



IMF Working Paper

Foreign Exchange Intervention: A Shield Against Appreciation Winds?

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Western Hemisphere Department

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Abstract

This paper examines foreign exchange intervention practices and their effectiveness using a new qualitative and quantitative database for a panel of 15 economies covering 2004–10, 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 IV-panel data approach to 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.

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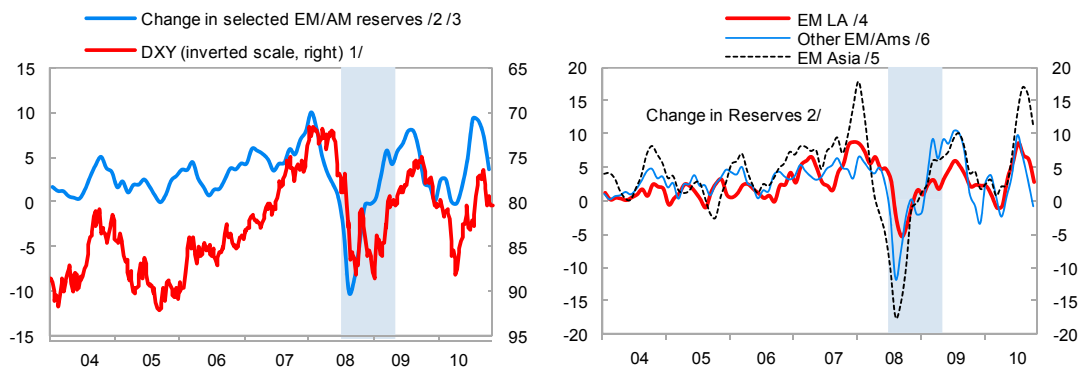
Contents	Page
I. Introduction	3
II. The Extent and Modalities of Intervention	6
A. Frequency and Size of Interventions.....	7
B. Declared Intervention Practices	8
III. The Effects of Foreign Exchange Intervention.....	12
A. Estimation Strategy	12
B. Data Issues.....	16
IV. Results.....	17
A. First Stage: Reaction Functions	17
B. Second stage: Effects of Intervention.....	18
V. Conclusions.....	22
Annex 1. Foreign Exchange Intervention and International Reserves: Data Availability.....	23
Annex 2. Instruments for Foreign Exchange Purchases	24
Annex 3. FXI Rules in Practice: Some Latin American Examples	26
References.....	27
 Tables	
1. Stylized Facts of Foreign Exchange Purchases	8
2. Effectiveness of Intervention	19
3. Factors Affecting the Effectiveness of Intervention	22
 Figures	
1. Global Conditions and Change in International Reserves—Selected EM/AM Economies.....	3
2. Intervention and Bilateral Exchange Rate in Latin America	4
3. Motives for Intervention	10
4. Framework for Intervention.....	10
5. How Do Latin American Countries Actually Intervene?	11
6. Instruments of Intervention.....	11
7. Daily Foreign Exchange Market Turnover?	11
8. When Are Amounts of Intervention Published?.....	11
9. US Trade-Weighted Exchange Rate and Flows to EME Asset Funds	14
10. Intervention and Exchange Rates around Identified Episodes	15
11. Actual Intervention data vs. International Reserves	17
12. Coefficients of Intervention Reaction Functions	18
13. Unveiling the Effect of FX Intervention—Results of Panel Approach under Different Specifications.....	20

I. INTRODUCTION

This paper examines *sterilized* foreign exchange intervention (FXI) practices and their effectiveness in mitigating appreciation pressures, using a new qualitative and quantitative database for a panel of 15 economies covering the period 2004–10, 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 policies? 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?²

The time span chosen is meant to capture—excluding the 2008–09 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.

Figure 1. Global Conditions and Change in International Reserves—Selected EM/AM Economies



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

1/ U.S. dollar trade-weighted exchange rate. A decline in the index corresponds to an appreciation.

2/ International reserves minus gold. Annualized 3-month moving average, in percent of 2006–07 average GDP.

3/ Includes Brazil, Chile, Colombia, Czech Republic, India, Indonesia, Israel, Hungary, Korea, Malaysia, Mexico, Peru, Philippines, Poland, Romania, Russia, South Africa, Thailand, Turkey, and Uruguay. Simple average.

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

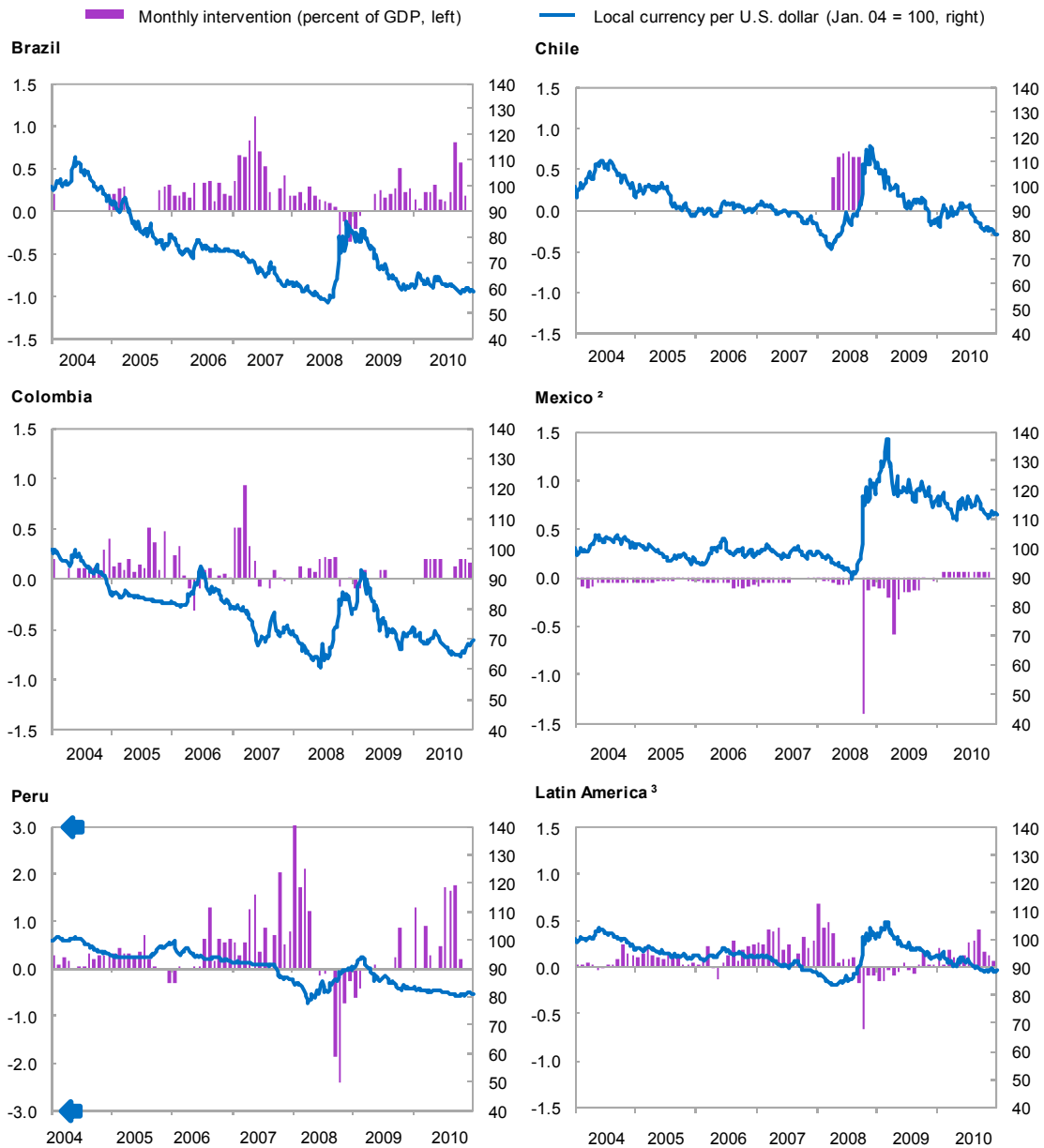
5/ Includes India, Indonesia, Korea, Malaysia, Philippines, and Thailand. Simple average.

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

² 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 (2011), Ostry et al. (2011), and May 2010 and October 2010 *Regional Economic Outlook—Western Hemisphere*.

Figure 2. Intervention and Bilateral Exchange Rate in Latin America¹



Source: IMF staff calculations on the basis of central bank data.

Note: Latin America includes Costa Rica, Guatemala, and Uruguay. Positive values of intervention refer to purchases, whereas negative values refer to sales. For the 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 scale has been changed relative to previous and subsequent panels.

¹ Intervention measured as a percentage of the 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 it 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 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.

(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 (see Kearns and Rigobon, 2005). Furthermore, under current global conditions favoring capital flows to emerging market economies (EMEs), and with added currency appreciation pressures arising from marked changes in fundamentals—e.g., terms of trade gains for commodity exporters—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*.³ Purchases have been and continue to be, by far, the more prevalent direction of intervention among the countries studied, and it is of considerable policy and academic interest to know whether such operations could mitigate current appreciation pressures. Thus, we exclude the period of the 2008–09 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.⁴

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 few existing studies that have examined FXI in emerging economies have focused on determining “de facto” motives behind these policies and/or its effectiveness in specific economies such as Chile, Colombia, Czech Republic, or Peru (e.g., Kamil, 2008; Galati and Diyatat, 2007; Humala and Rodriguez, 2008; Tapia and Tokman, 2004; and Rincón and Toro, 2010). In general, however, the literature has failed to reach a conclusion about the effects of FXIs on exchange rates, frequently suggesting the absence of any relationship (Neely, 2008; Galati and Diyatat, 2007; BIS, 2005; Sarno and Taylor, 2001; or Dominguez and Frankel, 1993). As for modalities of intervention, a number of recent paper 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 largely overlooked, partly reflecting the lack of data.⁵

Our contribution to the literature is therefore three-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

³ 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).

⁴ 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).

⁵ Exceptions are the work of Fatum and King (2005) on rules versus discretion in the case of Canada, and Fratzcher (2008) on the role of intervention announcements. Stone and others (2009) also discuss some aspects related to modalities of intervention, although without linking them to the effectiveness of such policies.

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. *Third*, to achieve identification, we 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 ensure 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).

We find robust results 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 II presents some stylized facts on the extent and modalities of intervention during the sample period. Section III discusses the econometric methodology to identify the effects of FXI on the behavior of the exchange rate. Section IV presents key results, and section V concludes with a brief discussion on policy implications.

II. 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 and others, 2006; and Canales-Kriljenko, 2003).⁶ 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)⁷ as well as qualitative information describing the manner in which central banks conduct interventions. The database was

⁶ 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 (see 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, 2005 and Sidaoui, 2005).

⁷ High-frequency data on intervention is available for Australia, Chile, Colombia, Costa Rica, Guatemala, Israel, Mexico, Peru, Turkey and Uruguay.

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:

(i) *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.

(ii) *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).

(iii) *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 (see Annex 2 for a brief discussion on considerations that affect the choice of instruments).

(iv) *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.

A. Frequency and Size of Interventions

How frequent are foreign exchange interventions? Most countries in the region have had a fairly regular presence in the FX market during the 2004–10 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).⁸ 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).

⁸ Data for Costa Rica, Guatemala, and Uruguay are not reported as it is confidential.

Table 1. Stylized Facts of Foreign Exchange Purchases, 2004–10

	Frequency (Percent of working days)	Intensity			Has there been active FX intervention in 2011?
		Cumulative intervention as percent of GDP ^{1,2}	Daily average (Millions of U.S. dollars) ¹	Daily maximum (Millions of U.S. dollars) ¹	
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 America⁴	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	4966	yes

Source: IMF staff calculations on the basis of central bank and its information.

Note: 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 US\$25 million and the maximum daily amount reaches US\$571 million.

⁴ Simple average.

⁵ Daily net foreign exchange market transactions as reported by the Reserve Bank of Australia.

⁶ Complementary measures have 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.

B. 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 2004–10 (except for the 2008–09 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, 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 no intention to influence the exchange rate (e.g., Chile and Mexico).⁹ 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 officially declared *targeting* 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 has been named ‘currency war’). Furthermore, it is

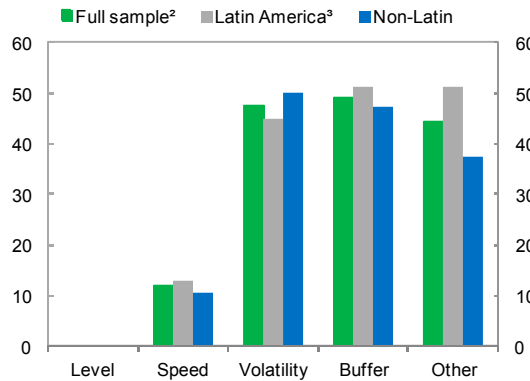
⁹ There is a large body of literature examining the reasons behind the accumulation of international reserves, which we do not address in this paper.

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 towards rules versus discretion when the framework actually matters. To answer this we examine the 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.

Figure 3. Motives for Intervention, 2004–10¹
(Percentage of countries)



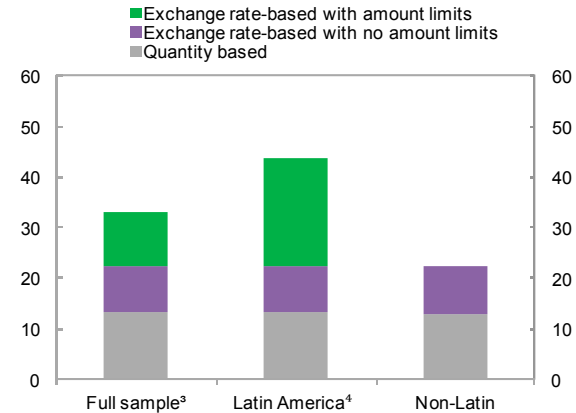
Source: IMF staff calculations.

¹ 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.

² Includes Latin America, Australia, India, Indonesia, Israel, Russia, Thailand, and Turkey.

³ Includes Brazil, Chile, Colombia, Costa Rica, Guatemala, Mexico, Peru, and Uruguay.

Figure 4. Framework for Intervention, 2004–10^{1,2}
(Percentage of countries in the sample)



Source: IMF staff calculations.

¹ 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.

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

³ Includes Latin America, Australia, India, Indonesia, Israel, Russia, Thailand, and Turkey.

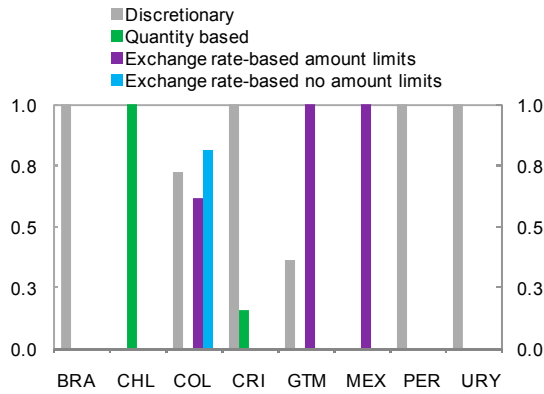
⁴ Includes Brazil, Chile, Colombia, Costa Rica, Guatemala, Mexico, Peru, and Uruguay.

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

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). LA 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 5. How Do Latin American Countries Actually Intervene? 2004–10¹

(Average intensity use of each rule^{2,3})



Source: IMF staff calculations.

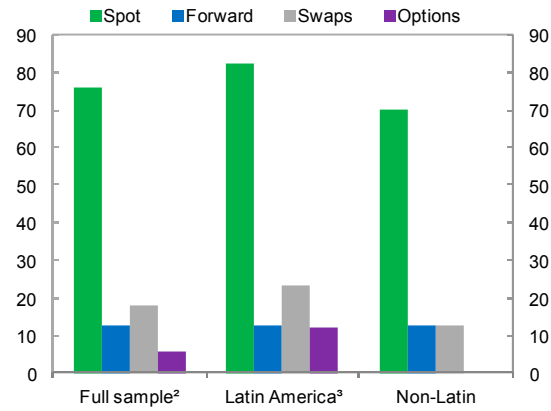
¹ Declared intervention rules according to official central bank statements (e.g., press releases, annual reports, web site, etc.). Exchange rate-based rules are triggered by some exchange rate-related measure (e.g., change or volatility). If the amount of intervention is specified then it is considered "with amount limits"; otherwise it is considered "with no amount 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.

² 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.

³ 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 2004–10¹

(Percentage of countries)



Source: IMF staff calculations.

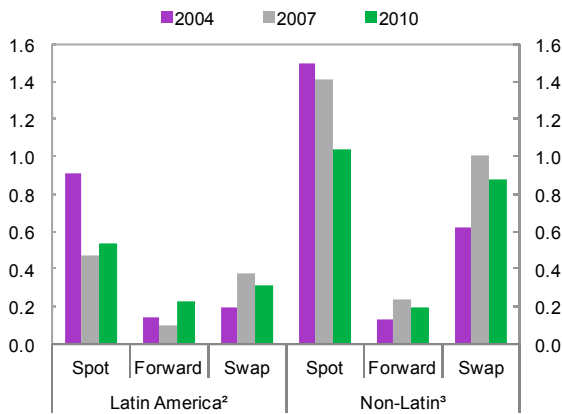
¹ Declared intervention instruments according to official central bank statements (e.g., press releases, annual reports, web site, etc.). More than one instrument may be used for intervention by a single central bank, thus totals do not add to 100. Averages for the period.

² Includes Latin America, Australia, India, Indonesia, Israel, Russia, Thailand, and Turkey.

³ Includes Brazil, Chile, Colombia, Costa Rica, Guatemala, Mexico, Peru, and Uruguay.

Figure 7. Daily Foreign Exchange Market Turnover?¹

(Percentage of GDP)



Source: Bank for International Settlements.

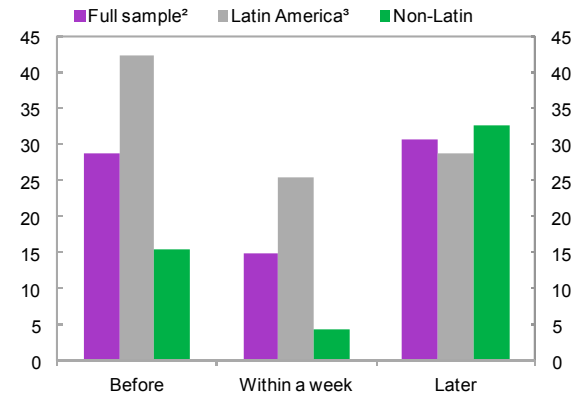
¹ According to Bank for International Settlements' definitions.

² Includes Brazil, Chile, Colombia, Mexico, and Peru.

³ Includes India, Indonesia, Israel, Russia, Thailand, and Turkey.

Figure 8. When Are Amounts of Intervention Published?¹

(Percentage of countries)



Source: 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.

III. 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 arbitrated 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.¹⁰ First, a *portfolio balance channel*, which operates when there is imperfect substitutability 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.

A. 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.

¹⁰ See Sarno and Taylor (2001) for a general overview of these mechanisms.

- 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 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.

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 2004–10 (always excluding the period September 2008–June 2009). Formally, the reaction function takes the following form:

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

- $I_{i,t}$ 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 currencies¹² (see discussion below on the appropriateness of using reserves as a proxy).
- $e_{i,t-1}$ denotes the lagged change in the nominal (U.S. 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 $(re_{i,t} - re_{i,t}^{eq})$ 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.

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.

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.

- $\sigma_{i,t}$ 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.

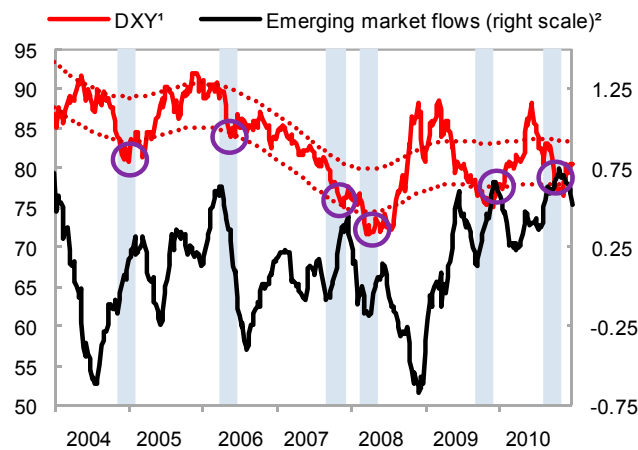
$R_{i,t-1}^{M2}$ and $R_{i,t-1}^{STD}$ denote the ratios of reserves-to-M2 and reserves-to-short-term debt *relative to the average of EM countries in the sample*. These two terms seek to capture possible precautionary motives.

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 U.S. 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 U.S. 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).

Figure 9. US Trade-Weighted Exchange rate and Flows to EME Asset Funds, 2004-10



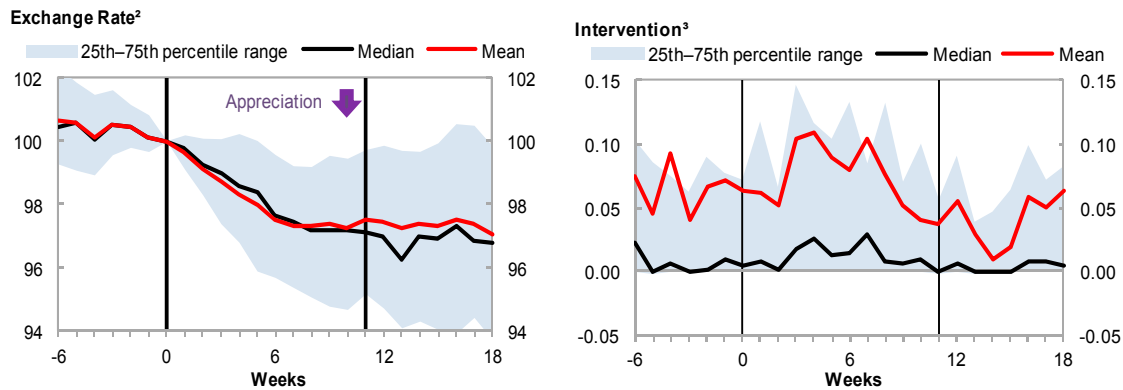
Sources: Bloomberg, L.P.; Haver Analytics; and IMF staff calculations.

¹ U.S. trade-weighted exchange rate, index 2000 = 100.

² Previous 12-week moving average, in percent of assets under management.

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 to 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 10. Intervention and Exchange Rates Around Identified Episodes



Source: IMF staff calculations.

¹ Episodes of global shocks identified on the basis of movements in the U.S. trade-weighted exchange rate (DXY).

² Local currency per U.S. dollar, Index $t_0 = 100$.

³ In percent of GDP.

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:

$$e_{i,t} = \gamma_1 + \gamma_2(i_{i,t} - i_t^*) + \gamma_3 S_{i,t} + \gamma_4 i_t^{DM} + \gamma_5 i_t^{PE} + \gamma_6 i_t^{PF} + \gamma_7 \hat{I}_{i,t} + \gamma_8 DXY_t$$

- $e_{i,t}$ denotes the log of the nominal exchange rate (against the US\$) for country i at time t . The variable is introduced in first and second differences (ensuring that it 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 U.S. FedFunds 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 use in the case of pre-announced amount-based rules, as FXI does not react to contemporaneous shocks in those cases.¹³

Note that 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 to be small as these policy measures tend to be less frequent than—and so show low correlation with—FX interventions.

B. 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, etc.

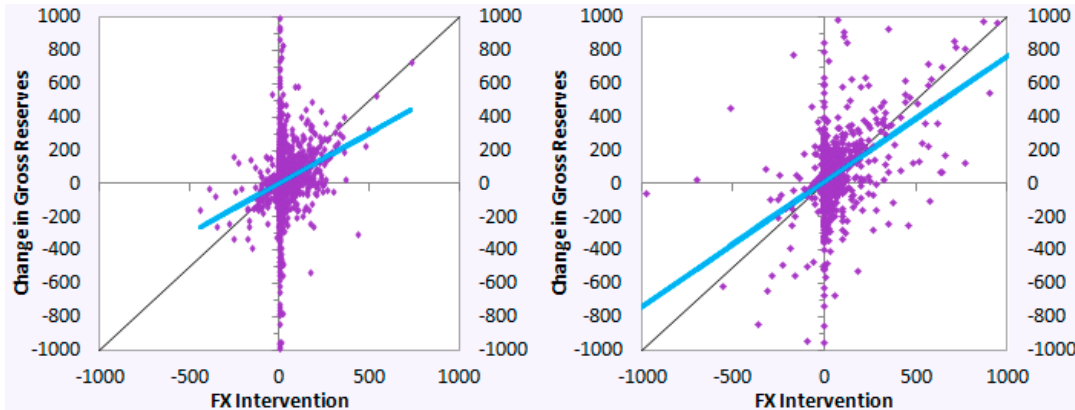
Thus a question that arises is how good a proxy for intervention is the change in reserves? To get a sense of the importance of the measurement error, we run a regression between intervention and the change in reserves for several countries for which both forms of data is available (Colombia, Costa Rica, 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

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.

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).

Figure 11. Actual Intervention data vs. International Reserves¹
Daily data (left) and weekly data (right), 2004-10, US\$ million



Source: IMF staff calculations.

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

¹ Includes Colombia, Costa Rica, Guatemala, Peru, and Uruguay.

IV. RESULTS

A. 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 (1-week) movements in the exchange rate seem to have been a source of concerns for many countries (1/2 of the sample), particularly outside LA. 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 (2/3 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 a poorer job in explaining the high frequency spikes often observed in the data.

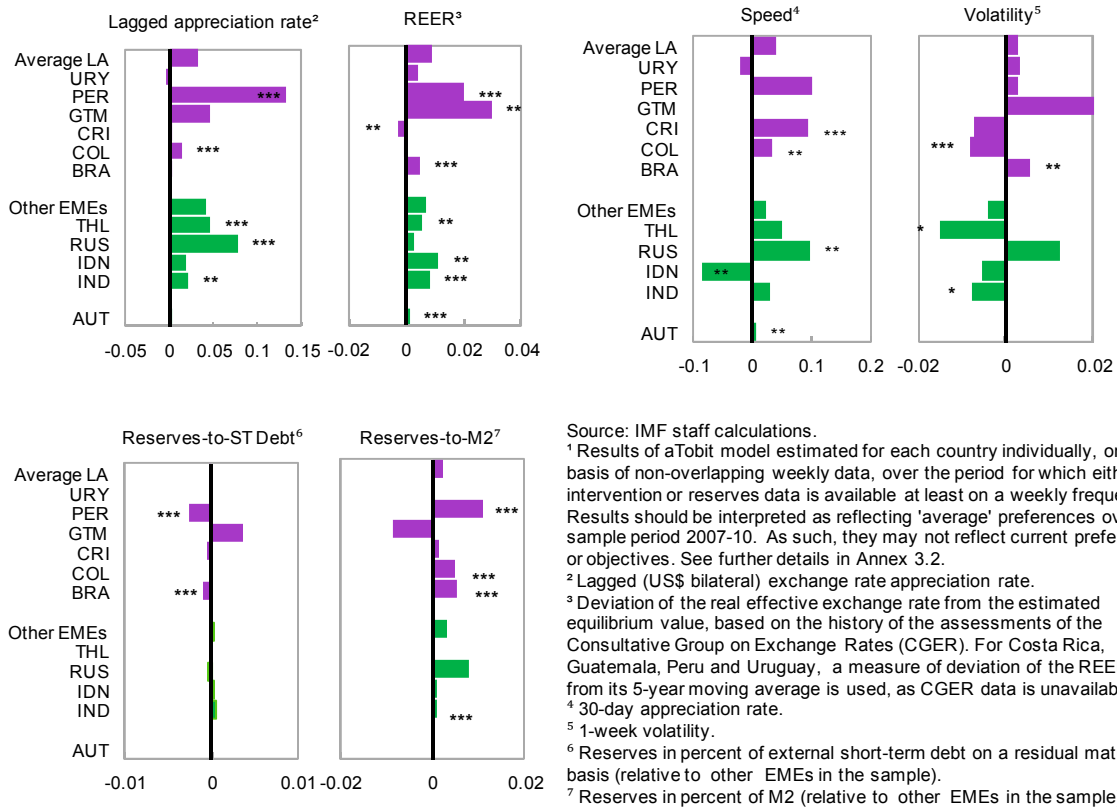
¹⁴ Results of the reaction function should be interpreted as reflecting the ‘average’ behavior over the sample period, and thus may not reflect current preferences.

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

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).

Figure 12. Coefficients of Intervention Reaction Functions

Central Bank Intervention Reaction Functions
Selected Coefficients¹



Source: 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 2007-10. As such, they may not reflect current preferences or objectives. See further details in Annex 3.2.

² Lagged (US\$ 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 1-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).

B. 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 I and II). 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). Interestingly, the introduction of controls (columns III and IV) 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 9 countries

for which actual intervention data is available (columns V and VI). 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 2008–09 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 VII).

Table 2. Effectiveness of Intervention¹

	Base Model (without controls) ²		Base Model (with controls) ³				
	Episodes:						Post 2008-09 crisis
	All (2004-10)						
Dependent 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		All		With actual FXI data		All
Regressors	I	II	III	IV	V	VI	VII
<i>Interest rate differential</i> ⁶							
First difference			0.24 *	0.35 *	0.15	0.31	1.51 *
			(1.73)	(1.77)	(0.93)	(1.31)	(2.46)
<i>Country spread</i> ⁷							
First difference			-0.14 ***	-0.14 ***	-0.30 ***	-0.28 ***	-0.11 *
			(6.41)	(4.36)	(-7.36)	(4.79)	(-2.37)
<i>Intervention</i>							
Amount ⁸	0.16	-2.78 ***	0.08	-2.86 ***	-0.35	-1.82 **	-3.17 **
	(0.30)	(-3.83)	(0.16)	(4.05)	(0.64)	(-2.36)	(-2.63)
<i>R</i> 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	1024	1024	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. *** denotes significance level at 1 percent; **, at 5 percent, and *, at 10 percent. See Annex 3.2 for details.

² No other controls in the regression.

³ Other control variables (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 Second difference of the exchange rate or pace of appreciation.

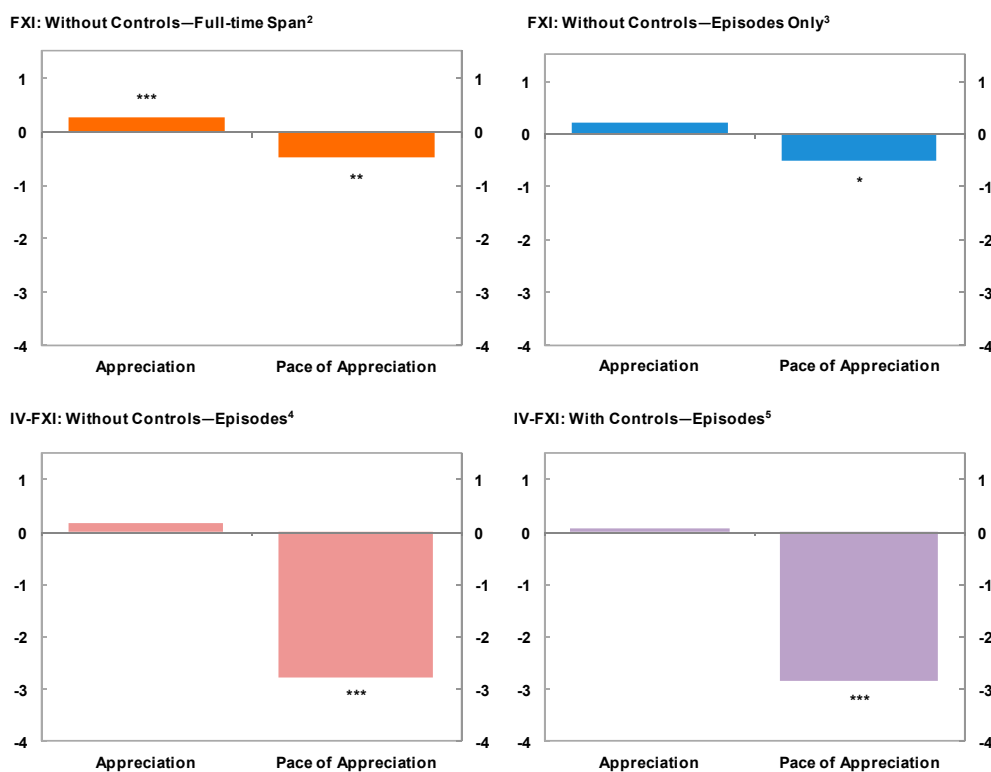
⁶ Domestic policy interest rate (or interbank rate) minus U.S. federal funds rate.

⁷ 5-year sovereign CDS spread (or EMBI spread when CDS spread is not available).

⁸ Intervention amount in percent of GDP.

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

Figure 13. Unveiling the Effect of FX Intervention—Results of Panel Approach under Different Specifications¹
(Coefficient of intervention variable in exchange rate equation)



Source: IMF staff calculations.

¹ Appreciation rate and 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 2004–10 (excluding the 2008–09 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 instrumented intervention variable, without controls, and over identified episodes only.

⁵ **IV-FXI: With Controls—Episodes** denotes model estimated with instrumented intervention variable, with controls, and over identified episodes only.

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 I). 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 II and III). 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 (see Fatum and King, 2005).
- 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 IV); however, this result seems to reflect other country characteristics that are correlated with transparency, as discussed below.

Table 3. Factors Affecting the Effectiveness of Intervention¹

Regressors	Modalities of Intervention			Financial Integration			Regional Comparisons						Exchange Rate Misalignment	
	Dependent Variable													
	Pace of Appreciation ²													
Sample of countries:	All			V	VI	VII	EM LA	EM Asia	Other EMES	All	EM LA	EM Asia		
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII		
<i>Interest rate differential</i> ³														
First difference	0.36 *	0.35 *	0.35 *	0.37 *	0.38 *	0.37 *	0.16	1.31 **	0.69	0.33	0.26	1.35 **		
	(1.79)	(1.74)	(1.77)	(1.86)	(1.89)	(1.85)	(0.67)	(2.48)	(1.44)	(1.63)	(0.80)	(2.56)		
<i>Country spread</i> ⁴														
First difference	-0.14 ***	-0.14 ***	-0.14 ***	-0.13 ***	-0.13 ***	-0.13 ***	-0.27 ***	-0.03	-0.35 ***	-0.14 ***	-0.33 ***	-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)		
<i>Intervention Amount</i> ⁵														
	-2.98 ***	-4.13 **	-2.86 ***	-4.86 ***	-9.00 ***	-9.44 ***	-1.81 **	-7.91 ***	-2.82	-2.13 ***	-1.52 *	-7.16 ***		
	(3.88)	(-2.53)	(4.02)	(4.60)	(-4.41)	(3.50)	(-2.14)	(-5.44)	(-1.60)	(-3.18)	(-1.87)	(-4.54)		
<i>Dummy of intervention</i> ⁶	0.06													
	(0.37)													
<i>Interaction with dummies of modalities</i>														
Dummy of discretionary setting ⁷		1.34												
		(0.86)												
<i>Rules with preannounced amounts</i> ⁸														
			-0.02											
			(0.00)											
<i>Transparency</i> ⁹														
				3.05 **										
				(2.54)										
<i>Interaction with dummy of capital account openness</i> ¹⁰														
					7.74 ***	9.07								
					(3.20)	(1.57)								
<i>Interaction with dummy of REER misalignment</i> ¹¹														
										-1.58 *	-6.53 ***	-2.24		
										(-1.72)	(2.54)	(-1.23)		
R ²	0.15	0.15	0.15	0.15	0.16	0.16	0.13	0.31	0.16	0.15	0.17	0.31		
Within	0.04	0.03	0.04	0.03	0.05	0.05	0.00	0.87	0.10	0.09	0.00	0.86		
Between	0.12	0.12	0.12	0.11	0.11	0.12	0.11	0.21	0.16	0.11	0.15	0.21		
Overall														
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*-statistics reported in parenthesis. *** denotes significance level at 1 percent; ** at 5 percent; and * at 10 percent. Other control variables (commodity prices and *DX*) are also included in the regression but not reported in the table. See Annex 3.2 for more details.² Second difference of the exchange rate or acceleration.³ Domestic policy interest rate (or interbank rate) minus U.S. federal funds rate.⁴ 5-year sovereign CDS spread (or EMBI spread) minus U.S. federal funds rate.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 (preannounced) amount-based rule.⁹ Dummy based on whether interventions are preannounced 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 of the REER and its 5-year backward-looking moving average. Dummy takes value 1 if the overvaluation gap is greater than 10 percent.

- 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 openness¹⁶ (column V): greater financial integration seems to reduce the effectiveness of intervention. Interestingly, when we control for financial integration (column VI), 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 VII–IX).
- 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 X–XII)

V. CONCLUSIONS

Over the past seven years, many central banks in LA have had a regular, and at times large, presence in FX markets. In most instances, this intervention was in one direction only, and coincided with easing of global financial conditions that put appreciation pressures on many EM currencies, including those of LA. 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—is able to detect a robust effect of intervention on 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.¹⁷

¹⁶ See Chinn and Ito, 2008.

¹⁷ For an in-depth normative discussion on some of these issues, see Eyzaguirre et al (2011) and *Fall 2010 and Spring 2011* editions of the *Regional Economic Outlook—Western Hemisphere*.

ANNEX 1. FOREIGN EXCHANGE INTERVENTION AND INTERNATIONAL RESERVES: DATA AVAILABILITY

	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						✓		
Malaysia						✓		
Mexico	✓				✓	✓	✓	✓
Peru	✓			✓		✓	✓	✓
Philippines						✓		
Polonia						✓		
Romania						✓		
Russia			✓ ²		✓	✓	●	✓
South Africa						✓		
Thailand					✓	✓	●	✓
Turkey	✓				✓	✓	●	✓
Uruguay	*			✓		✓	✓	✓
Australia	✓ ³				✓	✓	●	✓
Canada	✓					✓		
New Zealand			✓			✓		
Norway		✓ ⁴				✓		

Note: "●" indicates 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.¹⁸

- 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 nondeliverable.
- 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.¹⁹
- 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 and Mexico). Cross-currency swaps have been used only by Brazil (cupom cambial).²⁰

A number of considerations can influence the choice of instruments.²¹ 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

¹⁸ 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.

¹⁹ 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.

²⁰ 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/U.S. 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.

²¹ See also Canales-Kriljenko and others, 2003; Shogo and others, 2006; and Blejer and Schumacher, 2000.

unwinding of derivative positions, once appreciation pressures have receded, seems easier than the unwinding of the reserve accumulation that would result from spot transactions.

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 made use of 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 US\$180 million) whenever the exchange rate fell more than 5 percent below its average of the previous 20 working days.²² A similar rule was introduced in Guatemala in 2005, allowing the central bank to purchase specific amounts (US\$8 million per transaction and up to US\$32 million per day during 2010), whenever the exchange rate fell below its average of the previous 5 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 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 pre-announced 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)²³ 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.

²² 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.

²³ This mechanism was used by Banco de México between 1996 and 2001. See Sidaoui (2005).

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