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Foreign Exchange Interventions and their Impact on Exchange Rate Levels

Abstract

This paper examines foreign exchange intervention practices and their effectiveness in containing currency appreciation, using a new qualitative and quantitative database for a panel of 15 economies covering 2004-2010, with special focus on Latin America. Qualitatively, it examines institutional aspects such as declared motives, instruments employed, the use of rules versus discretion, and the degree of transparency. Quantitatively, it assesses the effectiveness of sterilized interventions in influencing the exchange rate using a two-stage

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IV-panel data approach, which helps overcome endogeneity bias. Results suggest that interventions slow the pace of appreciation, but the effects decrease rapidly with the degree of capital account openness. At the same time, interventions are more effective in the context of already overvalued exchange rates.

Keywords: Foreign exchange intervention, exchange rates, sterilization, appreciation.

JEL classification: F31, E58.

1. INTRODUCTION

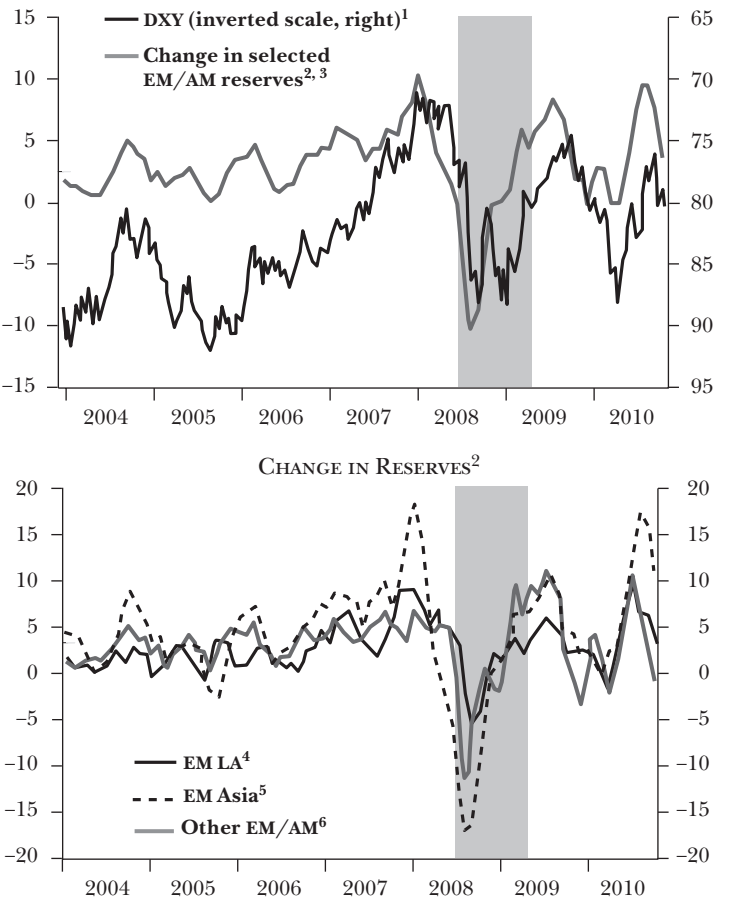
This paper examines *sterilized* foreign exchange intervention (FXI) practices and their effectiveness in mitigating appreciation pressures. It relies on a new qualitative and quantitative database for a panel of 15 economies covering the period 2004-2010, with special focus on Latin America (LA). In particular, we seek to answer the following questions: How have LA countries intervened in foreign exchange markets, and how has this differed from other EMEs? What motives have driven such polices? How effective have they been in influencing the exchange rate? And what country characteristics or aspects of the modalities of the intervention determine the degree of effectiveness of such policies?[1]

The time span chosen is meant to capture –excluding the 2008-2009 crisis– a period of ample global liquidity and accentuated capital flows to EMEs which brought along heavy FXI, particularly in the run up to the 2008 crisis and during the post-crisis period (Figure 1). A glance at changes in central banks' international reserves puts in perspective these trends, highlighting that FXI come in waves with a common (and asymmetric) direction of interventions across regions during the sample period.

[1] The paper leaves aside the normative discussion on the desirability of influencing the exchange rate, as well as the merits of FXI relative to other policy instruments. For such discussion, see Eyzaguirre et al. (2011), IMF (2011b), Ostry et al. (2011), and May 2010 and October 2010 IMF's *Regional Economic Outlook: Western Hemisphere.*

Figure 1

GLOBAL CONDITIONS AND CHANGE IN INTERNATIONAL RESERVES-SELECTED EM/AM ECONOMIES



Sources: IMF, International Financial Statistics, and IMF staff calculations.

[1] USD trade weighted exchange rate. A decline in the index corresponds to an appreciation.

[2] International reserves, minus gold. Anualized three month moving average, in percent of 2006-2007 average GDP.

[3] Includes Brazil, Chile, Colombia, Czech Republic, Turkey, and Uruguay. Simple average.

[4] Includes Brazil, Chile, Colombia, Mexico Peru and Uruguay. Simple average.

[5] Includes India, Indonesia, Korea, Malaysia, Philippines and Thailand. Simple average.

[6] Includes Czech Republic, Hungary, Israel, Poland, Romania, Russia, Turkey, and South Africa. Simple average.

Furthermore, a closer look at intervention and exchange rates in some LA countries shows that the widespread use of FXI during this period has been associated with marked currency appreciation (Figure 2). This highlights the difficulty of assessing the effect of these policies as, for example, simple correlations would misleadingly suggest that (positive) interventions tend to appreciate the currency. Discerning the direction of causality (as intervention affects the exchange rate but the decision to intervene also depends on the behavior of the exchange rate) requires more complex techniques, in order to overcome the endogeneity problem, well-known in the literature on FX intervention (e.g. Kearns and Rigobon, 2005). Furthermore, under global conditions favoring capital flows to emerging market economies (EMEs), as those prevailing during the period of analysis, and with added currency appreciation pressures arising from marked changes in fundamentals, the effects of FXI have become even more difficult to grasp as uncertainty about the counterfactual has increased markedly. Still, many central banks appear to believe in the effectiveness of FXI and continue to pursue such policies, as documented by recent surveys (Neely, 2008; BIS, 2005).

The object of our empirical study is sterilized FX *purchases*[2] as these were the more prevalent direction of intervention among the countries studied. Thus, we exclude the period of the 2008-2009 financial crisis from our analysis. The emphasis is on *sterilized* rather than un-sterilized interventions because only the former entails pure exchange rate policy –the latter involves also a decision to simultaneously relax monetary policy, for which an effect on the exchange rate would seem more obvious.[3]

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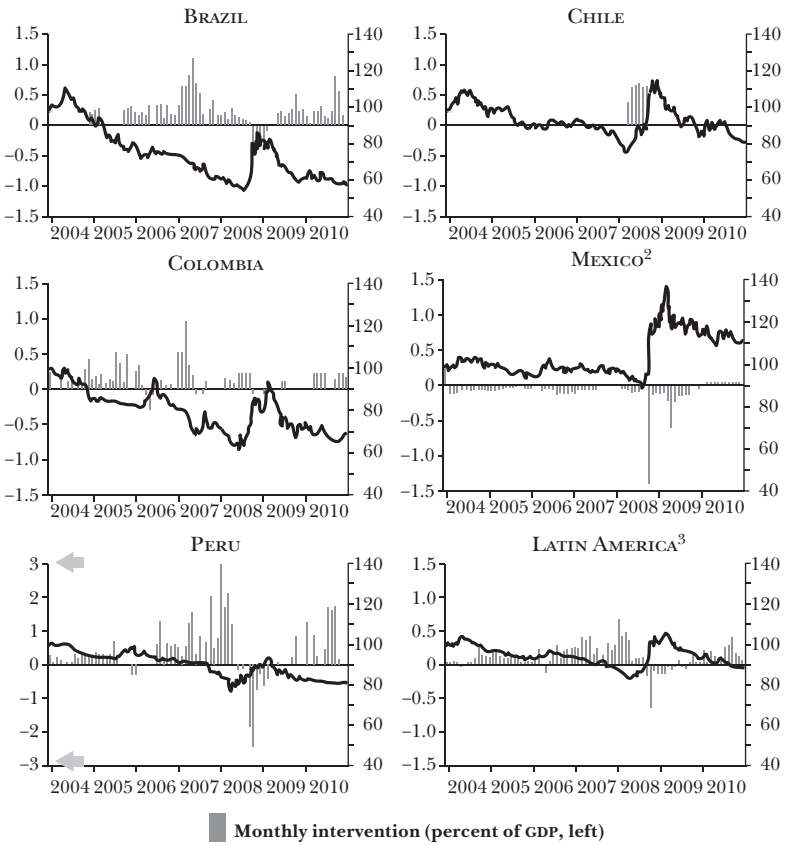
[2] There is often little clarity on the precise definition of FXI. Here we consider FXI to be any operation that affects the central bank's net foreign exchange (FX) position. In practice, however, high frequency data on central banks' FX position is often unavailable, requiring the use, instead, of observable FX market transactions or changes in international reserves as proxies (see Annex 1).

[3] Unsterilized intervention, as a policy that induces an expansion of the money supply would, ceteris paribus, lead to a loss of value of the currency (in terms of both inflation and currency depreciation).

Figure 2

Intervention and Bilateral Exchange Rate in Latin America[1]



Sources: IMF staff calculations on the basis of central bank data.
Notes: Latin America includes Costa Rica, Guatemala and Uruguay. Positive values of intervention refer to purchases, whereas negative values refer to sales. For sake of completeness, both purchases and sales are depicted. Upward movements of the exchange rate correspond to depreciations. Arrows on the axis denote that the scales has been changed relative to previous and subsequent panels.

[1] Intervention measured as a percentage of average annual GDP between 2004 and 2010.
[2] Some FX operations conducted by Banco de Mexico may not be considered as intervention and show how difficult is to have a proper definition. In particular, prior to the crisis, the central bank was selling, according to an announced rule, exactly half of the increase in net reserves, which reflected Pemex and the federal government's law-mandated transfers of their FX receipts to the central bank. The policy adopted by the Comisión de Cambios (Foreign Exchange Commission) was to reduce the pace of accumulation of international reserves. Actual purchases (through options) have taken place only since March 2010. Option auction data reported.
[3] Simple averages.

There is a growing empirical literature on the topic, but so far it has focused mostly on advanced economies and one country at a time (exploiting only the time series dimension). The existing studies that have examined FXI in emerging economies have focused on determining de facto motives behind these policies and its effectiveness in specific economies such as Chile, Colombia, Czech Republic, or Peru (e.g., Kamil, 2008; Galati and Diyatat, 2007; Humala and Rodríguez, 2009; Tapia and Tokman, 2004; Rincón and Toro, 2010; Echevarría et al., 2013; Pincheira, 2013; García-Verdú and Zercero, 2013; and Lahura and Vega, 2013). A recent exception is Contreras et al. (2013), who also explore cross-section variation by focusing on a group of 10 emerging economies; and Adler and Tovar (2013), who study the impact of interventions in the context of regime changes across different countries. In general, however, the literature has fallen short of reaching a definitive conclusion about the effects of FXIs on exchange rates, frequently suggesting the absence of any relation (Neely, 2008; Galati and Disyatat, 2005; BIS, 2005; Sarno and Taylor, 2001; or Domínguez and Frankel, 1993). The study by Contreras et al. (2013) is again a recent exception. Based on event analysis they find that for the period 2010-2012, the pace of appreciation slowdowns in the days that follow an intervention. The impact is even larger if the exchange rate was appreciating in the days prior to the intervention episode. As for modalities of intervention, a number of recent papers have discussed conceptually some of their implications (Fratzcher, 2008; Canales-Kriljenko et al., 2003; Fatum and King, 2005; Ishii et al., 2006) but their role in determining the effectiveness of interventions has been mostly overlooked, partly reflecting the lack of data.[4]

[4] Exceptions are the work of Fatum and King (2005) on rules versus discretion in the case of Canada; and Fratzcher (2008), Echevarría et al. (2013) and Pincheira (2013) on the role of intervention announcements. Stone et al. (2009) also discuss some aspects related to modalities of intervention, although without linking them to the effectiveness of such policies.

Our contribution to the literature is two-fold. First, on the qualitative side, the paper builds a new database describing central banks' declared motives of intervention, instruments, the use of rules vis-à-vis discretion, and features of transparency. This new data provides a picture of how FXI practices differ across countries and regions, and is used to assess whether such practices matter for the degree of effectiveness of these policies. Second, on the quantitative side, we examine the effectiveness of FXI in a high frequency (weekly) panel data setting. To overcome the endogeneity bias problem that characterizes the analysis of such policies we follow a two-stage estimation process. To achieve identification, we also propose an estimation strategy that relies on short time windows around episodes of large global (common) shocks, rather than using the whole sample period. In this manner, we increase the chance that unobservable idiosyncratic shocks remain small relative to the observable global shocks, which we can control for.

Our focus is on a sample of 15 countries, of which eight are Latin American EMEs (Brazil, Chile, Colombia, Costa Rica, Guatemala, Mexico, Peru, and Uruguay), and the remainder are either EMEs from other regions (India, Indonesia, Russia, Thailand, and Turkey,) or *small* advanced economies (Australia and Israel). The sample is designed to capture primarily EMEs –as they have been studied less in the literature– but also reflects significant constraints on data availability. Indeed, not many of the EMEs excluded from the sample publish data on their FXI operations (see Annex 1 for a detailed count of available data, including on countries not employed in our study).

The results suggest that interventions can slow the pace of appreciation, although the effect decreases rapidly with the degree of capital account openness (helping to explain differences in the degree of intervention across regions); whether interventions are conducted under rule-based or discretionary frameworks does not appear to matter; and interventions appear to be more effective when there are signs that the currency could already be *overvalued*.

The paper is structured as follows: Section 2 presents some stylized facts on the extent and modalities of intervention during the sample period. Section 3 discusses the econometric methodology to identify the effects of FXI on the behavior of the exchange rate. Section 4 presents key results, and Section 5 concludes with a brief discussion on policy implications.

2. THE EXTENT AND MODALITIES OF INTERVENTION

Despite its widespread use and a wide range of practices, knowledge about the manner and extent to which central banks intervene in FX markets is limited. This is partly because many central banks do not publish such information, but also because the country information that is available is dispersed, and the existing literature on intervention tends to focus on one country at a time. Some studies have examined intervention practices through surveys, aiming at drawing lessons on best practices (Neely, 2007, 2001; BIS, 2005; Ishii et al., 2006; and Canales-Kriljenko et al., 2003).[5] Still, systematic and up-to-date cross-country information on modalities of intervention is scarce.

In what follows, we characterize intervention practices in our sample, looking at the frequency of interventions (based on actual intervention data available on a daily basis)[6] as well

[5] These studies normally describe how central banks characterize and evaluate their own policies. For example, BIS (2005) presents a description of the central bank approaches to FX intervention in Chile and Mexico, in the context of building credibility of monetary regimes and on the relevance of announcements (De Gregorio and Tokman, 2005; and Sidaoui, 2005). In the case of Peru it also offers an overview of FX intervention considerations in a highly dollarized economy (Armas, 2005). Finally, the reviews for Colombia and Mexico present a perspective on the use of option rules for FX intervention (Uribe and Toro, 2005, and Sidaoui, 2005).

[6] High-frequency data on intervention is available for Australia, Chile, Colombia, Costa Rica, Guatemala, Israel, Mexico, Peru, Turkey and Uruguay.

as qualitative information describing the manner in which central banks conduct interventions. The database was constructed from official central bank statements, as found in their web sites, communiqués, press releases, and annual or other periodic reports. In particular, we extract the following information from such statements:

1) *Motives for intervention:* These are officially declared reasons for intervening in the FX market. We classify these statements on the basis of whether the declared intention is to *i)* affect the level of the exchange rate, *ii)* affect the speed of currency appreciation (or depreciation); *iii)* contain the volatility of the exchange rate; *iv)* increase reserve buffers for precautionary motives; or *v)* other reasons.

2) *Framework for intervention.* This qualitative aspect refers to whether central banks' interventions are governed by rules or conducted in a discretionary manner. When based on rules, we are also interested in examining the main features of such rules. In particular, we classify rules as being *a) exchange rate-based* if the intervention is *triggered by some exchange rate-related measure* (e.g., change, or volatility); or *b) quantity-based* if the rule does not specify any trigger for intervention, but do *specify an intervention amount* to be exercised over an announced *time horizon* (along with the daily or weekly intervention quantities).

3) *Instruments for intervention.* We document the use of different financial instruments through which central banks might influence the exchange rate, including FX purchases (sales) in the spot, forward, swaps and options markets (see Annex 2 for a brief discussion on considerations that affect the choice of instruments).

4) *Transparency.* We analyze central bank reports with the goal of determining the timing of disclosure of information regarding FX operations. In particular, we assess whether FX intervention amounts are published before the operation takes place, within a week, at a later stage or never.

2.1 Frequency and Size of Interventions

How frequent are foreign exchange interventions? Most countries in Latin America have had a fairly regular presence in the FX market during the 2004-2010 period (Table 1). On average about a third of the countries intervened in any given day, a relatively high number considering that most of them declare themselves to be floaters. While FXI in the region tends to come in waves –frequently corresponding with shifts in global financial conditions– there are important cross-country differences. The central banks of Brazil and Uruguay have had a very frequent presence in the market –about two-thirds of the time (not reported).[7] At the other extreme are central banks with fairly rare market presence –Chile, Mexico, and Guatemala for part of the period. Even so, two central banks traditionally viewed as *non-interveners* have entered the FX market recently, with announcements of reserve accumulation programs: Mexico in February 2010 and Chile in April 2008 and January 2011.

How large have foreign exchange purchases been? A rough comparison of the relative size of interventions –scaled by GDP– shows that Chile, Guatemala, Mexico, and Colombia (in that order) are low or moderate interveners. Uruguay and Peru –highly dollarized economies– are, on the other hand, heavy interveners (Table 1). Daily reserves data suggest that Brazil's interventions have also been large at times (Figure 2).

2.2 Declared Intervention Practices

This section provides a glance at key qualitative aspects of FXI practices. Statistics presented here refer to the average across countries and time for the period 2004-2010 (except for the 2008-2009 crisis).

Motives for intervention. The two reasons most often stated for intervening have been: *i)* to build international reserve buffers; and *ii)* to contain exchange rate volatility (in some sense,

[7] Data for Costa Rica, Guatemala, and Uruguay are not reported as it is confidential.

as discussed below). Slowing the *speed* of appreciation is a motive stated only at one point in our survey, by Colombia's central bank. A relatively large share of central banks stated *other* reasons for intervening, most of them being somewhat vague: correcting misalignments, addressing disorderly market conditions, managing liquidity in FX markets. Some central banks stated more than one motive at the same time.

At some point in the sample period, most of them declared that their intervention was aimed at strengthening their reserves buffers, often simultaneously stating that they had

Table 1

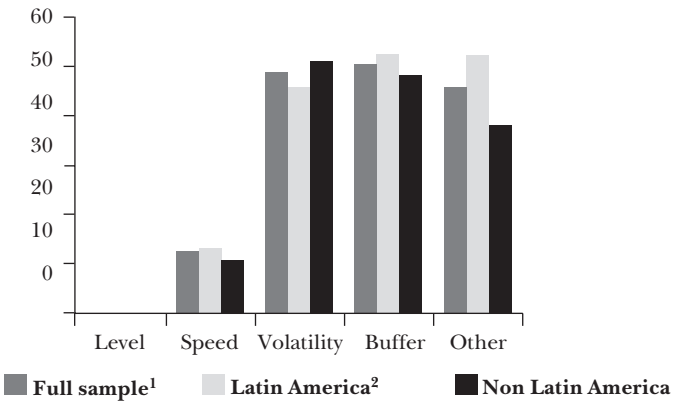
STYLIZED FACTS OF FOREIGN EXCHANGE PURCHASES, 2004-2010

		Intensity			
	Frequency *(percent of working days)*	*Cumulative intervention as percent of GDP*[1,2]	*Daily average (millions of US dollars)*[1]	*Daily maximum (millions of US dollars)*[1]	*Has there been active FX intervention in 2011?*
Chile	6	3.8	50	50	yes
Colombia	32	10.3	34	733	yes
Guatemala	19	1.6	9	332	yes
Mexico[3]	1	0.6	600	600	yes
Peru	39	36.1	55	494	yes
Latin America[4]	19	10.5	150	442	
Others					
Australia[5]	62	2.5	15	377	n.a.
Israel	24	22.3	84	300	no[6]
Turkey	66	12.5	61	4,966	yes

Source: IMF staff calculations on the basis of central bank and its information.
Notes: Some countries do not maintain an active permanent presence in the market during the full period (e.g., Chile, Israel, or Mexico). [1] Based on days with foreign exchange purchases. [2] Nominal average GDP for the period. [3] Option auction data. If exercised values are used, the daily average equals USD 25 millon and the maximum daily amount reaches USD 571 million. [4] Simple average. [5] Daily net foreign exchange market transactions as reported by the Reserve Bank of Australia. [6] Complementay measures has been adopted: A new requirement to report transactions in foreign exchange and in debt instruments, and the imposition of a liquidity requirement for foreign exchange transactions. n.a. stands for non-available.

Figure 3

MOTIVES FOR INTERVENTION, 2004-2010[a]
(percentage of countries)



Sources: IMF staff calculations.
[a] Based on declared ex post motives for intervening as made publicly available in official central bank statements (e.g., press releases, annual reports, web site, etc.); otherwise ex ante statements of objectives are employed. Averages for the period.
[1] Includes Latin America, Australia, India, Indonesia, Israel, Russia, Thailand and Turkey.
[2] Includes Brazil, Chile, Colombia, Costa Rica, Guatemala, Mexico, Peru and Uruguay.

no intention to influence the exchange rate (e.g., Chile and Mexico).[8] Other central banks (Peru, Colombia and Guatemala) have explicitly stated to have intervened to contain excessive exchange rate volatility, but –unless there was a rule in place– thresholds to determine what excessive meant were not always stated.

Not one central bank in our sample declared to officially *target* an exchange rate level as a motive for intervention, even after some country authorities became quite vocal about their concerns on the levels of the exchange rate (as part of what was

[8] There is a large body of literature examining the reasons behind the accumulation of international reserves, which we do not address in this paper.

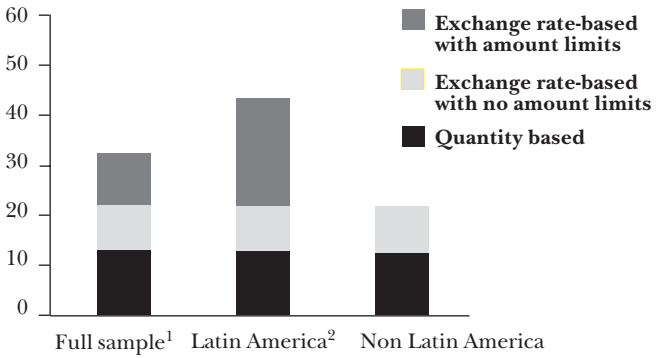
named *currency war*). Furthermore, it is noteworthy that a 2005 BIS' survey of EM central bankers reported that a significant share of them intervened to *influence* the exchange rate level or to *lean-against-the-appreciation-wind* (BIS, 2005). This seems to suggest a tension between declared and actual motives, although it could also reflect that stated objectives are often not precisely defined. For example, *influencing* the exchange rate is somewhat ambiguous, as it could refer to its level, its appreciation rate, or its high- or low-frequency volatility. Similarly, *leaning-against the wind* need not mean targeting a particular level of the exchange rate, and could be interpreted as seeking to reduce (low-frequency) exchange rate volatility, in the sense of dampening a perceived cycle of *temporary* excessive appreciation. All this reflects the frequent vagueness in central bank statements regarding its exchange rate policy, likely aimed at preserving discretion to intervene for various motives.

Intervention frameworks. On average about a third of the central banks had in place some form of rule-based intervention framework at any moment within our sample period (Figure 4). In Latin America the share of countries with such a framework was somewhat higher (almost half). About half of the rule-based systems relied on quantity-based frameworks –associated mainly with reserve accumulation programs– although in the case of Latin America exchange rate-based rules dominated the sample. Within the latter, rules with amount limits (that therefore did not guarantee any level of the exchange rate) were the predominant form. The volatility-triggered rules in Colombia and Guatemala are examples of this (see Annex 3 for a more detailed description of FXI rules in Latin America).

The discussion above presents statistics on declared frameworks irrespective of whether interventions have actually taken place or not. A slightly different question is what framework has been chosen at times when interventions have actually been conducted. The answer to this question would better reveal central bank preferences toward rules versus discretion when the framework actually matters. To answer this we examine the

Figure 4

FRAMEWORK FOR INTERVENTION, 2004-2010[a,b]



Sources: IMF staff calculations.

[a] Declared intervention rules according to official central bank statements (e.g., press releases, annual reports, web site, etc.). Exchange rate-based rules are triggered by some exchange rate-related measure (e.g., change or volatility). If the amount of intervention is specified then it is considered to be "with amount limits"; otherwise it is considered "with no amounts limits." Quantity-based rules specify an amount to be exercised over a horizon along with the specific daily or weekly quantities. Averages for the period.

[b] Rules using options are categorized as exchange rate that triggers the actual purchase of FX (that is, option is exercised).

[1] Includes Latin America, Australia, India, Indonesia, Israel, Russia, Thailand, and Turkey.

[2] Includes Brazil, Chile, Colombia, Costa Rica, Guatemala, Mexico, Peru, and Uruguay.

use of rules or discretion, conditional on being in the FX market (Figure 5). When they do intervene, Chile and Mexico always used rules. Colombia and Guatemala also relied on rules –with certain objectives in mind– but at the same time gave themselves room for discretionary purchases. Brazil, Paraguay and Uruguay did not use rules during the period of analysis.

2.2.1 Instruments of Intervention

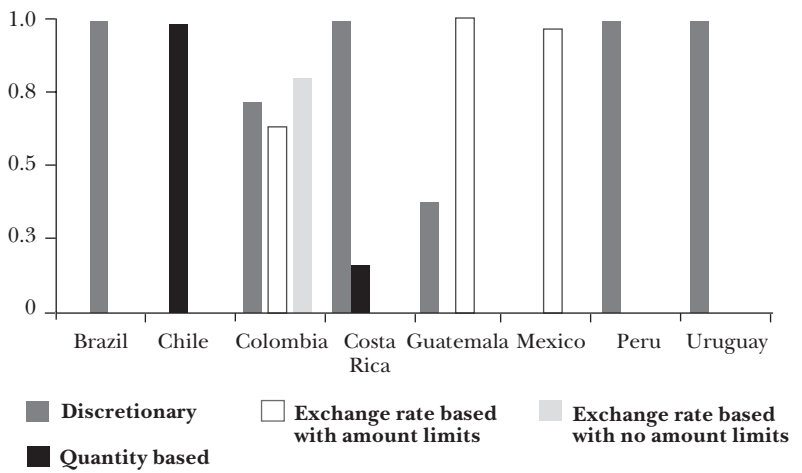
The dominant market for interventions across regions is the spot market (Figure 6), possibly reflecting a higher degree of

liquidity vis-à-vis other markets. As derivative markets have expanded over time, however, some central banks have increased the use of such instruments (Figure 7). In the region, Brazil is the main example, with operations in the forward and swap markets. Two other central banks in the region (Colombia and Mexico) have used options for some time. The rest have intervened only in the spot market. (See Annex 2

Figure 5

How Do Latin American Countries Actually Intervene?, 2004-2010[a]

(average intensity use of each rule)[1,2]



Sources: IMF staff calculations.

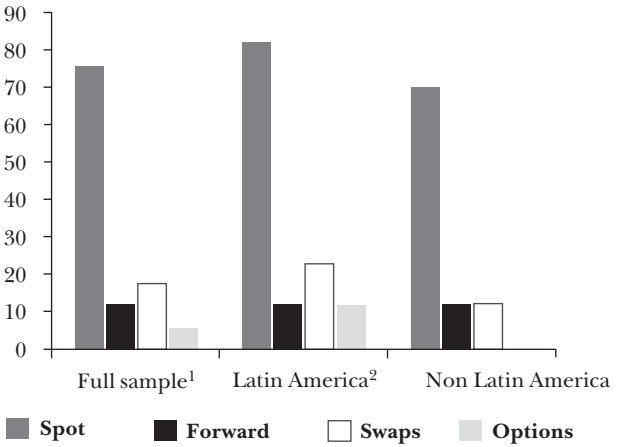
[a] Declared intervention rules according to official central bank statements (e.g., press releases, annual reports, web site, etc.). Exchange rate-based rules are triggered by some exchange rate-related measure (e.g. change or volatility). If the amount of intervention is specified then it is considered to be "with amount limits;" otherwise it is considered "with no amounts limits." Quantity-based rules specify an amount to be exercised over a certain time horizon along with the daily or weekly quantities of intervention. Averages for the period.

[1] 1 = always and 0 = never. Intensity refers to the proportion of days with FX purchases in which a specific rule is declared to be in place by the central bank.

[2] Rules using options are categorized as exchange rate-based because it is the exchange rate that triggers the actual purchase of FX (that is, the option is exercised).

Figure 6

INSTRUMENTS OF INTERVENTION, 2004–2010[a]
(percentage of countries)



Sources: IMF staff calculations.
[a] Declared intervention rules according to official central bank statements (e.g., press releases, annual reports, web site, etc.). More than one instrument may be used for intervention by a single central bank, thus totals do not add to 100. Averages for the period.
[1] Includes Latin America, Australia, India, Indonesia, Israel, Russia, Thailand and Turkey.
[2] Includes Brazil, Chile, Colombia, Costa Rica, Guatemala, Mexico, Peru, and Uruguay.

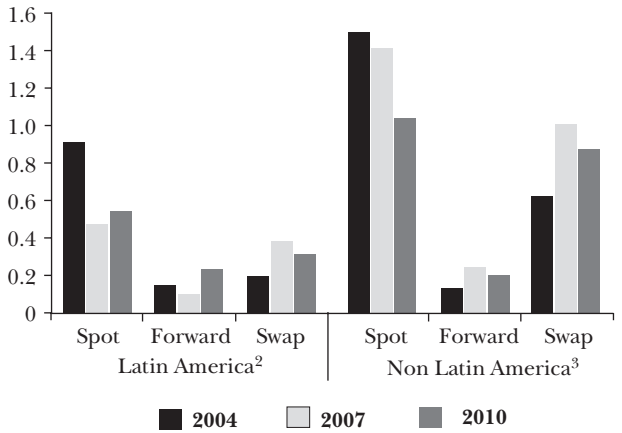
for a discussion on considerations for the choice of different instruments.)

2.2.2 Transparency

Around the world, most EMEs refrain from publishing information about their FXI operations (or reserve stocks on a high frequency basis, from which FXI might be inferred). Latin America is among the most transparent regions, with a level of transparency that has increased over the past seven years, particularly in comparison with other regions of the world. Furthermore, LA countries tend to publish information sooner than others that also publish (Figure 8).

Figure 7

DAILY FOREIGN EXCHANGE MARKET TURNOVER[1]
(percentage of GDP)



Sources: Bank for International Settlements.
[1] According to Bank for International Settlements' definitions.
[2] Includes Brazil, Chile, Colombia, Mexico, and Peru.
[3] Includes India, Indonesia, Israel, Russia, Thailand, and Turkey.

3. THE EFFECTS OF FOREIGN EXCHANGE INTERVENTION

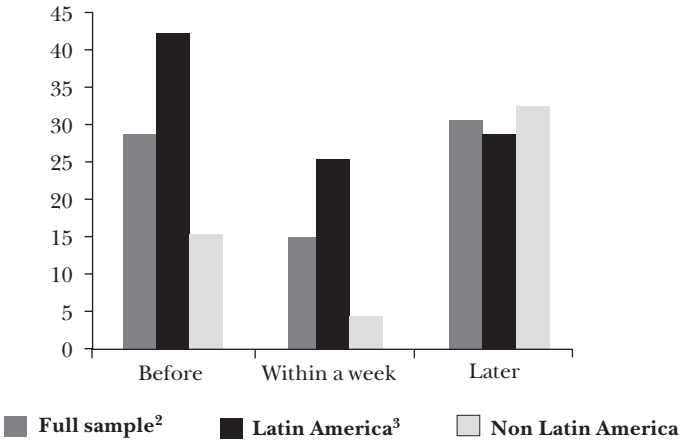
The extent to which FX intervention can affect the exchange rate is not obvious. Any shock, including an operation by the central bank, that could trigger a move of the currency away from its equilibrium value (i.e., implied by fundamentals or market perceptions of these) should be arbitraged away by private agents. Thus, some form of market friction is necessary for sterilized interventions to have an impact on the exchange rate.

The literature has identified three mechanisms through which interventions may operate.[9] First, a *portfolio balance channel*, which operates when there is imperfect substitutability

[9] See Sarno and Taylor (2001) for a general overview of these mechanisms.

Figure 8

WHEN ARE AMOUNTS OF INTERVENTION PUBLISHED?[1]
(percentage of countries)



Sources: IMF staff calculations.
[1] Disclosures according to official central bank statements (e.g., press releases, annual reports, web site, etc.). In certain cases, it was unclear when information was disclosed. Thus totals may not add to 100. Averages for the period.
[2] Includes Latin America, India, Indonesia, Israel, Russia, Thailand, and Turkey.
[3] Includes Brazil, Chile, Colombia, Costa Rica, Guatemala, Mexico, Peru, and Uruguay.

between domestic and foreign assets and the risk premium increases with the supply of domestic assets. Thus FXIs expands the amount of domestic assets (either high-powered money or sterilization instruments) potentially raising the risk premium and, by arbitrage, depreciating the currency. Second, an *informational/signaling channel*. In this case the central bank through FXIs signals its future policy stance. For example, it could indicate its willingness to adjust its monetary stance (i.e., reduce policy rates) to prevent further appreciation of its currency. Prospects of a lower interest rate would normally lead to a spot-market depreciation. Sterilization with interest-bearing instruments can reinforce this channel by increasing the financial gains of reducing interest rates. Interventions (or even simple *open mouth* operations) can also help to coordinate market

expectations about the appropriate level of the exchange rate, if market participants believe the central bank has an informational advantage in this regard. Finally, a *microstructure channel*. According to this mechanism frictions at a micro level can affect the extent to which information embedded in central bank operations (assuming an informational advantage exists) reaches market participants and shapes their expectations.

The extent to which these channels operate in practice remains an open question in the literature, as the empirical evidence on the effectiveness of intervention, let alone its channels, remains inconclusive.

Although of interest, in this paper we do not aim at identifying the relative strengths of these different channels of transmission, and focus instead on the overall impact of FXI on the exchange rate. Specifically, we seek to answer the following questions: Are FX purchases effective in depreciating the exchange rate? And, to what extent do the modalities of intervention and country characteristics influence the outcome of such policies? As mentioned before, our analysis focuses only on *positive* interventions (i.e., purchases of foreign exchange or derivative operations with similar effects) as these are the predominant form of intervention during the period of analysis.

3.1 Estimation Strategy

A critical problem in assessing the effectiveness of FX intervention is overcoming the endogeneity of changes in exchange rates and intervention. With this in mind, the econometric approach that we follow relies on two methodological innovations vis-à-vis previous studies:

- It estimates the effect of FX interventions in a panel setting, which takes advantage of the heterogeneous response of different central banks to (common) external shocks.
- It focuses on short time-span episodes of significant global shocks –leading to appreciation pressures in EMEs– during

which unobservable country specific shocks are less likely to be large (in relation to the identified global shock), thus helping to mitigate omitted variable bias.

Following the literature (e.g., Kearns and Rigobon, 2005), a two-stage estimation procedure is used, with the first stage estimating a de facto country-specific reaction function that allows for different behavior across countries. Predicted values of the reaction function are then used as instruments for the second stage, which entails estimating a behavioral equation linking the exchange rate to intervention, in the panel setting.[10]

3.1.1 First Stage: CB Reaction Function

The first stage entails estimating individual central bank reaction functions –for countries in the sample that display sufficient variability in their interventions.[11] Reaction functions are modeled as a censored variable (given our focus on purchases and their predominance during the sample period) and estimated with a Tobit model on a country-by-country basis. The goal is to allow for country-specific coefficient estimates as different central banks may have different preferences. The model is estimated with weekly data over the period 2004-2010 (always excluding the period September 2008-June 2009). Formally, the reaction function takes the following form:

$$I_{i,t} = max\left\{0, \alpha_{0,i} + \beta_{0,i} e_{i,t-1} + \beta_{1,i}\left(re_{i,t} - re_{i,t}^{eq}\right) + \beta_{2,i}\Delta_{i,t} + \right.$$
$$\left. + \beta_{3,i}\sigma_{i,t} + \beta_{4,i} R_{i,t}^{M2} + \beta_{5,i} R_{i,t}^{STD} + \varepsilon_{i,t}\right\}. \quad (1)$$

[10] Although the first stage of the methodology allows contrasting how the de facto motives of intervention differ from the declared (de jure) motives of intervention discussed in the previous section, this is not the main purpose of the paper. Also is worth noticing that both de jure and de facto motives for intervention play a role in the second stage of the paper.

[11] Cases of pre-announced amount-based rules (Chile, Israel, Mexico, and Turkey) do not show sufficient variability, for the most part, in their interventions in order to estimate a reaction function.

$I_{i,t}$ denotes country *i*'s amount of intervention (scaled by GDP) during week *t*. When available, actual intervention data is used. Otherwise, this variable is proxied by the change in the stock of international reserves adjusted for the estimated effect of changes in the value of reserve currencies[12] (see discussion below on the appropriateness of using reserves as a proxy).

$e_{i,t-1}$ denotes the lagged change in the nominal (US bilateral) exchange rate, and is meant to capture short term (1-week) exchange rate movements.

$re_{i,t}$ is an estimate of the real effective exchange rate; $re_{i,t}^{eq}$ is an estimate of the equilibrium real exchange rate (based on the history of assessments by the IMF's Consultative Group on Exchange Rates; i.e., CGER). Thus, the term $\left(re_{i,t} - re_{i,t}^{eq}\right)$ captures exchange rate misalignments. An average of the three CGER methodologies is used.

$\Delta_{i,t}$ denotes the 4-week speed of exchange rate appreciation. This is measured on a Hodrick-Prescott trend estimated recursively in order to capture the information available to the central bank at that point in time.

$\sigma_{i,t}$ is a measure of intra-week exchange rate volatility, computed as the sum of square values of deviations of the exchange rate from its HP trend, in order to strip the volatility arising simply from moving along the trend.

$R_{i,t-1}^{M2}$ and $R_{i,t-1}^{STD}$ denote the ratios of reserves-to-M2 and reserves-to-short-term debt *relative to the average of EM countries in the sample*. These two terms seek to capture possible precautionary motives.

Finally, $\varepsilon_{i,t}$ is the error term.

---

[12] The valuation adjustment is based in the shares of the different currencies in the stock of international reserves of the average EM country as reported by the Currency Composition of Official Foreign Exchange Reserves (COFER) database. Individual country data is not available (due to confidentiality restrictions). See <http://www.imf.org/external/np/sta/cofer/eng/index.htm> for details.

3.1.2 Second Stage: Exchange Rate Equation

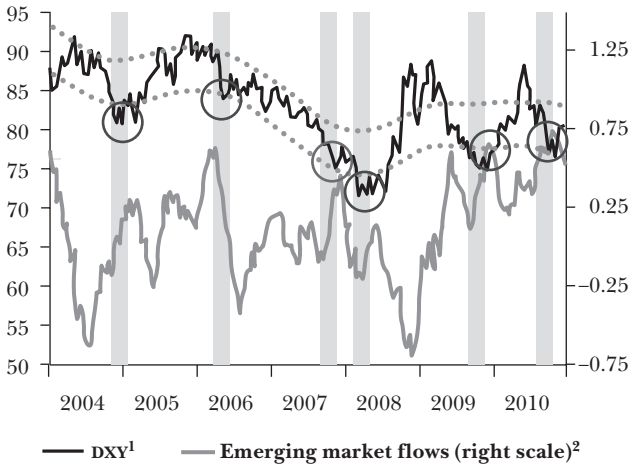
The second stage entails estimating a behavioral equation linking movements in the exchange rate to central bank interventions. As mentioned before, we instrumentalize the intervention variable to mitigate the endogeneity problem by using the *shadow* intervention value obtained from the predicted values of the previous exercise. Our specification includes a number of controls (interest rate differential, sovereign spreads, commodity price shocks and the US trade-weighted exchange rate), while allowing for country-specific effects in a number of them. As is common in the literature, we estimate the model in first and second differences. In doing so we are able to evaluate the possible effects on the rate and pace of appreciation (first and second differences of the exchange rate, respectively).

Our panel is estimated for the 15 countries in our sample pooling together six common 12-week episodes of interest. This gives us 12 weekly observations per episode and country, for a total of 1,080 observations in the panel. The six common episodes are identified by apparent shifts in global financial conditions as determined by a sharp decline in the US dollar trade-weighted exchange rate (DXY). To make the concept operational we identify the episodes by searching for deviations by at least one-standard deviation in the DXY index below its (HP- filtered) trend (Figure 9).

The resulting measure is a good proxy for risk appetite (similar to the VIX) and consequently identifies episodes that coincide roughly with periods when flows into EM asset funds were fairly high or were rising strongly. As expected, this criterion leads us episodes associated with strong appreciation trends in EM currencies (Figure 10). We also find evidence suggesting that countries relied more on FXI policies during these episodes, but the pattern is somewhat mixed, as illustrated by the amplitude between the 25th and 75th percentile range, as well as by the divergence between the median and the mean of interventions during these episodes. Such heterogeneous central bank response is what allows us to achieve the econometric identification of the effect of interventions.

Figure 9

US Trade-weighted Exchange Rate and Flows to EME Asset Funds, 2004-2010



Sources: Bloomberg, L.P.; Haver Analytics, and IMF staff calculations.
[1] USD trade weighted exchange rate, index 2000 = 100.
[2] Previous 12-week moving average, in percent of assets under management.

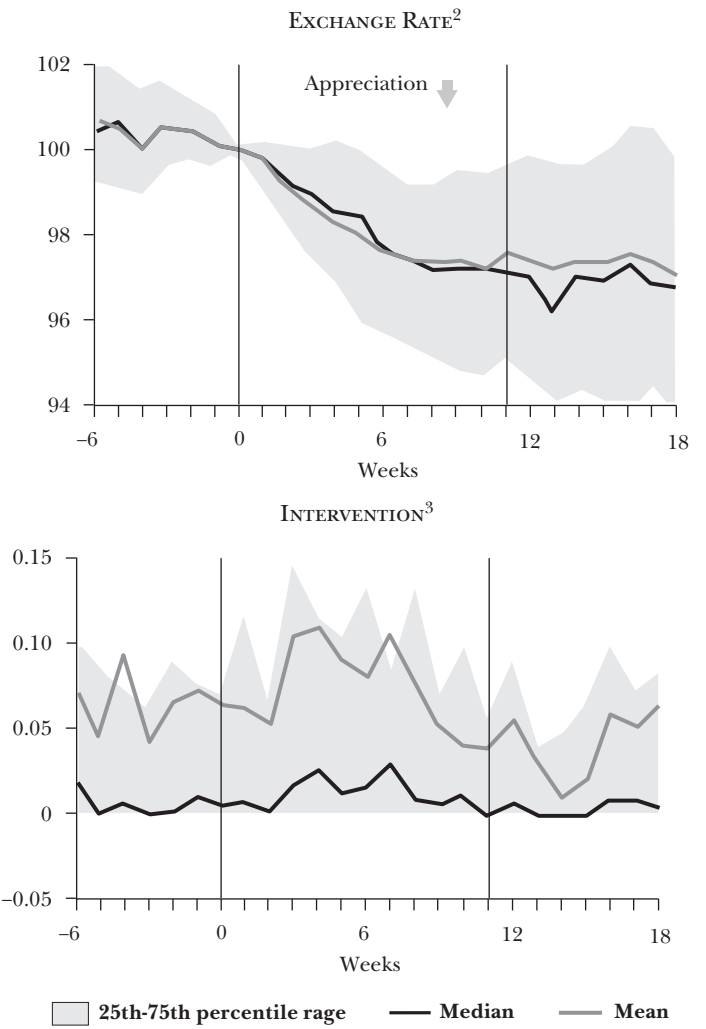
It should be noticed that in addition to the instrumentalization of the intervention variable, the focus on short (12-week) windows around a global shock helps to mitigate residual endogeneity (from having an imperfect instrument), because this ensures that the main source of disturbances is the identified global shock and that unobservable country-specific fundamentals do not change significantly over the episode window.

In absence of consensus in the literature on how to model the short-run determinants of exchange rates, we choose a simple specification for the exchange rate equation, of the following form:

$$e_{i,t} = \gamma_1 + \gamma_2\left(i_{i,t} - i_t^*\right) + \gamma_3 S_{i,t} + \gamma_{4,i} P_t^M + \gamma_{5,i} P_t^E + \gamma_{6,i} P_t^F + \\ + \gamma_7 \hat{I}_{i,t} + \gamma_{8,i} DXY_t + \vartheta_{i,t}. \quad (2)$$

Figure 10

INTERVENTION AND EXCHANGE RATES AROUND IDENTIFIED EPISODES[1]



Sources: IMF staff calculations.

[1] Episodes of global shocks indentified on the basis of movements in the US trade trade exchange rate (DXY).

[2] Local currency per USD. Index t_0=100.

[3] In percent of GDP.

$e_{i,t}$ denotes the log of the nominal exchange rate (against the USD) for country i at time t. The variable is introduced in first and second differences (ensuring that is stationary), in order to study possible effects on the rate and pace of appreciation (i.e., *speed* and *acceleration* respectively).

$i_{i,t}$ is the domestic policy interest rate or interbank rate; and i_t^* is the US Federal Reserve funds interest rate. The difference provides an estimate of the interest rate differential.

$S_{i,t}$ denotes the EMBI spread, the sovereign CDS spread when the EMBI is not available.

P_t^M, P_t^E, P_t^F are the logs of the indexes of international metal, energy and food prices, which are introduced as a way to control for high frequency movements in terms-of-trade.

DXY_t denotes the US nominal trade-weighted exchange rate index and is introduced as a measure of market sentiment (similar to the VIX, this measure correlates closely with flows to EMEs).

$\hat{I}_{i,t}$ denotes the predicted intervention amount estimated in the first stage. Actual intervention data is used in the case of pre-announced amount-based rules, as FXI does not react to contemporaneous shocks in those cases.[13]

Finally, $\vartheta_{i,t}$ is the regression composite error term.

The effect of commodity prices and the DXY are allowed to be country-specific, as different countries in the sample may have different trade structures and sensitivities to global financial shocks. Ideally, one would control also for other policy measures that could affect the exchange rate (e.g., changes in reserve requirements, capital controls, etc.). While their omission –due to lack of data availability– could potentially introduce a bias in the estimation, we argue that such bias is likely

[13] A possible criticism to this specification arises from the fact that it does not take into account market expectations about intervention. If one could measure intervention *expectations*, the relevant variable for the econometric exercise should be the unexpected component of the intervention. In practice, however, such measure is not available.

to be small as policy measures (i.e., *changes* in these policies) tend to be less frequent than FX interventions and unlikely to fall in the short time spans of our analysis.

3.2 Data Issues

A key variable for the analysis is, of course, the FX intervention. However, data on such operations is not available in many cases. As a result, the literature usually addresses this by using episode specific and high frequency data (e.g., intradaily data), or alternatively using the change in gross international reserves as a proxy for intervention. Actual intervention data and the change in gross reserves, however, frequently differ from each other. The reason is that reserves vary not only due to FX intervention, but also due to valuation changes, income flows (e.g., accrual of interest), debt operations on behalf of other agents, etcetera.

Thus a question that arises is how good a proxy for intervention is the change in reserves? To get a sense of the importance of the measurement error, we run a regression between intervention and the change in reserves for several countries for which both forms of data is available (Colombia, Costa Rica, Guatemala, Peru and Uruguay). The result suggests that, at a daily frequency, intervention data and the reserve proxy can differ markedly, with the regression coefficient being quite low. This is particularly clear in the case of highly dollarized economies, where reserves can change on account of regular liquidity operations with the domestic banking system. The proxy, however, improves markedly at weekly frequency (Figure 11). This feature supports the use of weekly reserve series as a proxy in the econometric exercise.

More importantly, the measurement error is unlikely to significantly affect the econometric estimates of the impact of intervention on the exchange rate, as the correlation between the measurement error and the exchange rate appears to be low and two-sided. And the instrumental variable approach also helps to address this potential source of bias, by stripping

off from the instrumental variable any variations that do not response to motives for intervention. This is confirmed by the econometric exercise shown next, which displays broadly similar estimates when using the whole sample or the subset of countries for which actual intervention data is available (see Table 2).

4. RESULTS

4.1 First Stage: Reaction Functions

First stage coefficient estimates suggest that central banks have intervened de facto for a number of different reasons (Figure 12).[14] Sharp short-term (one-week) movements in the exchange rate seem to have been a source of concerns for many countries (a half of the sample), particularly outside Latin America. Within the region, Peru has shown a very high sensitivity to such short-term movements, followed at a considerable distance by Colombia. Many central banks (two thirds of the sample) appear also to have intervened on concerns over real exchange rate misalignments –the main exceptions being Costa Rica, Uruguay and Russia. On the other hand, few countries responded to the speed of appreciation (Colombia, Costa Rica, and Russia); and there is also scant evidence that within-week *volatility* has triggered intervention both inside and outside the region (with the one exception of Brazil).[15] Interestingly, evidence of precautionary motives is weak (with some coefficients taking opposite signs), despite the fact that many central banks declared, during this period, to have intervened for motives of reserve accumulation.

In general –and possibly by construction– estimated reaction functions track intervention trends relatively well, but do

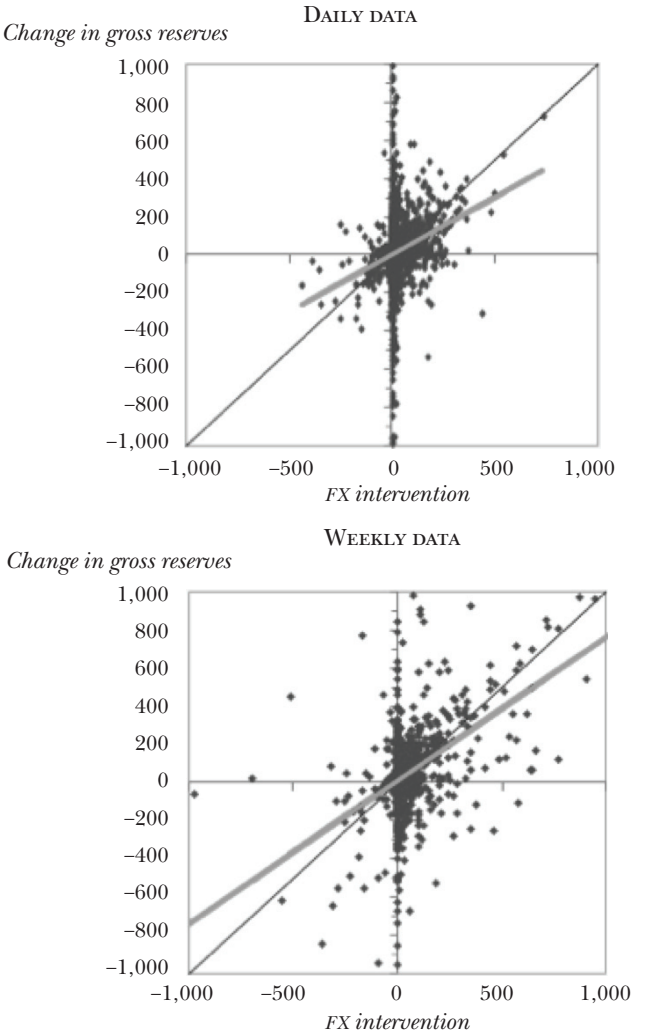
[14] Results of the reaction function should be interpreted as reflecting the *average* behavior over the sample period, and thus may not reflect current preferences.

[15] Some countries even display negative coefficients, possibly reflecting reverse causality (i.e., intervention reduces volatility).

Figure 11

ACTUAL INTERVENTION DATA VS. INTERNATIONAL RESERVES, 2004-2010[a]

(USD millions)



Sources: IMF staff calculations.

Notes: Daily chart gray line: predicted value. Black fine line: 45 degree line. Regression coefficient: 0.59 with standard error 0.03 and $R^2 = 0.03$. Weekly chart gray line: predicted value. Black fine line: 45 degree line. Regression coefficient: 0.75 with standard error 0.04 and $R^2 = 0.19$.

[a] Includes Colombia, Costa Rica, Guatemala, Peru, and Uruguay.

a poorer job in explaining the high frequency spikes often observed in the data. Perhaps this is symptomatic of most variables included in the right-hand side of the regression moving relatively slow (except for lagged exchange rate and volatility). This apparent weakness of the results, however, turns out to be a strength of the methodology because the specification allows us to construct an instrumental variable for the exchange rate equation that is less correlated with the contemporaneous exchange rate movement (i.e., an estimated reaction function with perfect fit would provide valuable information on motives but would not be useful as an instrument for the second stage).

4.2 Second Stage: Effects of Intervention

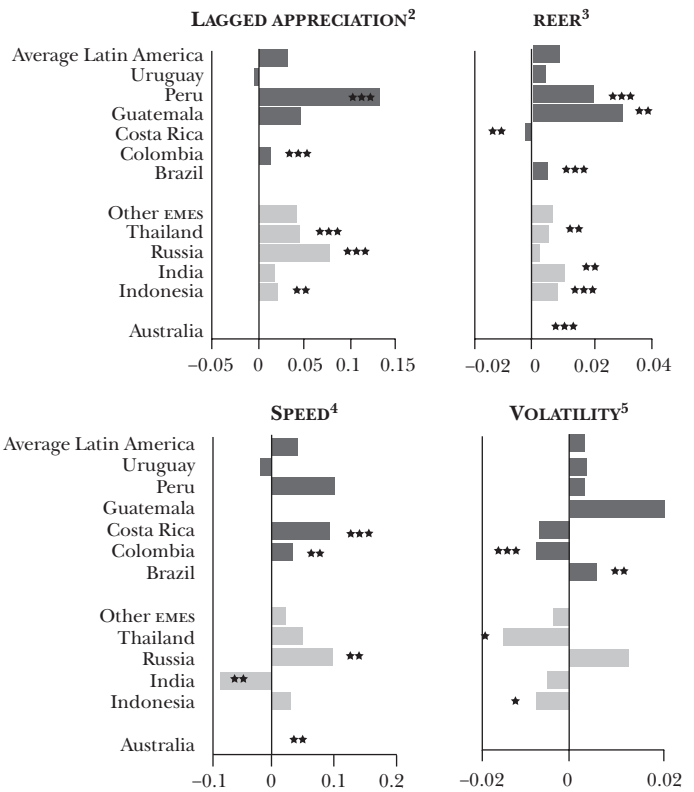
The econometric results of the second stage (exchange rate equation) do not detect an immediate impact of interventions on the rate of appreciation, but do find statistically significant effects on the *pace* (acceleration) of appreciation (Table 2, columns 1 and 2). The coefficient point estimates suggest that an additional 0.1 percent of GDP in FXI (about the size of the average weekly intervention during the identified episodes) would deliver in that week a 0.3 percent slowdown in the pace of appreciation (relative to a country that is not intervening).[16] Interestingly, the introduction of controls (columns 3 and 4) helps to increase the fit of the regression (R^2) but have little impact on the intervention coefficient, suggesting that such controls are less important for the identification of the effect of intervention under the proposed methodology. Also, to confirm that the use of reserves is a reasonable proxy for actual intervention data (i.e., it does not introduce a significant bias) we also run the estimation for a subsample of nine countries for

[16] Our result implies that interventions have an effect on the exchange rate with a two-week lag. To see this, take the first-difference of Equation 2 and back out the effect of intervention, reaching: $e_{i,t+2} = 2e_{i,t+1} - e_{i,t} + \gamma_7 \hat{I}_{i,t}$. Hence, γ_7 fully determines the impact of our measure of intervention on the exchange rate two periods ahead.

Figure 12

COEFFICIENTS OF INTERVENTION REACTION FUNCTIONS

(Central bank intervention reaction functions, selected coefficients)[1]



Sources: IMF staff calculations.

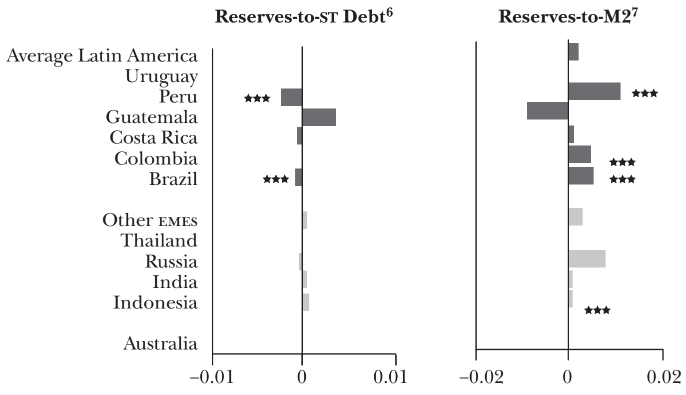
[1] Results of a Tobit model estimated for each country individually, on the basis of non-overlapping weekly data, over the period for which either intervention or reserves data is available at least on a weekly frequency. Results should be interpreted as reflecting *average* preferences over the sample period 2007-2010. As such, they may not reflect current preferences or objectives. See further details in Annex 2.

[2] Lagged (USD bilateral) exchange rate appreciation rate.

[3] Deviation of the real effective exchange rate from the estimated equilibrium value, based on the history of the assessments of the Consultative Group on Exchange Rates (CGER). For Costa Rica, Guatemala, Peru and Uruguay, a measure of deviation of the REER from its 5-year moving average is used, as CGER data is unavailable.

[4] 30-day appreciation rate.

[5] One-week volatility.



[6] Reserves in percent of external short-term debt on a residual maturity basis (relative to other EMEs in the sample).
[7] Reserves in percent of M2 (relative to other EMEs in the sample).

which actual intervention data is available (columns 5 and 6). Results confirm the direction of the results, with the coefficient of the intervention variable broadly in line with one obtained in the whole-sample estimation. Finally, we split the sample to check whether the effect is significantly different for the post 2008-2009 financial crisis period (when capital flows to EMEs became more pronounced). We find that the magnitude of the effect is only marginally higher than the one for the whole sample period (column 7).

It is worth also showing how the methodological approach helps unveil the effect of intervention on exchange rates. Figure 13 illustrates this by showing how the use of episodes rather than the full sample helps to eliminate the significance of the positive (wrong sign) coefficient in the equation in first difference (likely biased by endogeneity); and how the use of instruments rather than the actual intervention variable significantly increases the importance of the estimated effect. Finally, the introduction of controls in the regression does not appear to add much to the estimation, suggesting that the use of episode windows, rather than the full sample, usefully

Table 2

EFECTIVENESS OF INTERVENTION[1]

	Base model (without controls)[2]		*Base model (with controls)*[3]				
Episodes:	All (2004–2010)						Post 2008–2009 crisis
Dependet variable:	Appreciation[4]	Pace of appreciation[5]	Appreciation[4]	Pace of appreciation[5]	Appreciation[4]	Pace of appreciation[5]	Pace of appreciation[5]
Sample of countries:	All				With actual FXI data		All
Regressors	I	II	III	IV	V	VI	VII
Interest rate differential[6]							
First difference			0.24[a]	0.35[a]	0.15	0.31	1.51[a]
			(1.73)	(1.77)	(0.93)	(1.31)	(2.46)
Country spread[7]							
First difference			–0.14[c]	–0.14[c]	–0.30[c]	–0.28[c]	–0.11[a]
			(6.41)	(4.36)	(–7.36)	(4.79)	(–2.37)

Intervention							
Amount[8]	0.16 (0.30)	−2.78[c] (−3.83)	0.08 (0.16)	−2.86[c] (4.05)	−0.35 (0.64)	−1.82[b] (−2.36)	−3.17[b] (−2.63)
R^2							
Within	0.00	0.01	0.20	0.15	0.21	0.13	0.28
Between	0.10	0.02	0.24	0.04	0.41	0.12	0.08
Overall	0.00	0.01	0.20	0.12	0.21	0.11	0.22
Number of observations	1,024	1,024	964	964	573	573	335
Number of countries	15	15	15	15	9	9	14
Probability > F	0.7678	0.7619	0.0000	0.0000	0.0000	0.0003	0.0019

Source: IMF staff calculations.
[1] Results of fixed effects panel estimation of the exchange rate equation. *t*-statistics reported in parenthesis. See Annex 2 for details. [2] No other controls in the regression. [3] Other control variable (commodity prices and DXY) are also included in the regression but not reported in the Table, as effects are allowed to be country.specific. [4] Dependent variable is the first difference of the level, or appreciation rate (positive values indicate appreciation). [5] Seconds difference of the exchange rate or pace of appreciation. [6] Domestic policy interest rate (or interbank rate) minus US federal funds rate. [7] 5-year sovereign CDS spread (or EMBI spread when CDS spread is not available). [8] Intervention amount in percent of GDP.
[a] denotes significance level at 10 percent, [b] at 5 percent, and [c] at 1 percent.

filters out the impact of unobservable global and idiosyncratic shocks on the exchange rate that could otherwise introduce a source of bias.

A look at the effects of various modalities of intervention (Table 3) offers a number of additional insights:

- Amounts of intervention appear to matter more than the mere presence of the central bank in the FX market (column 1). This result could suggest either that the signaling channel is weak or that small interventions may not be enough to signal policy intentions.
- The regressions do not find evidence that effectiveness of interventions depends on whether they are conducted under rule-based (including with preannounced amounts) or discretionary settings (columns 2 and 3). This result is consistent with a previous finding in the literature showing that there is no clear evidence of a difference between discretionary and rule-based intervention in terms of their effectiveness (Fatum and King, 2005).[17]
- Transparency of FX operations (measured by whether intervention data are made publicly available within a week of the operations) seems to *weaken* the effect on the exchange rate (column 4); however, this result seems to reflect other country characteristics that are correlated with transparency, as discussed below.
- The effectiveness of interventions greatly depends on the degree of the country's financial integration with the rest of the world, as *captured* by the interaction with the Chinn-Ito index of capital account openness[18] (column 5): greater

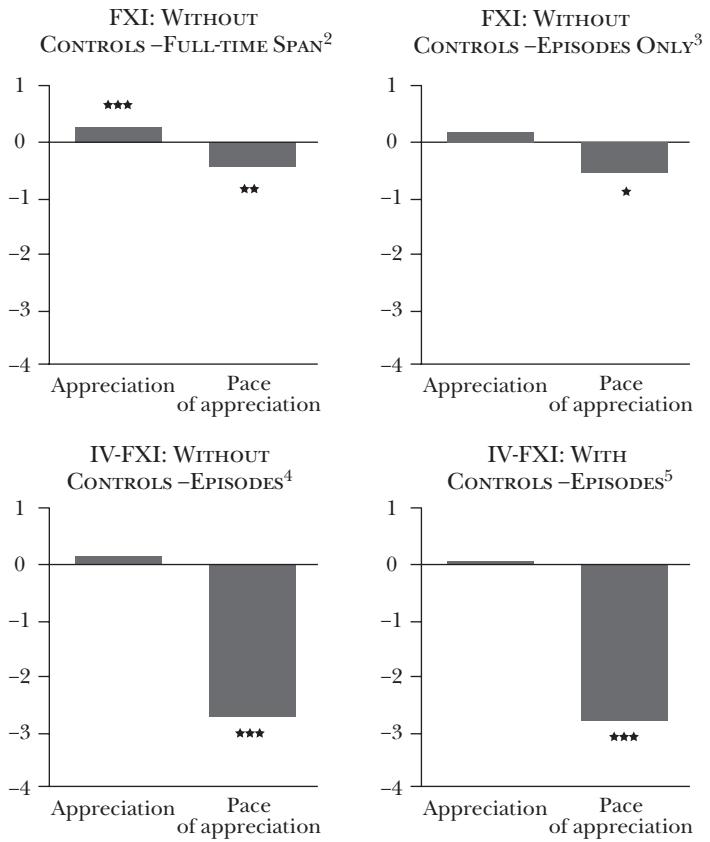
[17] This finding could be driven by the fact that rules are often designed to address exchange rate volatility issues. We thank an anonymous referee for raising this point. However, Adler and Tovar (2013) have found evidence that, at least temporarily, a regime shift toward preannounced rule-based FX intervention policies can revert the exchange rate appreciation and contain appreciation trends.

[18] See Chinn and Ito (2008).

Figure 13

Unveiling the Effect of FX Intervention –Results of Panel Approach under Different Specifications[1]

(coefficient intervention variable in exchange rate equation)



Sources: IMF staff calculations.

[1] Appreciation rate an pace of appreciation indicate first and second difference of the exchange rate.

[2] FXI: Without controls –Full-time span denotes model estimated with intervention variable (not instrument), without controls, and over the full period 2004-2010 (excluding 2008-2009 financial crisis).

[3] FXI: Without controls –Episodes denotes model estimated with intervention variable (not instrument), without controls, and over identified episodes only.

[4] IV-FXI: Without controls –Episodes denotes model estimated with intervention variable, without controls, and over identified episodes only.

[5] IV-FXI: With controls –Episodes denotes model estimated with intervention variable, with controls, and over identified episodes only.

Table 3

FACTORS AFFECTING THE EFFECTIVENESS OF INTERVENTION[1]

	Modalities of intervention				*Financial integration*		*Regional comparisons*			*Exchange rate misalignment*		
	Dependent variable											
	Pace of appreciation[2]											
Sample of countries	All						EM LA	EM Asia	Other EMEs	All	EM LA	EM Asia
Regressors	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Interest rate differential[3]												
First difference	0.36[a]	0.35[a]	0.35[a]	0.37[a]	0.38[a]	0.37[a]	0.16	1.31[b]	0.69	0.33	0.26	1.35[b]
	(1.79)	(1.74)	(1.77)	(1.86)	(1.89)	(1.85)	(0.67)	(2.48)	(1.44)	(1.63)	(0.80)	(2.56)
Country spread[4]												
First difference	−0.14[c]	−0.14[c]	−0.14[c]	−0.13[c]	−0.13[c]	−0.13	−0.27[c]	−0.03	−0.35[c]	−0.14[c]	−0.33[c]	−0.03
	(4.32)	(4.36)	(4.36)	(4.31)	(−4.24)	(−4.23)	(−5.06)	(−1.04)	(−2.84)	(4.42)	(5.84)	(−1.09)
Intervention												
Amount[5]	−2.98[c]	−4.13[b]	−2.86[c]	−4.86[c]	−9.00[c]	−9.44[c]	−1.81[b]	−7.91[c]	−2.82	−2.13[c]	−1.52[a]	−7.16[c]
	(3.88)	(−2.53)	(4.02)	(4.60)	(−4.41)	(3.50)	(−2.14)	(−5.44)	(−1.60)	(−3.18)	(−1.87)	(−4.54)
Dummy of intervention[6]												
	0.06											
	(0.37)											
Interaction with dummies of modalities												
Dummy of discretionary setting[7]		1.34										
		(0.86)										

Rules with preannounced amounts[8]			−0.02 (0.00)									
Transparency[9]				3.05[b] (2.54)			−0.89 (−0.25)					
Interaction with dummy of capital account openess[10]					7.74 [c] (3.20)	9.07 (1.57)						
Interaction with dummy of REER misalignment[11]										−1.58 [a] (−1.72)	−6.53 [c] (2.54)	−2.24 (−1.23)
R^2												
Within	0.15	0.15	0.15	0.15	0.16	0.16	0.13	0.31	0.16	0.15	0.17	0.31
Between	0.04	0.03	0.04	0.03	0.05	0.05	0.00	0.87	0.10	0.09	0.00	0.86
Overall	0.12	0.12	0.12	0.11	0.11	0.12	0.11	0.21	0.16	0.11	0.15	0.21
Number of observations	964	964	964	964	964	964	549	175	216	964	481	175
Number of countries	15	15	15	15	15	15	8	3	3	15	7	3
Probability > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0000	0.0017	0.0000	0.0000	0.0000

Source: IMF staff calculations.

[1] Results of fixed-effects panel estimation of the exchange rate equation. *t*-statics reported in parenthesis. Other control variables (commodity prices and DKY) are also included in the regression but not reported in the table. See Annex 2 for more details. [2] Second difference on the exchange rate or acceleration. [3] Domestic policy interest rate (or interbank rate) minus US federal funds rate. [4] 5-year sovereign CDS spread (or EMBI spread when CDS spread is not available). [5] Intervention amount in percent of GDP. [6] Dummy that takes value 1 if intervention amount is positive. [7] Dummy that takes value 1 if the framework allows for discretionary interventions. [8] Dummy for framework with (preannouced) amount-based rule. [9] Dummy based on whether interventions are preannouced or data are published (ex post) within a week. [10] Based on Chinn & Ito's index of capital account openness (normalized to take value between 0 and 1). [11] Dummy of REER misalignment is based on the difference between the level on the REER and its 5-years backward-looking moving average. Dummy value 1 if the overvaluation gap is greater than 10 percent.

[a] denotes significance level a 10 percent; [b], at 5 percent, and [c], at 1 percent.

financial integration seems to reduce the effectiveness of intervention. Interestingly, when we control for financial integration (column 6), the dummy on transparency loses significance, suggesting that there is high correlation between the degree of openness and the transparency of intervention operations. Still, the point estimate for capital account openness remains large, while the estimate for transparency decreases markedly.

- A breakdown by region points to significantly higher effects in Asia than in Latin America, which are consistent with a higher degree of financial integration in the latter (columns 7-9).
- Interventions are more effective when there are signs that the currency may be becoming overvalued (more precisely, when it already has appreciated significantly relative to its recent history). This result is particularly pronounced in Latin America (columns 10-12).

5. CONCLUSIONS

Over the past decade, many central banks in Latin America have had a regular, and at times large, presence in FX markets. In most instances, these FX interventions were in one direction only, and coincided with easing of global financial conditions that led to appreciation pressures on many EM currencies, including those of Latin America. While central banks have stated various motives for their interventions, their nature and timing often suggest an effort to mitigate currency appreciation pressures.

Whether these efforts have been successful is an empirical question that is inherently difficult to answer –precisely because intervention often takes place at the same time that other forces are acting to strengthen the currency. However, our methodological approach –based on a panel setting focused on episodes of common global shocks– suggests that interventions do have an effect, by slowing the pace of exchange rate

appreciation. This effect turns out to be smaller where there is a greater degree of capital account openness –helping to explain differences in the degree of intervention across regions– and larger when the currency already has appreciated substantially (a situation in which the currency is less likely to be undervalued).

Our effort to gather –for the first time– information on FX intervention practices shows that there is a wide range of modalities, regarding declared motives, frameworks, instruments and degree of transparency. Econometrically, however, it is unclear from our evidence that such modalities make a difference in terms of the impact that interventions may have on the exchange rate. This may suggest that central banks' choices of specific modalities may respond to other considerations, beyond the impact on the exchange rate. Such considerations may include concerns about exchange rate volatility, quasi-fiscal costs, consistency with other monetary policy objectives, etc. A discussion of these issues –as well as of whether and when affecting the exchange rate is desirable– is left for future research.[19]

Annex 1. Foreign Exchange Intervention and International Reserves: Data Availability

[19] For an in-depth normative discussion on some of these issues, see Eyzaguirre et al. (2011), Jara et al. (2008), and Fall 2010 and Spring 2011 editions of the *IMF's Regional Economic Outlook –Western Hemisphere.*

	Data availability						Data used in the Chapter	
	Foreign exchange intervention			Stock of international reserves			Section on modalities of intervention	Econometric section
	Daily	Weekly	Monthly	Daily	Weekly	Monthly	Daily	Weekly
Brazil			✓	✓		✓	•	✓
Chile	✓				✓	✓	✓	✓
Colombia	*		✓		✓	✓	✓	✓
Costa Rica	*			✓		✓	✓	✓
Czech Republic			✓			✓		
Guatemala	✓			✓		✓	✓	✓
Honduras						✓		
India					✓	✓	•	✓
Indonesia					✓[1]	✓	•	✓
Israel	✓		✓			✓	•	✓
Korea						✓		
Malasya						✓		
Mexico	✓				✓	✓	✓	✓
Peru	✓			✓		✓	✓	✓
Phillippines						✓		
Polonia						✓		

	Data availability						***Data used in the Chapter***	
	Foreign exchange intervention			*Stock of international reserves*			*Section on modalities of intervention*	*Econometric section*
	Daily	*Weekly*	*Monthly*	*Daily*	*Weekly*	*Monthly*	*Daily*	*Weekly*
Romania						✓		
Rusia			✓[2]		✓	✓	•	✓
South Africa						✓		
Thailand					✓	✓	•	✓
Turkey	✓				✓	✓	•	✓
Uruguay	*			✓		✓	✓	✓
Australia	✓[3]				✓	✓	•	✓
Canada	✓					✓		
New Zeland			✓			✓		
Norway		✓[4]				✓		

Note: • indicate that data is only used to describe qualitative information (e.g., motives, rules, instruments, transparency). * indicates that data is confidential basis.
[1] Weekly reserves data stops in 2007. [2] Information starts in 2008. [3] Not available for 2010. [4] Information starts in 2005.

Annex 2. Instruments for Foreign Exchange Purchases

Central banks have a range of instruments with which they might directly influence the exchange rate, including FX spot purchases, forwards, swaps, and options.[20]

- FX spot purchases are transactions made by the central bank for *immediate* delivery.
- Forward FX purchases entail a future purchase of FX at a preagreed exchange rate. These can be deliverable or non-deliverable.
- Cross-currency swaps involve the simultaneous purchase and sale of one currency for another at two different dates. Interventions with this instrument are composed of two legs: *i)* a spot FX purchase, reversed by *ii)* a future FX sale at the spot exchange rate at that time.[21]
- FX put options are contracts that give the holder the right to sell foreign exchange to the central bank under certain contingent conditions (see Annex 3).

The spot market is the most developed market in the region, and central banks have traditionally considered it as the natural market for interventions (see Figures 6 and 7).

Although forwards have been used only occasionally in Latin America, there is a long history of use of options (by Colombia

[20] Other policy instruments, not discussed here (for example, reserve requirements, interest rates), may also influence the exchange rate, but in a less direct manner, and are normally not used with this objective in mind.

[21] Cross-currency swaps are different from regular currency (FX) swaps. The latter –often issued for liquidity management, rather than FX intervention– entails a forward leg that is settled at a preagreed exchange rate, thus eliminating exchange rate risk. A cross-currency swap, on the other hand, carries exchange rate risk, as the forward leg is settled at the spot rate prevailing at the end of the contract, thus changing the FX position of the central bank and its counterparty.

and Mexico). Cross-currency swaps have been used only by Brazil (*cupom cambial*).[22]

A number of considerations can influence the choice of instruments.[23] For instance, *i)* the use of derivatives reduces the degree of transparency of central bank operations vis-à-vis spot transactions, thus weakening the signaling channel (although this can be partially addressed by a clear communication policy); *ii)* they obscure the central bank's balance sheet FX position; *iii)* although normally they do not require immediate sterilization (except for some cross-currency swaps) thus helping mitigate ex ante the quasi-fiscal costs of interventions, their use exposes the central bank to the risk of a sudden capital loss, if interventions fail to contain appreciation pressures; and *iv)* derivatives carry counterparty and liquidity risk, which can be particularly pronounced in thin markets. On the other hand, *i)* put options offer the additional benefit of working as automatic stabilizers of the exchange rate, as they are exercised only under conditions of appreciation pressures; and *ii)* derivatives can be settled in local currency, and do not necessarily entail the use of reserves at any point in the contract. This can be a desirable feature for central banks that prefer to avoid the potentially negative signaling associated with fluctuations in the level of reserves. Relatedly, the unwinding of derivative positions, once appreciation pressures have receded, seems easier than the unwinding of the reserve accumulation that would result from spot transactions.

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[22] The *cupom cambial* is a derivative equivalent to a cross-currency swap that pays the difference between the local interest rate and changes in the real/US dollar exchange rate. Although originally the central bank took the long real-open interest rate, it has recently switched to take the short real-interest rate position to dampen appreciation pressures.

[23] See also Canales-Kriljenko et al. (2003); Ishii et al. (2006); and Blejer and Schumacher (2000).

Annex 3. FXI Rules in Practice: Some Latin American Examples

Latin American central banks have relied on two main types of rules for conducting foreign exchange purchases: *i)* exchange rate-based rules (normally aimed at moderating exchange rate volatility); and *ii)* quantity-based rules (normally aimed at accumulating international reserves).

Exchange Rate-based Rules

These rules normally determine a trigger for FX purchases whenever the exchange rate moves beyond a preannounced threshold. The main elements of the rule are: A threshold determined by a moving average of the exchange rate; a tolerance band around it; and the amount of intervention.

Colombia and Guatemala have recently used these rules. In Colombia the rule –introduced in 1999 and discontinued in October 2009– authorized the central bank to auction put options up to a specific amount (currently USD 180 million) whenever the exchange rate fell more than five percent below its average of the previous 20 working days.[24] A similar rule was introduced in Guatemala in 2005, allowing the central bank to purchase specific amounts (USD 8 million per transaction and up to USD 32 million per day during 2010) , whenever the exchange rate fell below its average of the previous five days plus a tolerance band of 0.6 percent.

Quantity-based Rules

Two-rule-based mechanisms have been employed. The first one announces a window over which the central bank will purchase FXs in the spot market. The second one is a mechanism in which the central bank auctions a certain amount of put

[24] See the central bank's web site for further details. See also Rincón and Toro (2010) and Uribe and Toro (2005) for a detailed account of these rules in Colombia.

options that grant market participants the right to sell dollars to the central bank if certain conditions are met.

Chile has relied on the first type of rule in two occasions: For a first program of reserve accumulation launched in April 10, 2008, and a second program announced on January 3, 2011. Both programs preannounced daily amounts to be purchased through competitive auctions.

A current example of the second type is the rule used by Mexico. Launched on February 22, 2010 (and also used during 1996-2001)[25] the mechanism established monthly auctions of put options with a strike price equal to the previous day interbank reference rate (Fix), as long as it is below the previous 20-day moving average rate.

References

Adler, Gustavo and Camilo E. Tovar (2013), "On the Effectiveness of Foreign Exchange Intervention –Evidence from Rules-based Regime Changes," mimeo., International Monetary Fund. Available upon request from the authors.

Armas, Adrián (2005), "Forex Intervention in Peru: 2002-04," in *Foreign Exchange Market Intervention in Emerging Markets: Motives, Techniques and Implications,* BIS Papers, No. 24, Basel, May.

Bank for International Settlements (2005), *Foreign Exchange Market Intervention in Emerging Markets: Motives, Techniques and Implications,* BIS Papers, No. 24, Basel, May.

Bevilaqua, Afonso, and Rodrigo Azevedo (2005), "Provision of FX Hedge by the Public Sector: The Brazilian Experience," in *Foreign Exchange Market Intervention in Emerging Markets: Motives, Techniques and Implications,* BIS Papers No. 24, Basel, May.

Blejer, Mario I., and Liliana Schumacher (2000), *Central Banks Use of Derivatives and Other Contingent Liabilities: Analytical Issues and Policy Implications,* IMF Working Paper, No. 00/66, Washington, D. C.

Canales-Kriljenko, Jorge Iván, Roberto Guimarães, and Cem Karacadağ (2003), *Official Intervention in the Foreign Exchange Market: Elements of Best Practice,* IMF Working Paper, No. 03/152, Washington, D. C.

[25] This mechanism was used by Banco de México between 1996 and 2001. See Sidaoui (2005).

Chinn, Menzie D., and Hiro Ito, 2008, "A New Measure of Financial Openness," *Journal of Comparative Policy Analysis: Research and Practice,* Vol. 10, Issue 3, pp. 309-322.

Contreras M., Gabriela; Alfredo Pistelli M., and Camila Sáez M. (2013), "Efectos de intervenciones cambiarias recientes en economías emergentes," *Economía Chilena,* Vol. 16, No. 1, April.

De Gregorio, José, and Andrea Tokman (2005), "Flexible Exchange Rate Regime and Forex Intervention," in *Foreign Exchange Market Intervention in Emerging Markets: Motives, Techniques and Implications,* BIS Papers, No. 24, Basel, May.

Domínguez, Kathryn M. E. (2006), "When Do Central Bank Interventions Influence Intra-daily and Longer Exchange Rate Movements?," *Journal of International Money and Finance,* Vol. 25, pp. 1051-1071.

Domínguez, Kathryn M. E., and Jeffrey A. Frankel (1993), "Does Foreign-exchange Intervention Matter? The Portfolio Effect," *The American Economic Review,* Vol. 83, No. 5, December, pp. 1356-1369.

Domínguez, Kathryn M. E., Rasmus Fatum, and Pavel Vacek (2010), *Does Foreign Exchange De-accumulation Lead to Currency Appreciation?,* NBER Working Papers, No. 16044, National Bureau of Economic Research, June.

Echavarría, Juan , Luis Melo, Santiago Téllez and Mauricio Villamizar (2013), *The Impact of Pre-announced Day-to-day Interventions on the Colombian Exchange Rate,* BIS Working Paper, No. 428, Basel, September.

Eyzaguirre, Nicolás, Martin Kaufman, Steven Phillips, and Rodrigo Valdés (2011), *Managing Abundance to Avoid a Bust in Latin America,* IMF Staff Discussion Notes, No. 11/07, International Monetary Fund, Washington, D. C.

Fatum, Rasmus, and Michael King (2005), *Rules versus Discretion in Foreign Exchange Intervention: Evidence from Official Bank of Canada High-frequency Data,* SCCIE Working Paper, No. 04-24, Center for International Economics, Santa Cruz.

Fratzcher, Marcel (2008), "Oral Interventions versus Actual Interventions in FX Markets –An Event Study Approach," *The Economic Journal,* Vol. 118, July.

Galati, Gabriele, and Piti Disyatat (2005), *The Effectiveness of Foreign Exchange Market Intervention in Emerging Market Countries: Evidence from the Czech Koruna,* BIS Working Papers, No. 172, Basel, March.

García-Verdú, Santiago, and Miguel Zercero (2013), *On Central Bank Interventions in the Mexican Peso/Dollar Foreign Exchange Market,* BIS Working Paper, No. 429, Basel, September.

González, Maria (2009), "Leaning-Against-the-Appreciation-Winds or Self Insurance? Disentangling the Motives for Central Bank Intervention in Latin America," mimeo.

Humala, Alberto, and Gabriel Rodríguez (2009), *Foreign Exchange Intervention and Exchange Rate Volatility in Peru,* Working Paper Series, No. 2009-008, Banco Central del Perú, Lima, April.

International Monetary Fund (2007a), *World Economic Outlook,* Washington, D. C., October.

International Monetary Fund (2007b), *Regional Economic Outlook: Asia and Pacific,* Washington, D. C., October.

International Monetary Fund (2010a), *Regional Economic Outlook: Western Hemisphere,* Washington, D. C., May.

International Monetary Fund (2010b), *Regional Economic Outlook: Western Hemisphere,* Washington, D. C., October.

International Monetary Fund (2011a), *Regional Economic Outlook: Western Hemisphere*, Washington, D. C., May.

International Monetary Fund (2011b), *Recent Experiences in Managing Capital Inflows–Cross-cutting Themes and Possible Guidelines,* No. SM/11/30.

Ishii, Shogo, Jorge Iván Canales-Kriljenko, Roberto Guimarães, and Cem Karacadağ (2006), *Official Foreign Exchange Intervention,* IMF Occasional Paper, No. 249, Washington, D. C.

Jara, Alejandro, Ramón Moreno, and Camilo E. Tovar (2008), *Monetary and Financial Stability Implications of Capital Flows in Latin America and the Caribbean,* BIS Papers No.43, Basel, November.

Jara, Alejandro, Ramón Moreno, and Camilo E. Tovar (2009), "The Global Crisis and Latin America: Financial Impact and Policy Responses," *BIS Quarterly Review,* June, pp. 53-68.

Kamil, Herman (2008), *Is Central Bank Intervention Effective under Inflation Targeting Regimes? The Case of Colombia,* IMF Working Paper, No. 08/88, International Monetary Fund, Washington, D. C.

Kearns, Jonathan, and Roberto Rigobon (2005), "Identifying the Efficacy of Central Bank Interventions: Evidence from Australia and Japan," *Journal of International Economics,* Vol. 66, May, pp. 31-48.

Kisinbay, Turgut, Seiichi Shimizu, Anna Nordstrom, Jorge Restrepo, Scott Roger, and Mark R. Stone (2009), *The Role of the Exchange Rate in Inflation-targeting Emerging Economies,* IMF Occasional Paper, No. 267, Washington, D. C.

Lahura, Erik, and Marco Vega (2013), *Asymmetric Effects of Forex Intervention Using Intraday Data: Evidence from Peru,* BIS Working Paper, No. 430, Basel, September.

Neely, Chris (2008), "Central Bank Authorities' Beliefs about Foreign Exchange Intervention," *Journal of International Money and Finance,* Vol. 27, pp. 1-25.

Ostry, Jonathan D., Atish R. Ghosh, Karl Habermeier, Luc Laeven, Marcos Chamon, Mahvash S. Qureshi, and Annamaria Kokenyne (2011), *Managing Capital Inflows: What Tools to Use?,* IMF Staff Discussion Notes, No. 11/6, April.

Pincheira, Pablo (2013), *Interventions and Inflation Expectations in an Inflation Targeting Economy,* BIS Working Paper, No. 427, September.

Rincón, Hernán, and Jorge Toro (2010), "Are Capital Controls and Central Bank Intervention Effective?," *Borradores de Economía,* Banco de la República de Colombia, October.

Sarno, Lucio, and Mark Taylor (2001), "Official Intervention in the Foreign Exchange Market: Is It Effective and, If so, How Does It Work?," *Journal of Economic Literature,* Vol. 34, September, pp. 839-868.

Sidaoui, José (2005), "Central Banking Intervention under a Floating Exchange Rate Regime: Ten Years of Mexican Experience," in *Foreign Exchange Market Intervention in Emerging Markets: Motives, Techniques and Implications,* BIS Papers, No. 24, Basel, May.

Stone, Mark, Scott Roger, Seiichi Shimizu, Anna Nordstrom, Turgut Kisinbay, and Jorge Restrepo (2009), *The Role of the Exchange Rate in Inflation-targeting Emerging Economies,* IMF Occasional Paper, No. 267, Washington, D. C.

Tapia, Matías, and Andrea, Tokman (2004), "Effects of Foreign Exchange Intervention under Public Information: The Chilean Case," *Economia,* Vol. 4, No. 2, pp. 215-256, Brookings Institution Press.

Uribe, José Darío, and Jorge Toro (2005), "Foreign Exchange Market Intervention in Colombia," in *Foreign Exchange Market Intervention in Emerging Markets: Motives, Techniques and Implications,* BIS Papers, No. 24, May.

World Bank (2013), "Latin America's Deceleration and the Exchange Rate Buffer," *World Bank Semi-annual Report,* Office of the Regional Economist.