour of non-tradable inflation.

We conclude by stressing a limitation of the analysis. While constrained impulse responses allow to construct counterfactual scenarios, the analysis is only local in the following sense. We cannot use this tool to describe how dynamics would have evolved if Uruguay had never intervened in the FX market. Instead, a correct interpretation of these results is that we can tell what happens in a country that generally does intervene if the FX intervention is marginally different than what it is on average. In other words, this tool is silent about the consequences of the particular FX regime that the country chooses to have or what could happen if a different framework is adopted. For those types of questions, arguments related to the Lucas critique apply, and therefore a more structural analysis is still required.

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