

International reserve policy and the effectiveness of sterilized FX intervention in Colombia

By Hernando Vargas, Pamela Cardozo and Mauricio Villamizar¹

Abstract

Two FX policy issues are discussed based on the recent Colombian experience. First, the increased participation of foreign investors in local bond markets since 2014 induced a reassessment of international reserve adequacy. We present the resulting Liquidity Coverage Ratio-type methodology to evaluate adequacy, together with a brief description of the international reserves management strategy in Colombia. Second, we shed some light on the debate regarding the effectiveness of sterilized FX intervention, showing that exchange rate effects depend on the “flimsiness” of exchange rate expectations or their fundamental determinants. To support this, we provide empirical and theoretical evidence.

JEL classification: F31, E58

Keywords: sterilized FX intervention, international reserves, Colombia

¹ Banco de la República’s Deputy Technical Governor, Deputy Governor for Monetary Operations and International Investments, and Deputy Governor for Economic Studies, respectively. The opinions contained in this document are the sole responsibility of the authors and do not necessarily represent those of Banco de la República nor its Board of Directors.

1. Introduction

The FX intervention strategy of the Central Bank of Colombia (BR) considers a clearly specified set of objectives, which include preserving adequate levels of external liquidity, alleviating illiquidity episodes in the FX market, overcoming shortages of short-term external funding for the country, curtailing excess volatility of the exchange rate and correcting exchange rate misalignments that could risk de-anchoring inflation expectations. Each of these motivations has specific triggers, conditions and associated instruments for the intervention (Cardozo, 2019). In any case, FX intervention is sterilized so that the short-term interest rate does not deviate from the policy interest rate, which is determined within the Inflation Targeting scheme used to guide monetary policy in Colombia.

In this context, the increasing importance of foreign investors in Colombian capital markets over the last four years led to a revision of the gauges of international liquidity adequacy. Since 2014, the participation of foreign investors in the local public bond market has risen from 6% to around 25%. While this is appreciated in terms of the development of domestic capital markets and a reduced FX risk exposure of the government, it poses some challenges with regards to the stability of the local public bond market and the adequacy of the international liquidity position of the country. The latter has been recently analyzed by the BR, resulting in the definition of a new methodology to assess international reserves adequacy and a program of reserve accumulation. This is described in some detail in the first part of this document.

The stock of international reserves (USD 51.5 billion as of April 2019) is managed in two tranches with very low credit risk. A “liquid” tranche of approximately 60% of the stock has a duration of 2.6 and its currency composition is set to track the price index of imports and the currency composition of other outlays of the balance of payments. The second tranche has a higher duration and is mostly invested in US dollar-denominated assets. The definition of the size and the characteristics of these tranches is explained in the second part of this document.

On the other hand, the effectiveness of sterilized FX intervention (SFXI) to affect the level or the volatility of the exchange rate has been a permanent matter of debate in Colombia, even though intervention with this purpose has been negligible in the last four years. In the third part of this document, we postulate a new determinant of effectiveness that has to do with the “flimsiness” of exchange rate expectations or their fundamental determinants. We posit a partial equilibrium model to explain this channel and present empirical evidence.

2. International liquidity adequacy in the context of large foreign participation in the domestic capital markets

A tax reform at the end of 2012 substantially reduced and simplified the withholding taxes on foreign portfolio investment in the local debt market. After the taper tantrum subsided, these tax incentives prompted some emerging market (EM) bond indices to increase the share of Colombian domestic public bonds in their benchmarks. As a result, about USD 9 billion flowed into the local public bond market in 2014, driving up the participation of foreigners from 6% in January 2014 to 16% in January 2015.

Afterwards, further inflows continued, albeit at a slower pace. Today that participation stands at 25%.

This is a phenomenon that is welcome, for it reduces the FX risk exposure of the government (as it is transferred to foreign investors) and helps alleviate the “original sin” problem (Eichengreen and Hausmann, 1999). It may also contribute to the development of local capital markets. However, it poses challenges in terms of both the stability of the local public debt market and the adequate level of the country’s international liquidity. Although foreign investors have not been particularly volatile so far (or at least more volatile than domestic investors), there is the risk that they may flee more easily in the face of adverse conditions of the economy or public finances. Also, some foreign investors are known to exit a country rapidly after the domestic macroeconomic policy framework becomes less orthodox.

Consequently, the growing presence of these investors in local capital markets requires rethinking the criteria to set the adequate level of a country’s international liquidity. This has been the case at the BR. Previously, the BR established the adequate level of international reserves by setting combined targets for four traditional reserve coverage indicators (the ratios of reserves to imports, current account deficit plus external debt amortizations, broad monetary aggregate, and GDP). Reserve purchases were concentrated in those periods of time when the estimated probability of an exchange rate misalignment was highest.

After the jump in foreign participation in local capital markets, a new methodology akin to the Liquidity Coverage Ratio was developed. It requires international reserves to cover at least the expected current account deficit plus external debt amortizations over the next year. Moreover, the sum of international reserves and the International Monetary Fund (IMF) Flexible Credit Line (FCL) must cover the abovementioned expected outlays plus an estimation of potential portfolio outflows from residents and non-residents. The latter are calculated for a one-year period assuming stressed prices in all financial and FX markets. Currently, the stock of international reserves exceeds the current account deficit plus external debt amortizations, and covers part of potential portfolio outflows. The sum of reserves and the FCL covers all estimated outflows.

The IMF FCL is a temporary instrument and Colombia has agreed to gradually reduce its access; external risks permitting. This implies that probably Colombia’s renewal of the FCL in 2020 would be for a lower amount and, therefore, that international reserves must be accumulated. In consequence, at the end of September 2018 the BR announced a program to purchase USD through monthly auctions of put options. This instrument had been used in the early 2000s with the same purpose, and was chosen to minimize the impact of the FX intervention on the exchange rate. This is so because these options can only be exercised when the average exchange rate (COP/USD) of the previous day is below its 20-day moving average. Thus, purchases occur only when there is an appreciation of the COP. This is an important feature in the current context of fundamental-driven pressures for COP depreciation (monetary policy normalization in advanced economies and highly volatile terms of trade), since it is deemed undesirable that the reserve accumulation program induces excess volatility of the exchange rate.

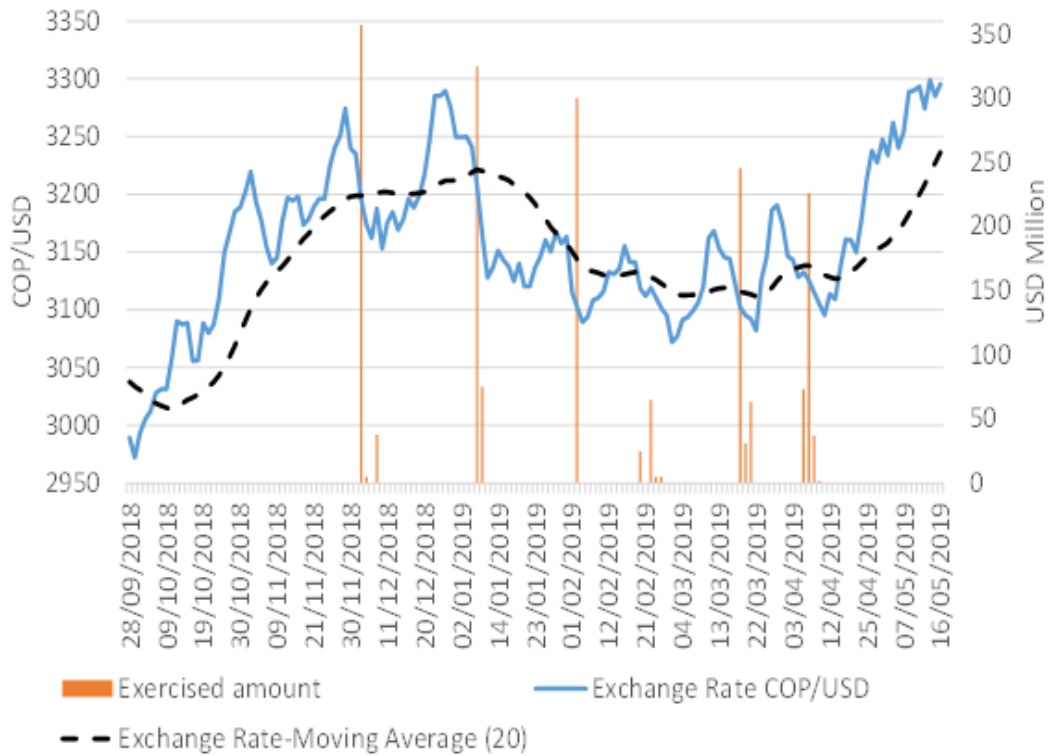
In September 2018, the BR announced the start of the program, but not its end date nor the total amount to be purchased, so that the authorities could retain flexibility given potential risks of a sharp depreciation of the COP. Since October 2018, the BR has held eight auctions of put options at the beginning of each month, each

for USD 400 million. Options have a one-month maturity. In total, USD 1,878 million has been exercised (Figure 1).

Recent USD purchases through put options

Exchange rate & central bank's USD Purchases

Figure 1



Source: Banco de la República

3. International reserve tranches in Colombia

The BR manages its international reserves with very low credit risk. To date, the minimum accepted rating for sovereigns is A- and for corporates A+. Given a substantial increase in the stock of international reserves since 2010 (USD 21,857 million) and the low return stemming from global liquidity conditions, in 2015 a new two-tranche approach to manage reserves was introduced.

The first tranche maximizes its return, given a currency composition, subject to the constraints that i) its return cannot be negative in a one-year period with a probability of 95%, and that ii) the conditional value at risk (CVaR) cannot be above 1% in the same period. Its currency composition seeks to mimic the price index of imports and the currency composition of other outlays of the balance of payments.² The second tranche maximizes its return in US dollars, subject to the constraints that

² An index is constructed, as the weighted average of the good import price index, the currency index of the external debt service and the currency index of service imports, all in US dollars. The weights correspond to the participation of those items in their sum.

i) its three-year return cannot be negative with a probability of 95%, and that ii) the CVaR cannot be above 1% in the same period.

Eligible currencies for the indexes of both tranches must have a reserve currency status for the BR³ and the public debt of the currency issuer must satisfy the following three conditions: i) it must have positive interest rates; ii) the BR should be able to invest directly in it; and iii) the BR's participation in that market should not exceed 5%. Currently, the duration of the first (short term) and second tranches is 2.6 and 4.2, respectively. The currency composition of the short-term tranche is USD 82%, AUD 9%, CAD 5%, NZD 2% and NOK 2%. For the second tranche, the currency composition is USD 93%, GBP 3% and AUD 4%.

The objective of the first tranche is to be able to address the potential balance of payments outflows in cases of periods of stress during a one-year period (hence its currency composition). To determine its size, the BR uses a modification of the Adequate Reserve Adequacy (ARA) metric proposed by the IMF.⁴ The original ARA methodology sums FX shortfalls stemming from external debt payments, foreign portfolio investment, reductions in M3, and lower inflows from exports, during periods of exchange market pressure. The BR's modification takes into account the correlations among these variables during those periods. This way, the BR's approach is less conservative than the IMF's, considering that the methodology does not seek to determine the adequate level of total reserves, as is the case in the IMF's methodology, but to establish the size of the first (liquid) tranche. The second tranche is the difference between the stock of international reserves and the short-term tranche.

4. Effectiveness of sterilized FX intervention and the "flimsiness" of exchange rate expectations⁵

The BR has had a rich history of SFXI in terms of objectives, modalities and market conditions.⁶ Consequently, there has been a growing strand of empirical work centered on its effectiveness, i.e. the ability to alter the level or volatility of the exchange rate.⁷ Results are mixed but, in general, when SFXI is found to be effective, the size of the effects are small and short lived (less than one month).

Nevertheless, it is well known that isolating the effect of SFXI is empirically difficult and that many studies in the field are plagued with identification problems. In addition, previous studies have overlooked the influence of uncertainty about the future path of the exchange rate or its fundamentals when evaluating the

³ DKK, NOK, SEK, AUD, CAD, USD, NZD, EUR, CHF, GBP, JPY, CNH/CNY, HKD, SGD, KRW. External Resolution 1, 2018. Article 1.

⁴ <https://www.imf.org/external/np/spr/ara/>

⁵ This section is taken directly from Vargas-Herrera and Villamizar-Villegas (2019). In some cases, entire excerpts are used.

⁶ For an in-depth view of the regulatory framework on exchange rate intervention conducted by the Central Bank of Colombia, see Nota Editorial (2016) and Circular Externa DODM-143 (2011).

⁷ Studies that center on the Colombian case include: Mandeng (2003), Kamil (2008), Toro and Julio (2005), Rincon and Toro (2010), Echavarría et al. (2010, 2014, 2018), Fuentes et al. (2014), Villamizar (2015), Ocampo and Malagon (2015), and Kuersteiner et al. (2018). See Table 9.2 of Cardozo, 2019.

effectiveness of SFXI. This is an important factor, for it affects the strength of investors' responses to central bank intervention. Thus, we posit a partial equilibrium model to illustrate this and present empirical evidence based on a discontinuous regression model that provides a clear-cut identification strategy within a quasi-experimental framework, taken from Vargas-Herrera and Villamizar-Villegas (2019).

4.1 A model of SFXI and the “flimsiness” of exchange rate expectations

In this section, a model with frictions in the FX market is put forward in which the degree of effectiveness of SFXI is related to the uncertainty of market participants on the future exchange rate. When uncertainty on the future exchange rate or its fundamentals is low, SFXI is likely to be less effective, for agents would be willing to “bet more money” against it if it runs against the expected exchange rate or its fundamentals. By contrast, if uncertainty on the future exchange is high, SFXI will face a weaker countervailing force from speculators and arbitragers. In this case, there will be less certainty about the inconsistency between SFXI and exchange rate fundamentals, and, consequently, less money will be “bet against” intervention. The concept of uncertainty about the future exchange rate is, in this context, understood as the variance of the investors' distribution of the future exchange, which is related to the variance of exchange rate fundamentals.

Suppose a FX market had the following features:

- A very short period of time in which macroeconomic aggregates like foreign and domestic income and price levels are taken as given. Foreign and local interest rates are assumed to be constant as well.
- A “net supply” of foreign currency that has two components. A first component, NX , depends positively on the real exchange rate defined as p^*e/p . e is the price of the foreign currency in domestic currency units. In the short run, both foreign and domestic price levels are assumed to be constant, so that this component of the FX “net supply” depends positively on the nominal exchange rate, $NX = NX(e)$, $\frac{dNX(e)}{de} > 0$. The second component, K , is exogenous and does not depend on the exchange rate. It may be thought to include the autonomous and income-dependent parts of the current account balance and those net capital flows that do not respond to the exchange rate. Thus, the FX “net supply” is given by:

$$NX(e) + K \tag{1}$$

- A group of “speculators” with no financial constraints, who bet on a future appreciation or depreciation of the local currency using the forward market⁸. The speculators choose the amount of forward net sales of FX, F , aiming at maximizing the expected utility of their profits in the future, $F(f - e_1)$. f is the forward price of the FX and e_1 is the future spot exchange rate. The speculators face uncertainty on the latter and, consequently, on the future return of their bet. f is known (taken as given from the market), but e_1 is not. More specifically, e_1 is assumed to have a normal distribution, so that:

⁸ Much like the “off-shore” agents in the Colombian FX market.

$$f - e_1 \sim N(f - E[e_1], \sigma_{e_1}^2) \quad (2)$$

- Uncovered interest rate parity (UIP) does not hold, thereby rendering SFXI effective by construction in the model. However, covered interest rate parity (CIP) does hold. There are non-financially constrained agents that arbitrage interest rate differentials using the forward FX market, so that:

$$f = \frac{e(1+i)}{(1+i^*)} \quad (3)$$

- It is assumed that these agents do not hold open net FX positions⁹, so that any shift in their forward position is matched by an opposite shift in their spot position. In particular, these agents are the counterparty of the speculators and, therefore, any net forward purchases by the speculators produce net spot purchases by the arbitragers of the same amount.
- Equilibrium in the spot market requires that:

$$NX(e) + K = -F \quad (4)$$

Recall that F are the speculators' net forward sales. Thus, -F are their net forward purchases. The latter produce net spot purchases of the same amount by arbitragers, as explained above. Thus, the LHS and RHS of equation (4) may be interpreted as the spot FX net supply and demand, respectively. The nominal exchange rate, e, adjusts to clear the spot FX market. Based on the types of agents assumed, this model could be considered a simplified characterization of the Colombian FX market in the short run.

To complete the description of equilibrium, the optimal level of F must be derived from the "representative speculator's" problem:

$$\max_F E\{U[F(f - e_1)]\}$$

Assuming a CARA utility function, $U = -exp^{\lambda w}$, and using the normality assumption in (2), the above problem may be stated as a mean-variance optimization model. Notice that $F(f - e_1) \sim N(F(f - E[e_1]), F^2 \sigma_{e_1}^2)$. Hence, the optimization problem may be expressed as:

$$\max_F F(f - E[e_1]) - \frac{\lambda}{2} F^2 \sigma_{e_1}^2$$

The first order condition of this problem implies:

$$F = \frac{f - E[e_1]}{\lambda \sigma_{e_1}^2} \quad (5)$$

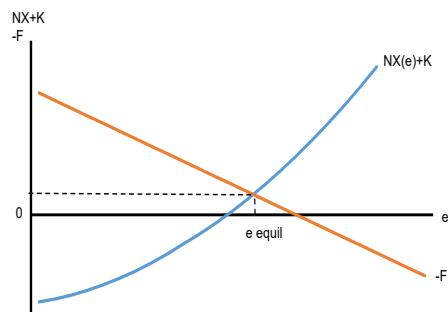
Notice that the magnitude of the speculators' net forward sales, |F|, depends negatively on the variance of the speculators' distribution of the future exchange rate, $\sigma_{e_1}^2$, and the degree of risk aversion, λ . The greater the uncertainty on the future exchange rate, the lower the magnitude of net forward sales or purchases of the risk-averse speculators.

The equilibrium level of the spot exchange rate, e, is obtained by substituting (3) and (5) into the equilibrium condition (4):

$$NX(e) + K = \frac{E[e_1]}{\lambda \sigma_{e_1}^2} - \frac{e(1+i)}{\lambda \sigma_{e_1}^2 (1+i^*)} \quad (6)$$

⁹ Much like banks in the Colombian FX market.

The LHS of equation (6) depends positively on e , while the RHS depends negatively on e . Graphically the short-term equilibrium in the FX market may be depicted as follows:



To explore the impact of changes in $\sigma_{e_1}^2$ on the effectiveness of SFXI, the equilibrium condition (6) may be differentiated as follows:

$$NX_e de + dK = -\frac{(1+i)}{(1+i^*)\lambda\sigma_{e_1}^2} de$$

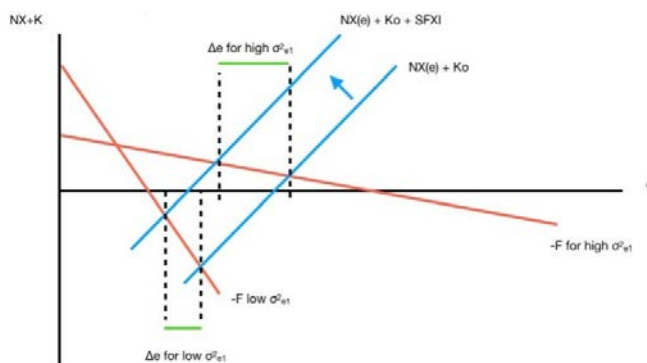
Here $NX_e \equiv \frac{dNX}{de}$ and dK represents the variation in the autonomous component of the FX net supply due to central bank FX sales. This differentiated equation implies:

$$\frac{de}{dK} = -\left[NX_e + \frac{(1+i)}{(1+i^*)\lambda\sigma_{e_1}^2}\right]^{-1} < 0 \quad (7)$$

$$\text{and } \frac{\partial^2 e}{\partial K \partial \sigma_{e_1}^2} = \frac{-(1+i)}{(1+i^*)\lambda(\sigma_{e_1}^2)^2} \left[NX_e + \frac{(1+i)}{(1+i^*)\lambda\sigma_{e_1}^2}\right]^{-2} < 0 \quad (8)$$

Equation (7) measures the response of the equilibrium nominal exchange rate to the increased supply of FX by the central bank. Notice that the currency appreciates, even though the domestic interest rate is kept unchanged (the FX intervention is sterilized). Hence, SFXI is effective. Equation (8) shows that the response of the exchange rate to SFXI increases in magnitude with the variance of the investors' distribution of the future exchange rate. The greater this variance, the larger the reduction of the exchange rate (the more effective is the SFXI).

Graphically:



Intuitively, a high value of $\sigma_{e_1}^2$ implies that small movements in F shift the "marginal cost" of risk significantly. Consequently, F does not react strongly to changes in the marginal benefit, $f - E[e_1]$. Thus, the speculators' offsetting response to SFXI is weak and the latter becomes more effective. For example, if the central bank

sells FX in the market, it will produce an appreciation of the currency ($\downarrow e$). Given the interest rate differential, by arbitrage this will reduce the forward exchange rate ($\downarrow f$), resulting in lower expected returns to forward sales ($\downarrow (f - E[e_1])$) and reduced net forward sales by the speculators. However, the size of this response will be smaller, the greater the variance $\sigma_{e_1}^2$, since any drop in F will significantly decrease risk. Ultimately, the reduction in the speculators' net forward sales is substantially lower than the central bank FX sales, increasing SFXI effectiveness.

Importantly, the foregoing results assume that the SFXI does not change the speculators' distribution of the future exchange rate.

Hence, the "flimsier" the expectations of the future exchange rate (the higher $\sigma_{e_1}^2$), the more effective is SFXI. If the speculators' distribution of the future exchange rate is related to the distribution of its fundamentals, then the "flimsiness" of fundamentals will have an impact on SFXI effectiveness. In the empirical tests of this channel shown below, the time-varying variance of exchange rate fundamentals is used as a proxy of the uncertainty of market participants about future fundamentals behavior.

4.2 Empirical evidence

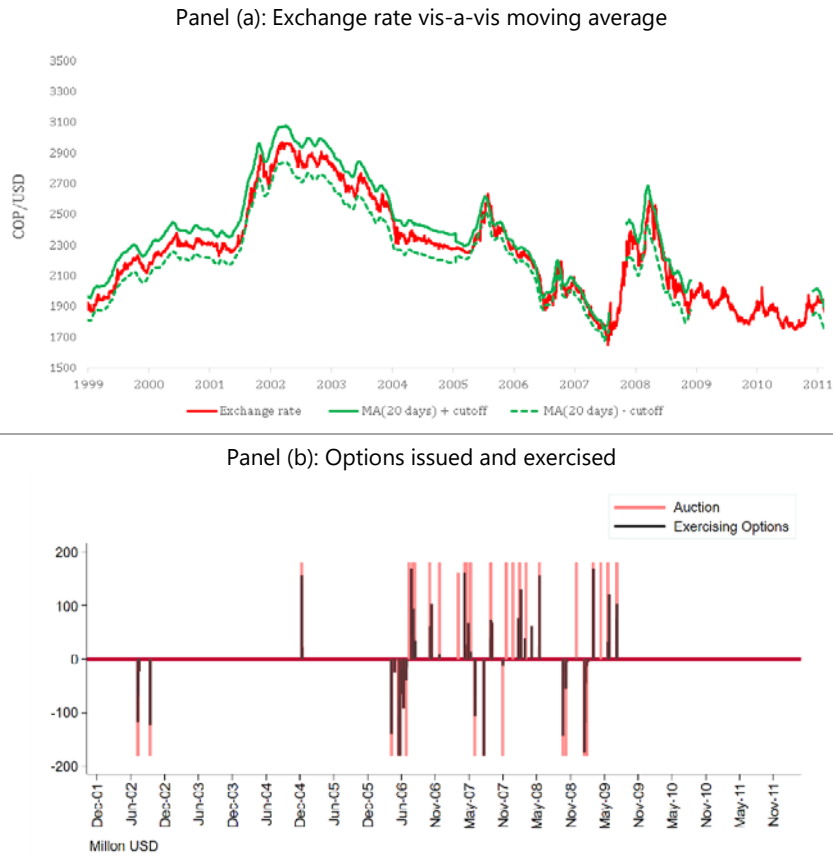
4.2.1 Data

The empirical application focuses on the rule-based FX options put in place by the BR from 2002 to 2012, aimed at stemming exchange rate volatility. In brief, the BR issued FX options whenever the exchange rate vis-à-vis its last 20-day moving average exceeded an established cutoff value, generally set at $\pm 4\%$ (-4% for puts and $+4\%$ for calls), as seen in Figure 2 (Panel a). This cutoff was temporarily modified to $\pm 2\%$ from December 19, 2005 to June 24, 2008 and to $\pm 5\%$ from October 7, 2008 to October 27, 2009. The mechanism was temporarily suspended from June 26, 2008 to October 6, 2008 and from October 28, 2009 to October 30, 2011. It was permanently suspended on February 6, 2012.

During the sample period, the rule was triggered 231 times. If options from a previous auction were outstanding, then market participants could exercise existing options. If no options were outstanding, then the rule triggered a new auction. As seen in Figure 2 (Panel b), 38 auctions were triggered by these 231 events, and options were exercised in 75 cases. Purchases through put options totaled USD 2.4 billion, and sales through call options totaled USD 2.3 billion dollars. Daily average of exercised options sales when (USD 68.5 million) were only slightly higher than average purchases (USD 57.9 million).

Figure 1A (Appendix A) depicts the measures of flimsiness employed in our empirical exercise. They include: (a) the one-month COP/USD exchange rate volatility, (b) the one-month-ahead exchange rate forecast dispersion of market participants,¹⁰ (c) the overnight Colombia-USA yield spread volatility, (d) the VIX index, (e) the implicit oil price (Brent) "IVOLCRUD", (f) the MOVE index which captures expected risks in US Treasury yields, and (g) the EM risk index "MXEFOCXO".

¹⁰ The one-month-ahead exchange rate forecast dispersion is constructed from the BR's Expectations Survey. Intuitively, high values of this flimsiness variable indicate greater disagreement about the future exchange rate. The relationship between forecast disagreement (dispersion in expectations) and market uncertainty is made explicit in Lahiri and Sheng (2010).



Source: Banco de la República.

4.2.2 The Impact of “flimsiness” on the effectiveness of SFXI

An evaluation of the degree in which uncertainty about the future path of the exchange rate or its fundamentals either magnifies or lessens the effectiveness of SFXI is presented. This is done by extending Kuersteiner et al. (2018)’s work, which studies the effects of the rule-based SFXI, described in the previous sub-section, within a localized approach. The authors compare episodes in which the intervention rule was barely missed with episodes in which it was barely triggered. Hence, exchange rate variation within the vicinity of the triggering threshold is *as good as randomly assigned* and hence forms the basis for identifying causal effects.

For the case of Colombia, the BR issued FX options whenever the assignment variable (exchange rate vis-à-vis its last 20-day moving) exceeded a given threshold: $X_t \geq x_0$.

The empirical contribution is thus to extend the RDD exercise in Kuersteiner et al. (2018) to allow for an incremental effect of policy, by including an interaction term between exchange rate intervention and a measure of “flimsiness”. As such, Jorda (2005)’s method of local projections is used to estimate the following model:

$$\arg \min_{\theta} \sum_{j=1}^J \sum_{i=2}^{T-j} (y_{t+j} - a_j - \theta_j D_t - b_j (X_t - x_0) - \tau_j D_t (X_t - x_0) - \psi_j Flim_t - \delta_j D_t Flim_t)^2 K\left(\frac{X_t - x_0}{h}\right) \quad (11)$$

where $\delta = (\delta_1, \delta_2, \delta_3, \dots, \delta_j)'$ accounts for the incremental impact of the flimsiness variable, j periods after treatment, and $K(\cdot)$ is a kernel function with bandwidth h .¹¹ The inclusion of the term $\tau_j D_t(X_t - x_0)$ allows for different specifications of how the running variable affects the outcome, at either side of the cutoff.

Table 1 shows the main estimation effects, as reported in Vargas-Herrera and Villamizar-Villegas (2019). Essentially, the estimated Impulse Response Functions (IRFs) plot the vector δ of equation (11) across the different time horizons: $j=1-21$ working days. All of the flimsiness measures are standardized in order to make the effects comparable (i.e. the impulse shock corresponds to one standard deviation). Finally, the focus is on the effects of put options since, as noted in Kuersteiner et al. (2018), call options sometimes coincided with other methods of SFXI, in some cases offsetting purchases with sales of foreign currency.

Incremental effect of the different flimsiness variables

Table 1

	1 Day	3 Days	6 Days	9 Days	12 Days	15 Days	18 Days	21 Days
Benchmark	0.009***	0.010*	0.024**	0.016*	0.016**	0.011	0.010	-0.002
Kuersteiner et al. (2018)	(0.003)	(0.006)	(0.011)	(0.008)	(0.008)	(0.008)	(0.009)	(0.009)
Exchange rate volatility	-0.0001	0.004	0.016***	0.011**	0.010**	0.011**	0.009*	0.003
	(0.002)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.006)	(0.006)
1-month dispersion	0.004	0.012***	0.026***	0.020***	0.016***	0.020***	0.016***	0.010*
	(0.002)	(0.004)	(0.006)	(0.006)	(0.005)	(0.005)	(0.006)	(0.005)
Yield spread volatility	0.002	0.006*	0.011**	0.005	-0.004	0.001	0.0003	-0.003
	(0.002)	(0.004)	(0.005)	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)
VIX	0.003	0.010**	0.019***	0.016***	0.013***	0.015***	0.011*	0.005
	(0.002)	(0.004)	(0.006)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)
Implicit oil volatility	0.001	0.005	0.016**	0.011**	0.007	0.010*	0.009	0.007
	(0.002)	(0.005)	(0.007)	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)
US Treasury yields risk	0.002	0.006**	0.014***	0.014***	0.015***	0.014***	0.012**	0.008
	(0.002)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)
Emerging market risk	-0.001	0.006	0.02	0.023*	0.032**	0.029**	0.036**	0.028
	(0.006)	(0.012)	(0.017)	(0.013)	(0.015)	(0.012)	(0.016)	(0.017)

Source: Table taken from Vargas-Herrera and Villamizar-Villegas (2019).

As a benchmark comparison, an initial model without “flimsiness” is estimated and reported in the first row of Table 1. Namely, the exchange rate depreciates (i.e. values in COP-USD increase) by up to 2% during the first week of intervention before the effects subside. This effect is the same result as the one found in Kuersteiner et al. (2018).

The remaining variables (rows) correspond to the incremental effect of the different “flimsiness” variables based on market conditions. Specifically, the second row shows that the one-month exchange rate volatility magnifies the effect of the intervention by about 1% during a period of three weeks (20 working days). Similarly, the third row shows a significant incremental effect by up to 2% during a period of approximately three weeks. The fourth row shows that the effects of SFXI increases by 1% in periods of high yield spread volatility, although in this case the duration of the effects remain significant only during the first week. The fifth row shows that high

¹¹ In the exercises that follow, a triangular kernel is used with the optimal bandwidth as described in Imbens and Kalyanaraman (2012).

values of the VIX index augment the effect of intervention by almost 2% during a period of three weeks.

The remaining flimsy variables show similar results. The sixth row of Table 1 shows that high values of implicit oil price volatility increase intervention by 1% during the second week. The seventh row shows that volatility in US Treasury yields captured by the MOVE Index augment the effect of intervention by 1.5% during a period of three weeks. Finally, the eighth row shows that high values of the EM risk index amplifies intervention effects by close to 2% during the second and third week.

5. Conclusion

The adequate level of international reserves, reserve management and the effectiveness of SFXI have been important policy topics in Colombia in recent years. These topics are briefly reviewed in this document. The relevance of an adequate level of international liquidity increased after the participation of foreign investors in Colombia's local capital markets rose markedly beginning in 2014. A new methodology akin to the Basel LCR was developed in this respect. The new approach requires international reserves plus the IMF FCL to cover the sum of the expected current account deficit, external debt amortizations over the next year and an estimation of potential portfolio outflows from residents and non-residents during one year. Consequently, a program of reserve accumulation was put in place in October 2018.

Given a substantial increase in the stock of international reserves since 2010 and the low return stemming from global liquidity conditions, in 2015 a new two-tranche approach to manage reserves was introduced. The first tranche has low duration and a currency composition that mimics the price of imports and the currency composition of other balance of payments outlays. The second tranche has longer duration and is mostly invested in US dollar-denominated assets.

Finally, we posit a new channel of SFXI effectiveness in which the greater the uncertainty of the future path of the exchange rate (driven by the "flimsiness" of its fundamentals), the larger the impact of intervention on the level of the spot exchange rate. We provide both theoretical and empirical evidence to support the relevance of this channel.

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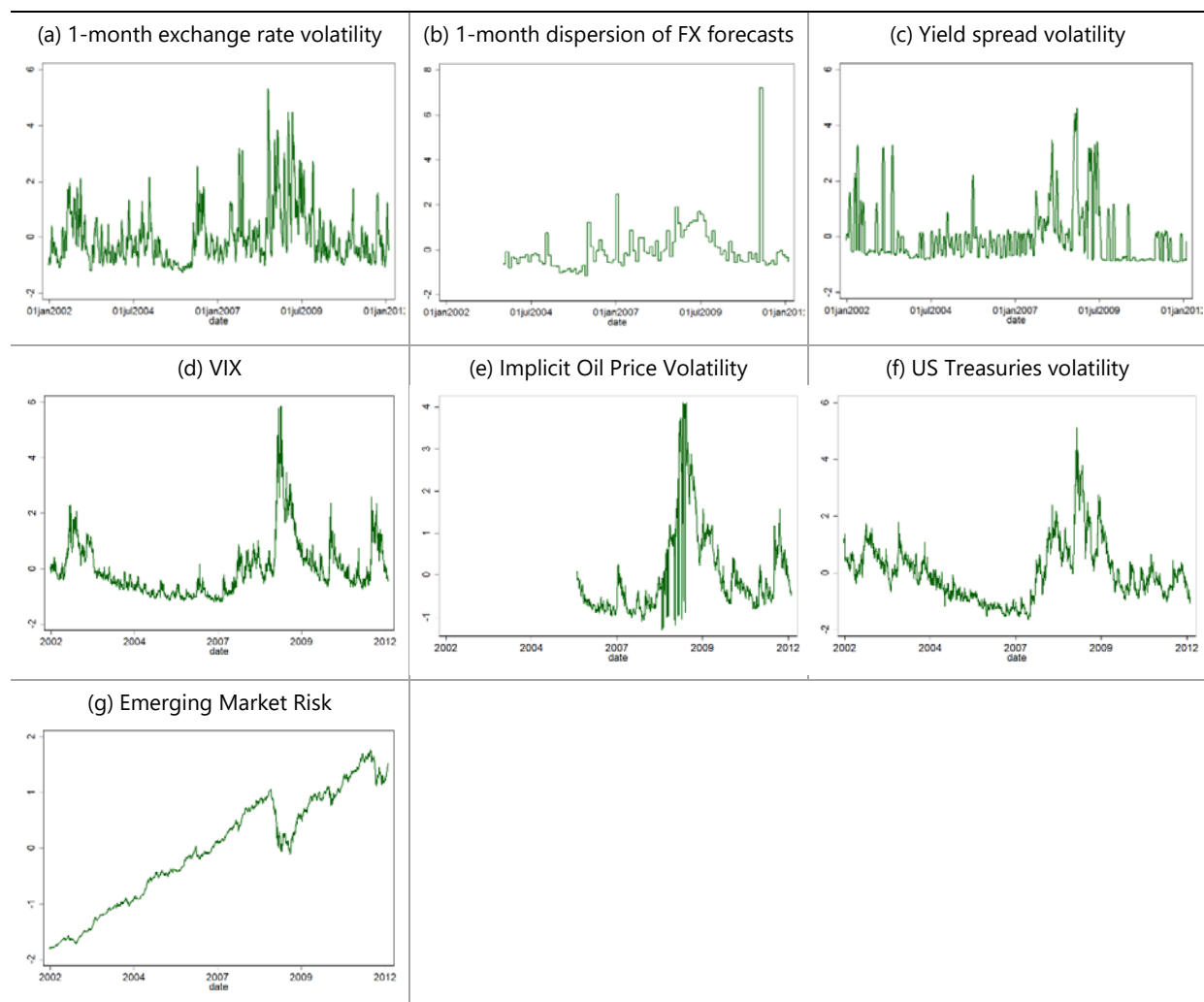
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Appendix: Flimsiness variables

Standardized volatility in exchange rate and fundamentals

Figure 1A



Sources: Banco de la República and Bloomberg. Authors' calculations.