CEMLA
CENTER FOR LATIN AMERICAN MONETARY STUDIES

MONETARIA

English Edition

Volume II, Number 1
January-June 2014

MONETARIA

English Edition

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Monetaria is an academic journal published by CEMLA. It provides an international forum for publishing original current high level economic research, both in Spanish and English (edited in two volumes), covering both theoretical and empirical issues and, preferably, using these jointly to possibly influence the design of public policies. It is available printed and electronically <www.cemla.org>. For articles and essays submission: <publicaciones@cemla.org>. The opinions expressed in **Monetaria** are those of the authors, and do not necessarily reflect those of the Center and its authorities, the Editorial Committe, or the organization to which the authors are affiliated. Indexed in: EBSCO and Research Papers in Economics (RePec).

Analysis of the Real Exchange Rate in the Dominican Republic: A Study Based on the International Monetary Fund's Assessment Methodologies

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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

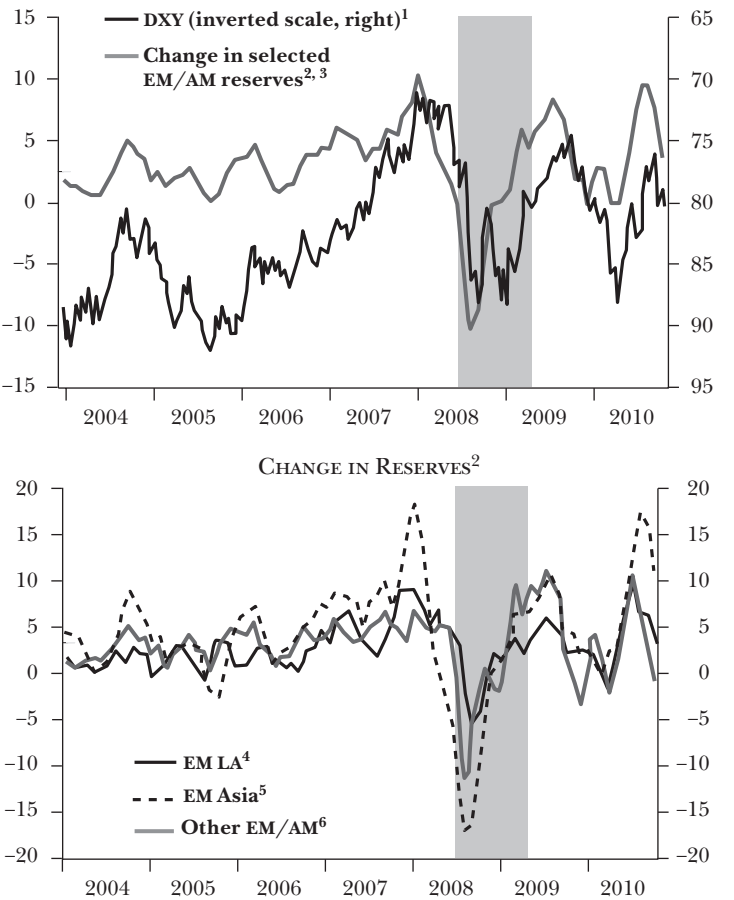
This paper examines *sterilized* foreign exchange intervention (FXI) practices and their effectiveness in mitigating appreciation pressures. It relies on a new qualitative and quantitative database for a panel of 15 economies covering the period 2004-2010, with special focus on Latin America (LA). In 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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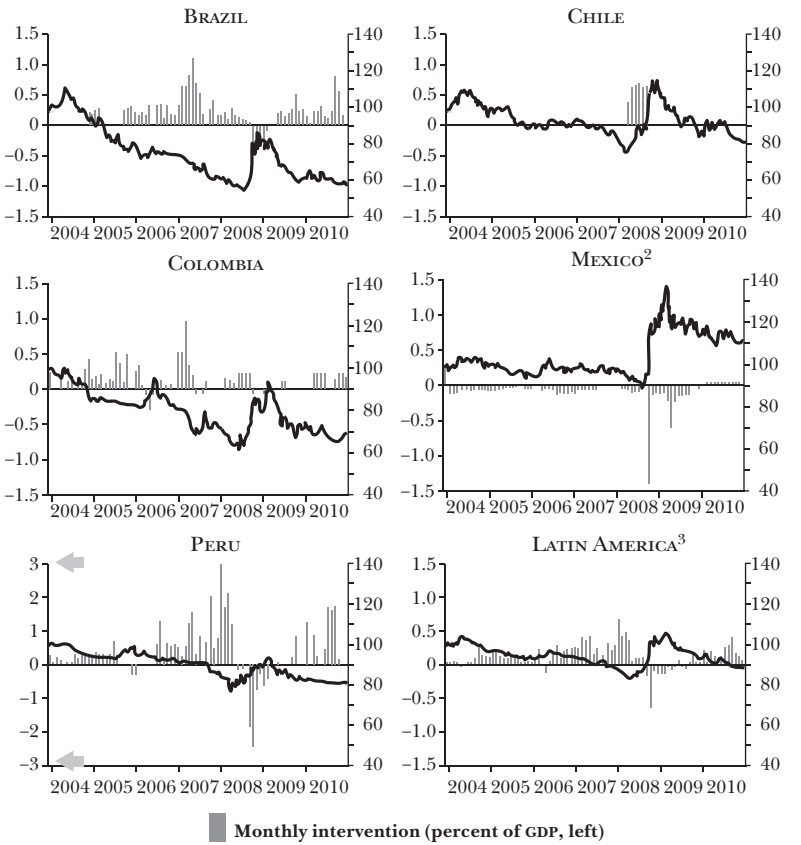
[2] There is often little clarity on the precise definition of FXI. Here we consider FXI to be any operation that affects the central bank's net foreign exchange (FX) position. In practice, however, high frequency data on central banks' FX position is often unavailable, requiring the use, instead, of 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

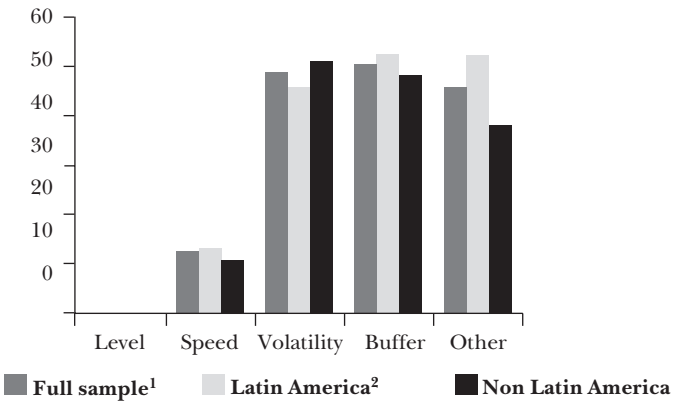
STYLIZED FACTS OF FOREIGN EXCHANGE PURCHASES, 2004-2010

		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.

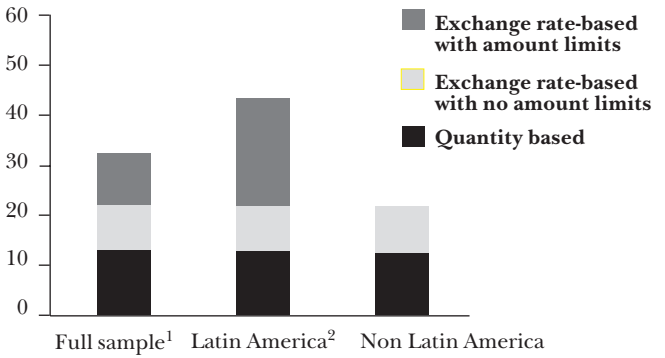
named *currency war*). Furthermore, it is noteworthy that a 2005 BIS' survey of EM central bankers reported that a significant share of them intervened to *influence* the exchange rate level or to *lean-against-the-appreciation-wind* (BIS, 2005). This seems to suggest a tension between declared and actual 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

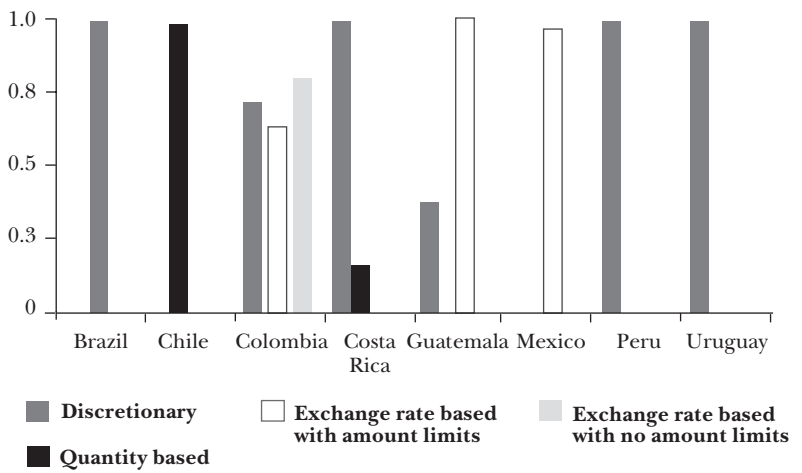
The dominant market for interventions across regions is the spot market (Figure 6), possibly reflecting a higher degree of

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.

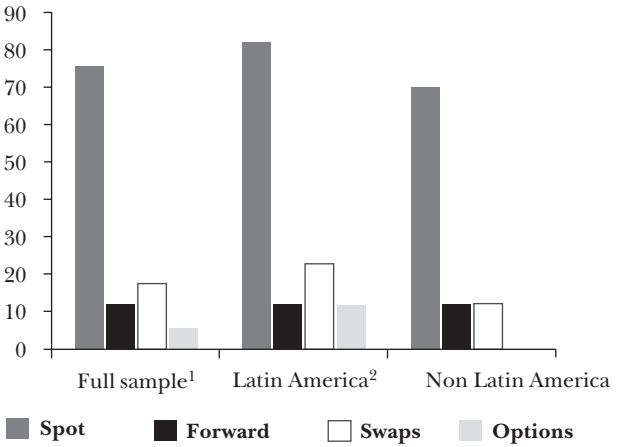
[a] Declared intervention rules according to official central bank statements (e.g., press releases, annual reports, web site, etc.). Exchange rate-based rules are triggered by some exchange rate-related measure (e.g. change or volatility). If the amount of intervention is specified then it is considered 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.

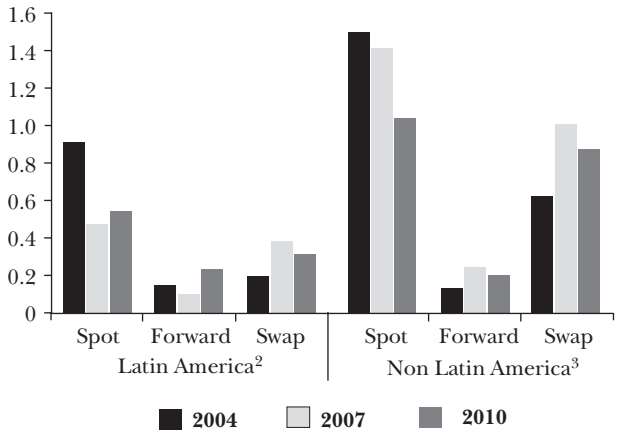
for a discussion on considerations for the choice of different instruments.)

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

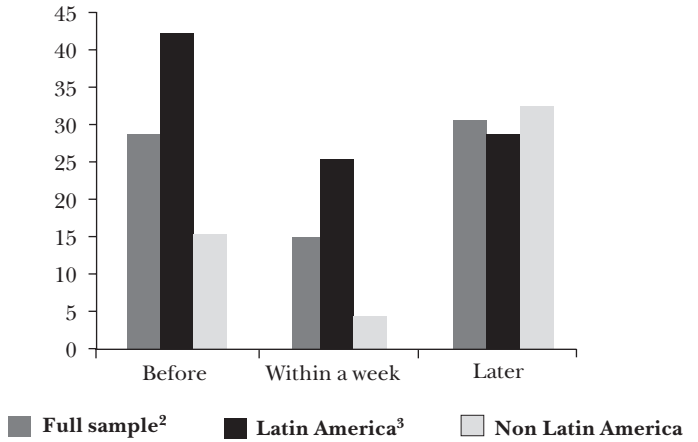
The extent to which FX intervention can affect the exchange rate is not obvious. Any shock, including an operation by the central bank, that could trigger a move of the currency away from its equilibrium value (i.e., implied by fundamentals or market perceptions of these) should be arbitraged away by 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

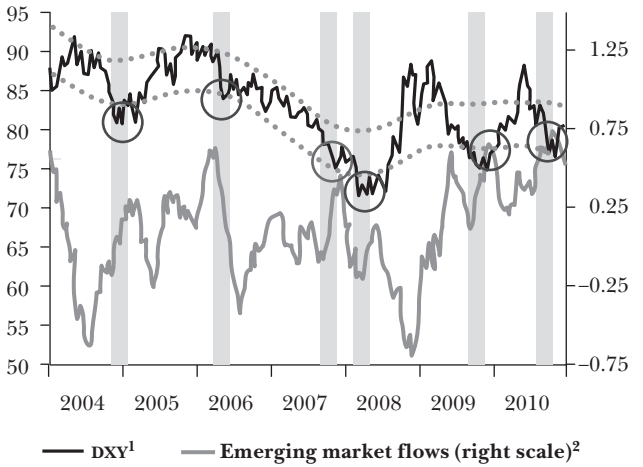
The second stage entails estimating a behavioral equation linking movements in the exchange rate to central bank interventions. As mentioned before, we instrumentalize the intervention variable to mitigate the endogeneity problem by using the *shadow* intervention value obtained from the predicted values 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.

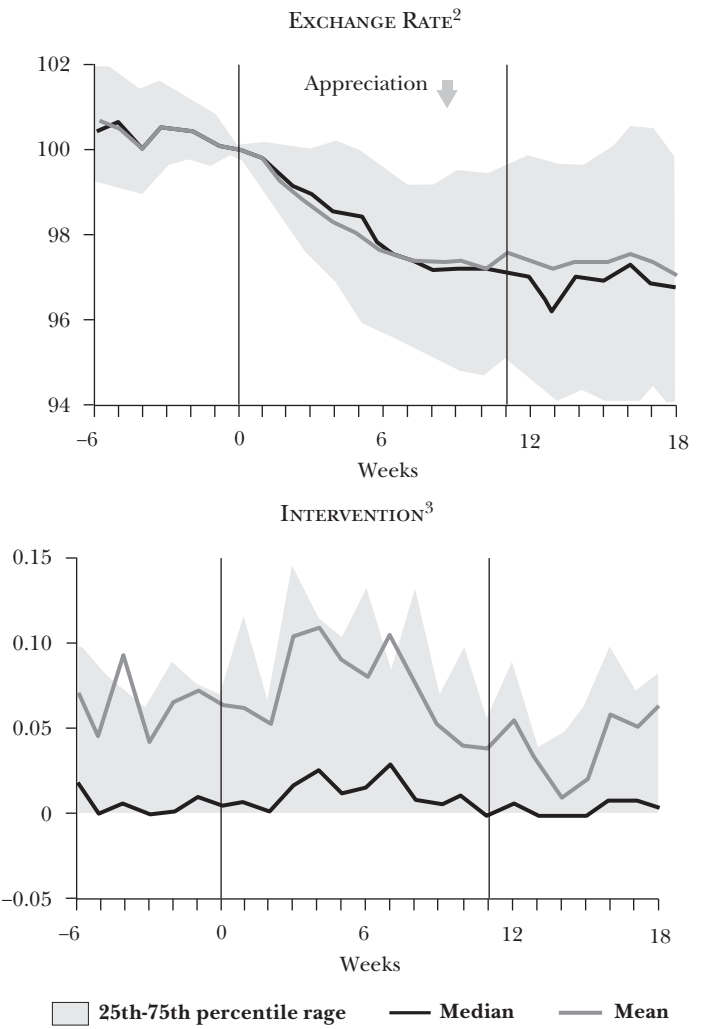
It should be noticed that in addition to the instrumentalization of the intervention variable, the focus on short (12-week) windows around a global shock helps to mitigate residual endogeneity (from having an imperfect instrument), because this ensures that the main source of disturbances is the identified 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

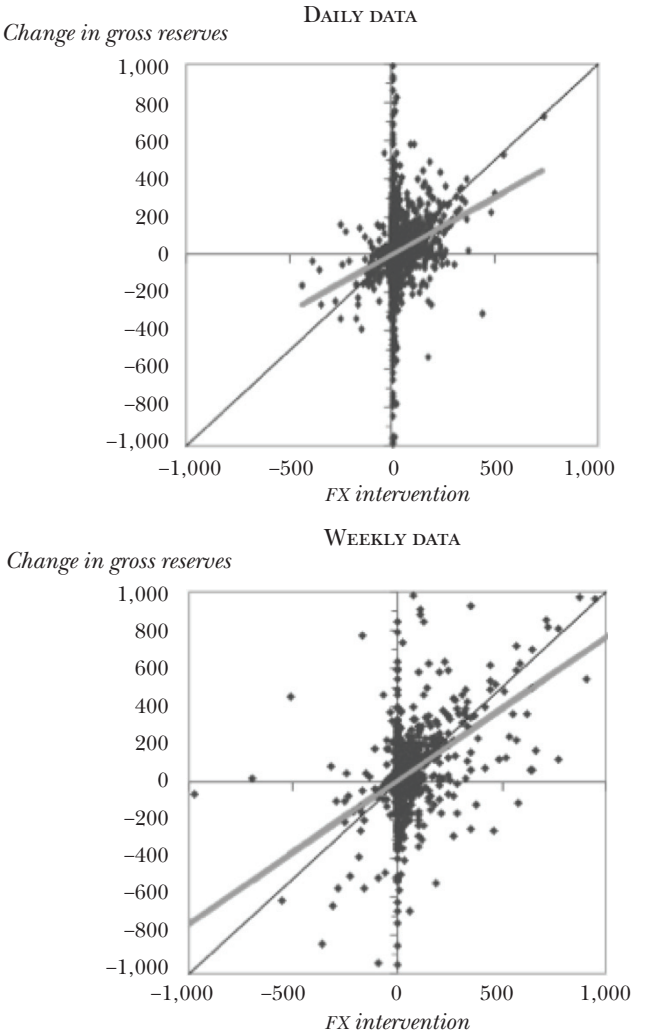
[14] Results of the reaction function should be interpreted as reflecting the *average* behavior over the sample period, and thus may not reflect current preferences.

[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

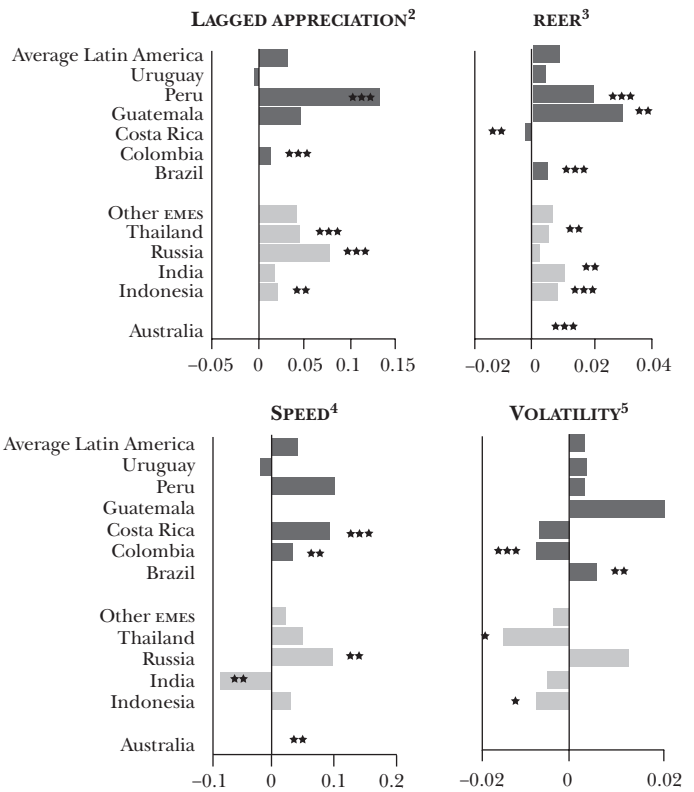
The econometric results of the second stage (exchange rate equation) do not detect an immediate impact of interventions on the rate of appreciation, but do find statistically significant effects on the *pace* (acceleration) of appreciation (Table 2, columns 1 and 2). The coefficient point estimates suggest 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.

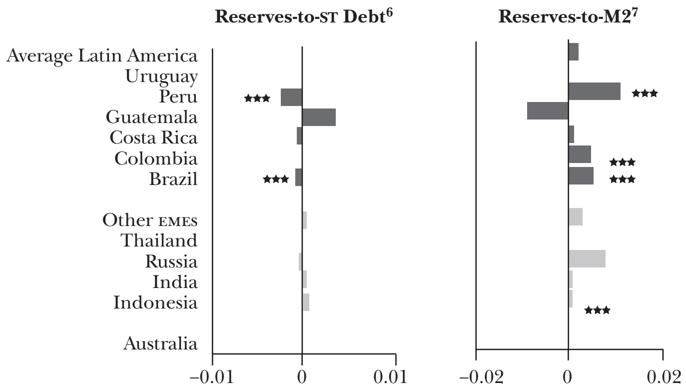
[1] Results of a Tobit model estimated for each country individually, on the basis of non-overlapping weekly data, over the period for which either intervention or reserves data is available at least on a weekly frequency. Results should be interpreted as reflecting *average* preferences over the sample 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

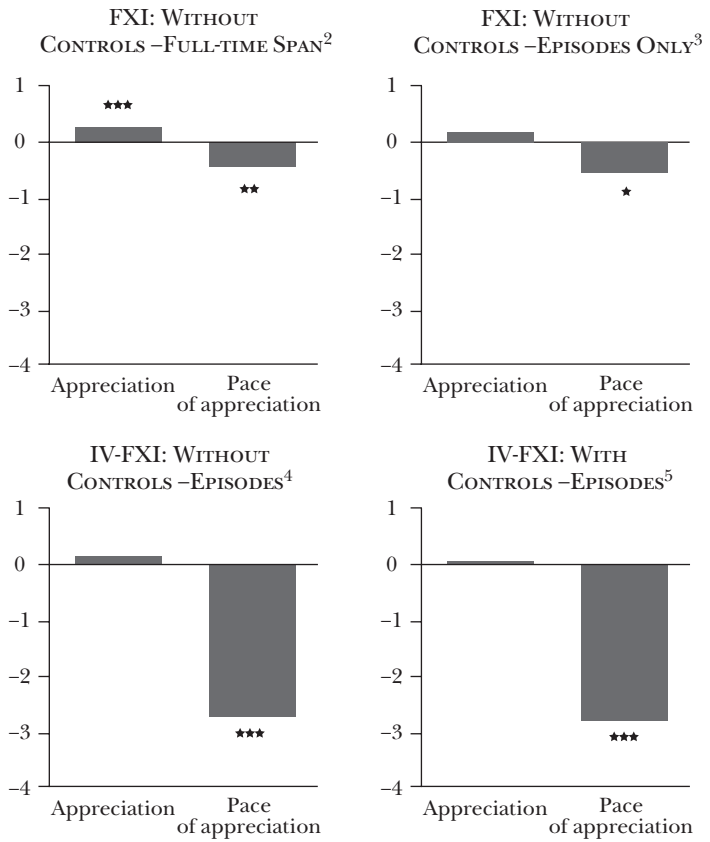
[17] This finding could be driven by the fact that rules are often designed to address exchange rate volatility issues. We thank an anonymous referee for raising this point. However, Adler and Tovar (2013) have found evidence that, at least temporarily, a regime shift toward preannounced rule-based FX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

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

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Anchoring of InflationExpectations after Adverse Supply Shocks

Abstract

In order to create an environment of low and stable inflation in Mexico it has been necessary to generate a framework for the conduction of monetary policy focused on preserving an environment of price stability along with fiscal discipline. In this context, this paper describes some structural achievements to control inflation that have been attained in Mexico. In addition, it shows empirical evidence in favor of the anchoring of inflation expectations, particularly those for the medium

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and long term, being recently strengthened. It presents an analysis considering three episodes in which inflation in Mexico was subject to different supply shocks, and it finds that of the episodes analyzed, which were within the period 2004-2012, it was during the episode observed in 2012 when inflation expectations showed greater stability, which suggests a strengthening of the credibility of the Bank of Mexico's commitment to price stability.

Keywords: inflation expectations, anchoring inflation expectations, cost-push shocks, monetary policy, Mexico.

JEL classification: E52, E58, E65.

INTRODUCTION

After the episodes of high inflation during the seventies and eighties, when several advanced economies recorded double digit inflation and some emerging economies even experienced hyperinflation, a consensus emerged that monetary authorities should mainly focus on achieving and maintaining an environment of low and stable inflation. Moreover, some central banks that had not been autonomous became so, while monetary authorities also placed increasing emphasis on improving their communication strategies and improving their transparency. This framework for the conduct of monetary policy contributed to a prolonged period of low inflation in advanced economies, as well as in some emerging ones. This, in turn, strengthened the credibility of monetary policy and the anchoring of inflation expectations, leading to a positive feedback between monetary policy, low inflation and well-anchored inflation expectations.[1]

In the case of Mexico it is important to point out that since 1994 the country has had an autonomous central bank whose main priority is to ensure the stability of the domestic currency's purchasing power. Since 2001 Banco de México has conducted monetary policy under an inflation targeting regime.[2] In

[1] Mishkin and Schmidt-Hebbel (2007).

[2] The Monetary Program for 2001 published by Banco de México

particular, it was given the task of attaining an annual inflation for the consumer price index (CPI) of 3%.[3] This framework for the conduction of monetary policy, together with prudent fiscal policy, has allowed for controlling the phenomenon of inflation in Mexico. Among the most outstanding structural achievements in controlling inflation are: *i)* the reduction in the level, volatility and persistence of inflation; *ii)* a pricing process that resembles the way prices are determined in economies with a long history of price stability; and *iii)* a performance of inflation expectations that is consistent with an environment of low and stable inflation. The aforementioned has also allowed for a more efficient functioning of the economy's pricing system. The latter has been reflected in, among other things, a decrease of the pass-through effect of exchange rate fluctuations, commodity price increases and tax adjustments to inflation.

These achievements have helped to increase the credibility of Banco de México's commitment to price stability. As will be assessed in this paper, this prevents the supply shocks which affect inflation from negatively influencing inflation expectations so that such shocks just have a transitory impact on inflation.[4] In this respect, this paper analyzes three episodes between 2004 and 2012 when inflation in Mexico was affected by supply shocks. These episodes correspond to 2004, 2006-2008 and 2011-2012. The latter period stands out because inflation expectations exhibited greater stability.

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presents the most important reasons for choosing this scheme, among which announcing an official target for inflation and continuous efforts to improve transparency and communication with the public stand out.

[3] However, given that there is a wide range of factors that influence the behavior of inflation in the short-term, which are beyond the central bank's control, Banco de México has set a variability interval of plus/minus one percentage point around the 3% target. On this matter, Banco de México has emphasized that said interval is not an indifference range, but a practical way of representing the uncertainty associated with the behavior of inflation.

[4] For a more detailed explanation of supply shocks and their effect on inflation see the Monetary Program for 2012 and 2013.

The paper is organized as follows: the first section briefly describes some of the achievements that have been made in Mexico regarding price stability. The second section analyzes the performance of inflation expectations during the three periods in which different supply shocks affected inflation in Mexico. Finally, some conclusions are presented.

1. PROGRESS IN THE CONSOLIDATION OF PRICE STABILITY

A monetary policy oriented at ensuring price stability, together with fiscal discipline, has enabled inflation to be controlled in Mexico. In this regard, Ramos-Francia and Torres (2005) describe monetary policy in Mexico after the crisis of 1995, showing that once a sustainable fiscal position was reached, the inflation targeting scheme helped anchor inflation expectations and steadily reduce inflation. In this context, some of the structural achievements that have been made in controlling inflation in Mexico are described below.

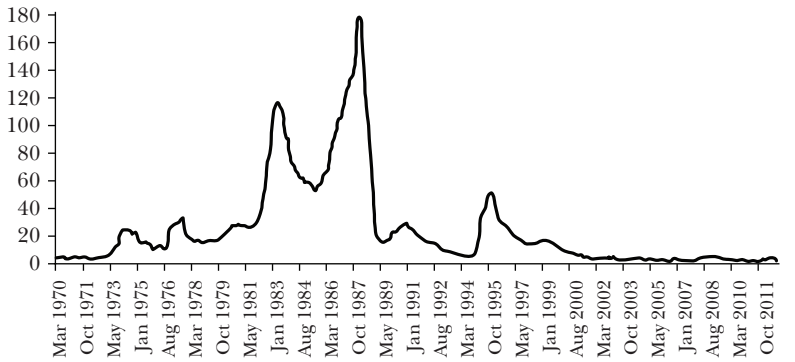
1.1 Level, Volatility and Persistence of Inflation

Headline inflation in Mexico has declined gradually from levels of over 100% during the decade of the eighties to the values of around 3% observed recently (Figure 1). Inflation has therefore been converging toward the 3% target. The technical chapter "Change in the Nominal System of the Mexican Economy in the Early 2000's," published by Banco de México in the *Quarterly Report* of October-December 2010, presents empirical evidence for the fact that headline inflation has undergone some structural changes. In particular, since approximately 2001 inflation has fluctuated modestly around a value that is the lowest since CPI calculations began in Mexico. Thus, inflation has changed from being a highly volatile process into a more stable one.

Regarding the reduction in the inflation level in Mexico, a process of convergence of inflation in Mexico toward that of the United States has been observed during the last decade. The

Figure 1

HEADLINE INFLATION
(in annual percentage)



Source: Banco de México and INEGI.

box "Comparison of Inflation Experience in Mexico and the U.S. during the Last Decade," published by Banco de México in the *Quarterly Report* of January-March 2012, and based on Cortés et al. (2012), presents empirical evidence for such process of convergence.

Inflation persistence in Mexico has decreased. Inflation is said to be highly persistent when the shocks affecting it, such as fluctuations in certain relative prices like foodstuffs or commodities, have a prolonged impact. Chiquiar et al. (2007) study some statistical properties of inflation in Mexico during 1995 and 2006, employing techniques to identify changes in the persistence of time series. The results suggest that inflation in Mexico shifted from being a non-stationary process to a stationary one toward the end of the year 2000 or the start of 2001.

1.2 Pricing Process in the Economy

In addition to the aforementioned, progress in controlling inflation has also caused the pricing process in Mexico to become more similar to the way prices are determined in economies that managed to achieve price stability many years ago. In countries

that experience an environment of low and stable inflation the price formation process is characterized by three main aspects: *i)* prices exhibit downwards flexibility; *ii)* the magnitude of price adjustments is moderate; and, *iii)* predominance of time-dependent price revision strategies, where firms update their prices in order to make adjustments in the predetermined periods.

The technical chapter "Features of the Price Formation Process in Mexico: Evidence from CPI Micro Data," published by Banco de México in the *Quarterly Report* of October-December 2011 and based on Cortés et al. (2011), uses the micro data employed for calculating the CPI to study the pricing process in Mexico. This study describes how the downward flexibility of prices has increased over the last decade and shows evidence that the proportion of price reductions in Mexico is currently similar to that observed in the United States. It has also been found that, unlike during the past, the magnitude of price changes in Mexico is moderate nowadays.

In addition to the above, evidence was found that time-dependent pricing strategies currently predominate. This as opposed to the way in which prices were formed during the past decade, when state-dependent strategies were followed, where firms updated their prices according to the circumstances faced by such firms at the macroeconomic level. Thus, the way in which prices are currently formed in the Mexican economy is in line with a stable and predictable macroeconomic environment. Moreover, the box "Relative Price Changes and Inflation Convergence toward the 3 Percent Target," published by Banco de México in the *Quarterly Report* of April-June 2013, presents evidence that the aforementioned features of the price formation process were not affected by the supply shocks experienced by the Mexican economy during 2012 and at the start of 2013.

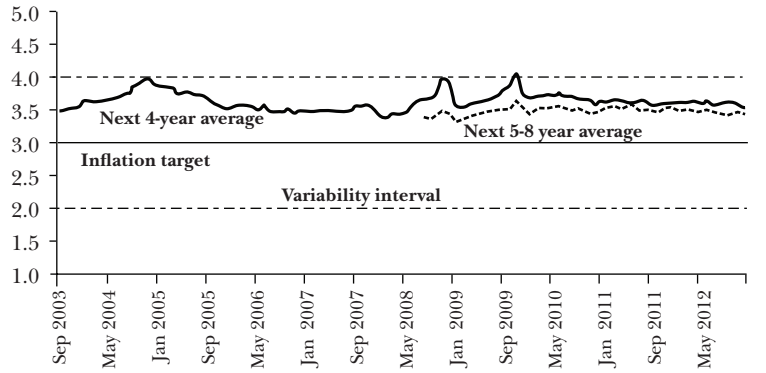
1.3 Performance of Inflation Expectations

Under this context, positive results in the fight against inflation have led to a high degree of credibility regarding Banco de México's commitment to price stability. The latter has also

allowed the anchoring of economic agents' inflation expectations (Figure 2).

Figure 2

HEADLINE INFLATION EXPECTATIVES
(in annual percentage)



Source: Banco de México Survey of Expectations.

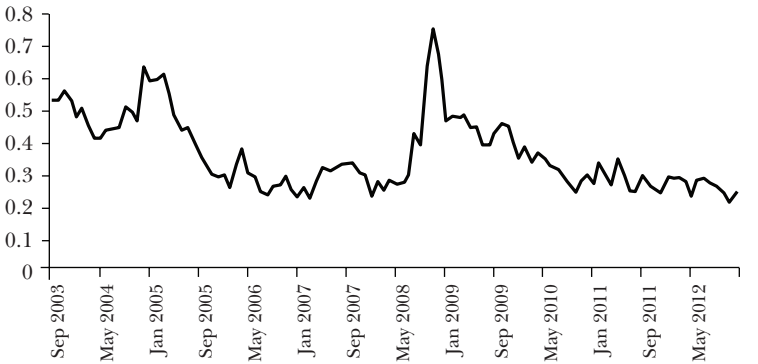
Efforts to consolidate price stability in Mexico have been associated with a favorable evolution of inflation expectations. The aforementioned is documented in the technical chapter "Evolution of Inflation Expectations in Mexico," published by Banco de México in the *Quarterly Report* of July-September 2011, and in García Verdú (2012). It is therefore possible to highlight some features of the dynamics of inflation expectations in Mexico. First, their value has gradually converged toward the inflation target. Second, their dispersion has decreased as a result of the low uncertainty conditions associated with an environment of low and stable inflation (Figure 3). Finally, the behavior of inflation expectations shows that the perception of upside risks to inflation performance has declined significantly relative to the perception of downside risks to it.

The behavior of inflation expectations is crucial for maintaining price stability. This is due to the fact that inflation expectations can influence observed inflation as price adjustments made by economic agents in each period mainly depend

Figure 3

STANDARD DEVIATION OF EXPECTED HEADLINE INFLATION OVER THE NEXT FOUR YEARS

(standard deviation)



Source: Banco de México Survey of Expectations.

on the inflation that is expected in future periods. Thus, the credibility of Banco de México's commitment to price stability is essential in order for the institution to effectively maintain an environment of low and stable inflation.

1.4 Functioning of the Price System

Price stability has contributed to a smooth and efficient functioning of the economy's price system. This means that relative prices efficiently transmit information on prevailing conditions in each market, particularly regarding the relative scarcity of goods and services. Prices therefore serve as signals for coordinating the production, distribution and consumption of goods and services, encouraging the efficient allocation of resources inside the economy. This can be illustrated with some examples.

First, the reduction of the pass-through of exchange rate fluctuations to domestic prices that has been observed in Mexico over the last ten years. The aforementioned has been documented in the technical chapter "Exchange Rate Pass-through

to Prices," published by Banco de México in the *Quarterly Report* of January-March 2011, as well as by Capistrán et al. (2011) and Cortés (2013).

Second, the fact that increases in the relative prices of certain goods, such as commodities that usually exhibit highly volatile behavior, have transitory effects on inflation. Thus, the box "Considerations on the Impact of International Commodity Price Fluctuations on Consumer Prices in Mexico," published by Banco de México in the *Quarterly Report* of April-June 2012, concludes that in the case of Mexico there is no evidence of second-round effects on the pricing process in Mexico.

Finally, tax increases, such as those corresponding to the fiscal adjustments that came into force in 2010, only lead to temporary increases in inflation (only once the impact of the taxes is included in the price of taxed goods and services, do such prices stop increasing) in the absence of other shocks. On this point, the box "Evidence on the Absence of Second-round Effects on the Pricing Process Associated with the Tax Adjustments for 2010 Approved by Congress," published by Banco de México in the *Quarterly Report* of January-March 2010 did not find evidence that the fiscal adjustments which came into force in 2010 had contaminated the price formation process in the economy.

Thus, the reduced pass-through of exchange rate fluctuations, changes in commodity prices and tax adjustments to inflation is associated with the absence of second-round effects. This suggests that inflation expectations, particularly long-term expectations, have not been negatively affected by shocks such as those referred to. The following section therefore analyzes in detail the behavior exhibited by inflation expectations in Mexico upon supply shocks.

2. RESPONSE OF INFLATION EXPECTATIONS TO SUPPLY SHOCKS

As described above, variations in the relative prices of goods and services have only a transitory impact on inflation in Mexico, which tends to dissipate rapidly. The anchoring of inflation

expectations has been crucial to this process because, as mentioned previously, their evolution affects the performance of inflation. In general terms, inflation expectations are said to be anchored when they are relatively insensitive to inflation shocks. On this point, it is worth pointing out that the performance of medium and long-term inflation expectations is most relevant, given that short-term ones naturally increase to some extent as a result of such shocks.[5]

The degree to which inflation expectations are anchored does not necessarily remain constant over time. Both timing and magnitude of its variations can be the result of different factors, among which the central bank's conduction of monetary policy stands out. Thus, a monetary policy oriented at procuring price stability, while generating an environment of low and stable inflation, can contribute to the anchoring of inflation expectations (Figure 4).

In this sense, several empirical works have explored the relation between the framework for the conduction of monetary policy and the behavior of inflation expectations. In the case of advanced economies, Gürkaynak et al. (2010) found that long-term inflation expectations were better anchored in Sweden, an economy that had had an inflation targeting regime for several years, than in the United States, where said regime had still not been formally implemented. The work also shows evidence that the anchoring of long-term inflation expectations in the UK has strengthened since the Bank of England gained legal independence in the nineties. In the case of emerging economies, Pooter et al. (2013) study the behavior of long-term inflation expectations in Brazil, Chile and México, finding that expectations have become better anchored in recent years. However, they conclude that it is still very premature to say they are well-anchored.

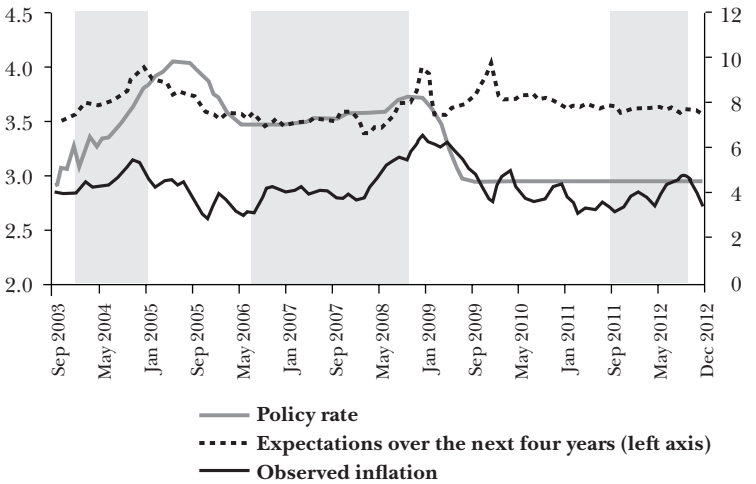
In addition to the above, Capistrán and Ramos-Francia (2010) examine the effect of having an inflation targeting regime on

[5] In general terms, the expectation referring to an indicator formulated for the next 12 months or less is considered a short-term expectation.

Figure 4

INFLATION, EXPECTED INFLATION OVER THE NEXT FOUR YEARS AND POLICY RATE[1]

(annual percentage)



Source: Banco de México and INEGI.

[1] The gray columns indicate supply-shock episodes.

the dispersion of professional analysts' inflation forecasts using a panel of 26 countries, including 14 with inflation targets, Mexico among them. These authors find that the dispersion of long-term inflation expectations is lower in countries that have adopted inflation targeting regimes, especially in the case of emerging market economies such as Mexico.

This section analyzes the way in which inflation expectations in Mexico have responded to supply shocks that affected inflation.[6] In particular, three episodes between 2004 and 2012 in which inflation in Mexico was affected by past supply shocks are analyzed. These correspond to 2004, 2006-2008 and 2011-2012. The periods of supply shocks were determined based on

[6] This paper considered the inflation expectations that were obtained from the survey Banco de México conducts among private sector specialists.

the *Quarterly Report* and the "Monetary Policy Decision Announcements." This is due to the fact that the monetary policy actions implemented by the central bank are based on the members of the Board of Governors' interpretation of the economic situation and the outlook for inflation. This interpretation is also communicated to participants in the market and the general public through different media, such as the *Quarterly Report* and the "Monetary Policy Decision Announcements."

We therefore review such media, as well as the international prices of commodities (Figure 5), in order to identify the periods when concerns were raised regarding the appearance of supply shocks. For each of these periods we describe the observed shocks, their impact on inflation and its expectations, mainly long-term, as well as the monetary policy actions that were implemented. The period 2011-2012 stands out because inflation expectations exhibited greater stability, which suggests increased credibility in the monetary authority's commitment to price stability.[7] An econometric exercise is also presented which finds evidence that the anchoring of inflation expectations has indeed strengthened during recent years.

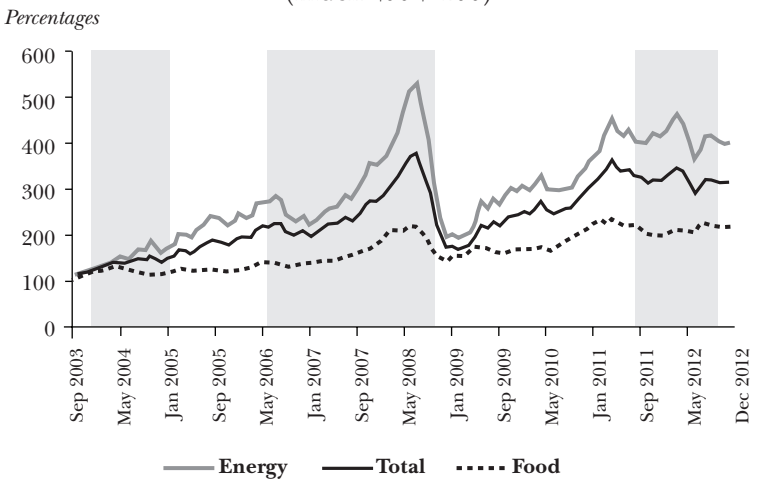
2.1 2004 Episode

The first episode of supply shocks analyzed in this paper corresponds to 2004, when the Mexican economy was subject to the following shocks: increases in the international prices of

[7] Besides the aforementioned, toward the end of the first quarter and start of the second quarter of 2013 another episode of supply shocks was observed and, although short lived, this led to a rebound in inflation. In particular, the frosts that occurred in March damaged the production of some crops. An outbreak of avian flu also affected the prices of eggs and chicken meat. Nevertheless, medium and long-term inflation expectations were not affected and headline inflation swiftly regained its downward path once the referred shocks had dissipated.

Figure 5

INTERNATIONAL PRICES OF COMMODITIES[1]
(index 2002=100)



Source: International Monetary Fund.
[1] The gray columns indicate supply-shock episodes.

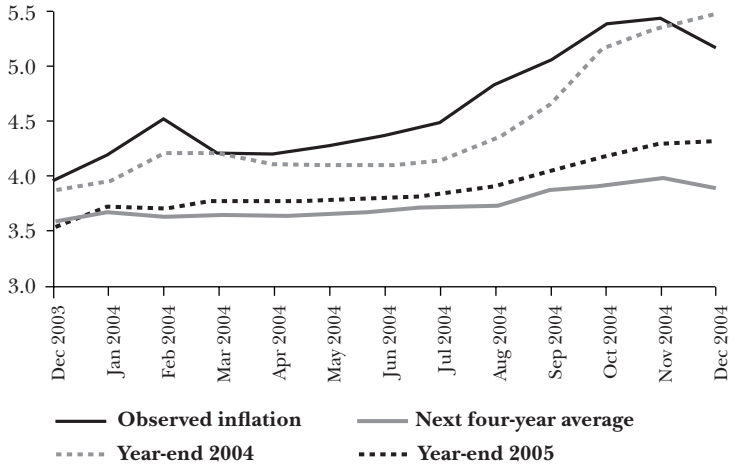
different commodities, increments in the prices of some goods and services administered and regulated by the government and increases in the prices of certain agricultural products due to climatic factors.

In this context, during 2004 annual headline inflation recorded considerable growth, shifting from 3.98% in December 2003 to 5.43% in November 2004 (Figure 6). Inflation expectations for different horizons gathered in Banco de México's survey were also affected (Figure 6).[8] In particular, those corresponding to inflation for the next four years went from 3.57% in December 2003 to 3.91% in December 2004. As for monetary policy, the central bank increased the *corto* (the level of commercial banks' current account balances at Banco de México) on nine occasions

[8] The inflation expectations referred to throughout this section correspond to the average of inflation expectations collected in Banco de México's survey.

Figure 6

SUPPLY SHOCK EPISODE 1: OBSERVED AND EXPECTED INFLATION
(annual percentage)



Sources: Banco de México and Banco de México Survey of Expectations.

during 2004. Thus, the interbank funding rate increased from its lowest level registered in the year, 4.73% recorded on January 19, to 8.75% on December 31 (Figure 7).

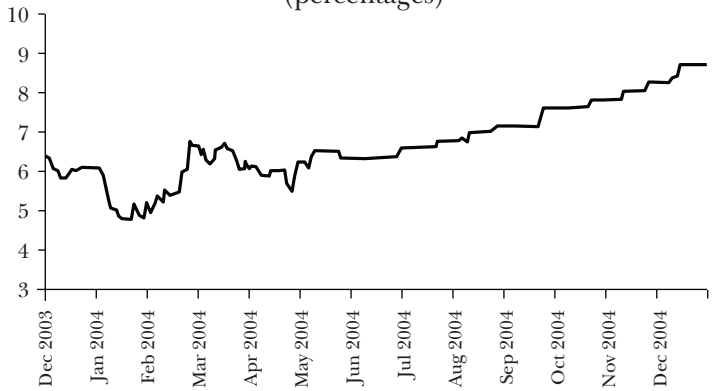
2.2 2006-2008 Episode

The second supply shock episode corresponds to the period between the second half of 2006 and the third quarter of 2008, when the following events took place: increases in the international prices of commodities, increments in some agricultural products' prices due to climatic conditions, and the approval of tax reform in September 2007 establishing new taxes.

Annual headline inflation increased from 3.06% in July 2006 to 4.21% in March 2007. In the following months, annual headline inflation remained at high levels, fluctuating around 4%. It then grew significantly throughout 2008, reaching 5.47% in September that year (Figure 8). As for the behavior of inflation

Figure 7

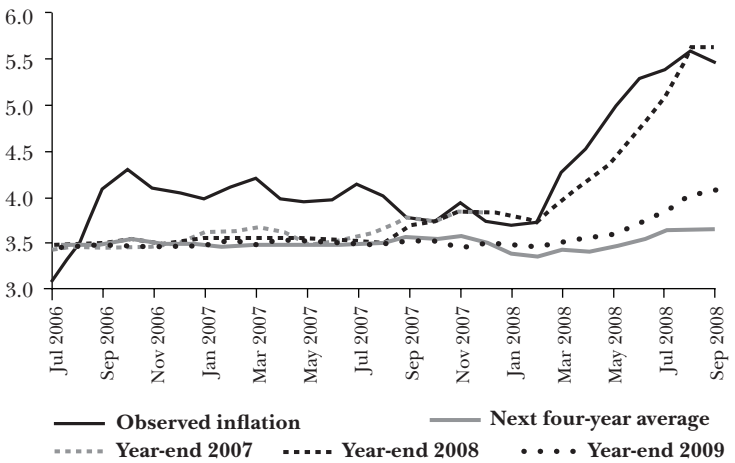
SUPPLY SHOCK EPISODE 1: POLICY RATE
(percentages)



Source: Banco de México.

Figure 8

SUPPLY SHOCK EPISODE 2: OBSERVED AND EXPECTED INFLATION
(annual percentage)



Source: Banco de México and Banco de México Survey of Expectations.

expectations, those for a horizon of less than a year deteriorated insofar as inflation rebounded. Meanwhile, inflation expectations for the next four years remained close to 3.5% from mid-2006 to December 2007. However, they grew during 2008, reaching 3.66% in September that year.

Banco de México tightened monetary conditions in April and October 2007.[9] Thus, the target bank funding rate went from 7% to 7.25% in April and, subsequently, located at 7.5% from October onwards. It also decided to raise the target for the target overnight interbank interest rate by 25 basis points consecutively in June, July and August 2008. Thus, the referred interest rate shifted from 7.5% to 8.25% (Figure 9).

2.3 2011-2012 Episode

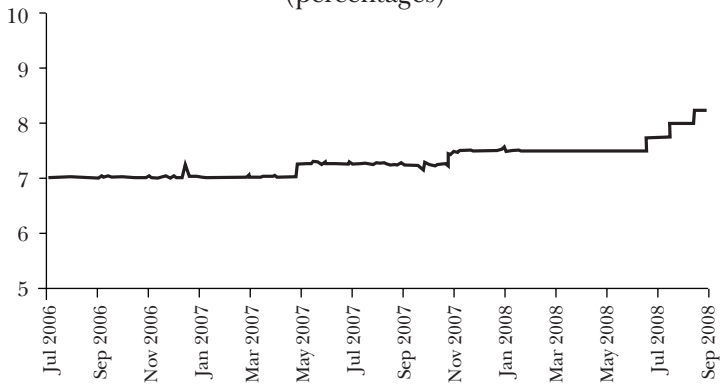
The last episode corresponds to the period from the third quarter of 2011 to the third quarter of 2012. During this period, the Mexican economy was affected by supply shocks, mainly domestic ones: the relative prices of some agricultural goods increased due to climatic and sanitary factors, and exchange rate depreciation episodes were observed in the period.

Headline inflation, which had been 3.14% in September 2011, surpassed the upper bound of the variability interval in June 2012, recording a level of 4.34% in the referred month. Later, it continued to increase until it reached 4.77% in September (Figure 10). As for the evolution of inflation expectations, although short-term expectations increased, medium and long-term expectations remained relatively stable, unlike during the previous episodes. In particular, longer-term expectations remained anchored within the variability interval established around the inflation target. Inflation expectations for the next

[9] It is important to mention that during the period analyzed in this section, Banco de México changed the operational target for monetary policy. In particular, on January 21, 2008, Banco de México adopted the overnight interbank interest rate as an operational target instead of the current account balance that commercial banks maintain at the central bank (the *corto*).

Figure 9

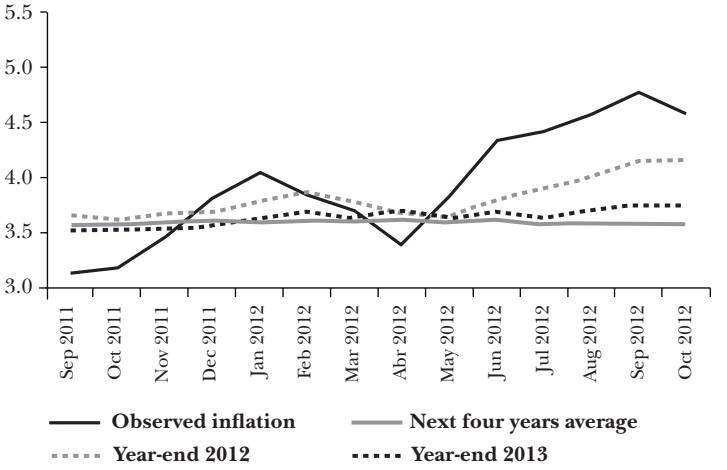
SUPPLY SHOCK EPISODE 2: POLICY RATE
(percentages)



Source: Banco de México.

Figure 10

SUPPLY SHOCK EPISODE 3: OBSERVED AND EXPECTED INFLATION
(annual percentage)



Source: Banco de México and Banco de México Survey of Expectations.

four years changed from 3.56% in September 2011 to 3.60% in September 2012. In this context, during the period in question the target for theovernight interbank interest rate remained unchanged.

Table 1 in Appendix A shows the performance of inflation expectations during the third episode of supply shocks as compared to the two previous episodes. Inflation expectations for the next four years increased less during the third episode than in the previous ones. The comparison between the first and third episodes is particularly relevant given that, even though the rise in inflation was greater in the third episode with respect to the first one, the growth of inflation expectations was lower. This would suggest that inflation expectations are currently better anchored.

Regarding the comparison between the second and third episodes, it is important to point out that the latter was shorter and that both inflation and its expectations increased less. As a consequence, based on this descriptive analysis, it is unclear whether the lower response of inflation expectations was the result of a more solid anchoring or the smaller impact of shocks on inflation. Therefore, a more formal analysis is required. The following section therefore presents an econometric exercise analyzing the evolution of the anchoring of inflation expectation during recent years.

2.4 Econometric Exercise

This section presents an econometric exercise to analyze how inflation shocks have affected short and long-term inflation expectations in Mexico. This is done using the methodology of Mariscal, Powell y Tavella (2013) as a reference. The data employed corresponds to inflation expectations for the next 12 months and for the next four years taken from the monthly survey on this topic that Banco de México conducts among private sector analysts. Meanwhile, observed annual inflation corresponds to that published on a monthly basis by the National Institute of Statistics and Geography (*Instituto Nacional*

de Estadística y Geografía, INEGI). The period of analysis corresponds to 2004-2012. Based on the referred sample, the following regression was estimated:

$$E_t\left(\pi_{t+i}\right)=\alpha+\gamma E_{t-1}\left(\pi_{t+i}\right)+\delta Max\left\{\pi_{t-1}-\pi^*,0\right\}+\epsilon_t\,,$$

where π is the annual inflation rate, π^* is Banco de México's permanent inflation target. The subindex *t* refers to the month in which the inflation survey was conducted and E_t refers to the expectation at the moment *t*. For instance, $E_t\left(\pi_{t+12}\right)$ considers the inflation expectation at the moment *t* for the following 12 months.

The calculations were made with a 36-month moving window. Thus, the specification presented above is estimated employing information available on inflation expectations for the next 12 months and for the next four years.

The result this exercise attempts to identify corresponds to the response of inflation expectations to inflation shocks throughout time, i.e., the main interest is on the evolution of parameter δ. In the regression equation, such parameter corresponds to the coefficient of a variable that takes the maximum value between zero and the difference between observed inflation in the previous period and the 3% inflation target. Thus, said variable measures how far observed inflation is above the 3% permanent target. A higher value of parameter δ suggests increases in inflation expectations associated to the occurrence of inflation shocks. Thus, a more solid anchoring of expectations would be related to the reduction of the value of this parameter.

In line with the aforementioned, the estimated regression can have the following interpretation.[10] Rewriting the regression gives the expression:

$$E_t\left(\pi_{t+i}\right)-\gamma E_{t-1}\left(\pi_{t+i}\right)=\alpha+\delta Max\left\{\pi_{t-1}-\pi^*,0\right\}+\epsilon_t\,.$$

[10] This interpretation was proposed by an assessor in the editorial process for this journal.

The left hand term can be interpreted as a quasi-revision of inflation expectations. Thus, when parameter δ takes a value equal to zero it means that deviations of observed inflation from the target do not lead to a revision in inflation expectations. In such case it can be said that inflation expectations are well-anchored. Lower values of parameter δ would generally be associated with a better anchoring of inflation expectations.

The results obtained after considering the average of inflation expectations for the next 12 months and for the next four years, show that the parameter δ has been decreasing over time, to become close to values not statistically different from zero in the recent period (Figures 11 and 12).

Furthermore, as short-term expectations correspond to those for the next 12 months, higher values were obtained when these were used in the regression as compared to longer-term ones.

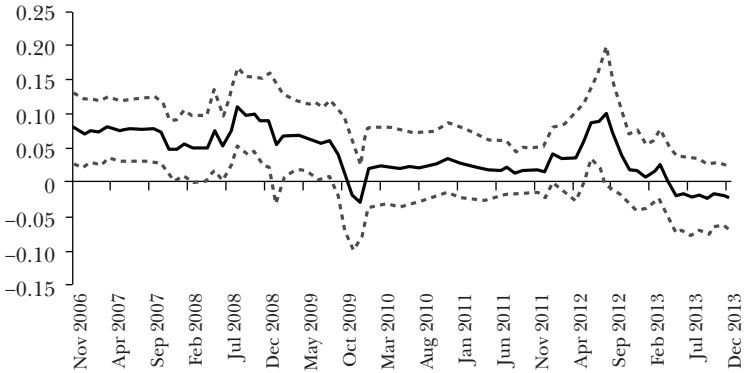
It is worth mentioning that for the estimation that considered the average of inflation expectations for the next 12 months, it was found that after the second episode of supply shocks, when inflation remained under control despite the magnitude of the shocks, a decrease in the parameter in question was registered. Thus, it shifted from positive values to values not statistically different from zero, except for a brief period in the middle of 2012.

As for the estimation that considered expectations for the next four years, a downward trend in this parameter was observed after the second episode of shocks, which went from positive values to values not statistically different from zero. Nevertheless, the referred parameter exhibited positive values in some months of the last episode, it subsequently decreased to values not statistically different from zero.

Although, as has been mentioned, this work is primarily interested in the evolution of parameter δ, it also describes the behavior of parameters α and γ, which correspond to the constant and coefficient of lagged inflation expectations in the regression equation. Figures 13 and 14 show the evolution of these parameters for the estimation that considered the average of inflation expectations for the next 12 months, while Figures 15 and 16 illustrate the behavior of said parameters

Figure 11

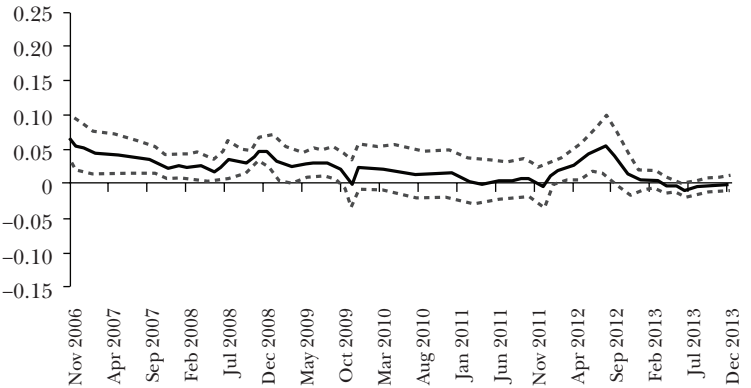
Average Inflation Expectations over the Next 12 Months
Coefficient (δ_E)[1]
(36-month moving window)



Source: Banco de México and Banco de México Survey of Expectations.
[1] Confidence interval at 90 percent.

Figure 12

Average Inflation Expectations over the Next Four Years
Coefficient (δ_E)[1]
(36-month movig window)



Source: Banco de México and Banco de México Survey of Expectations.
[1] Confidence intervals at 90 percent.

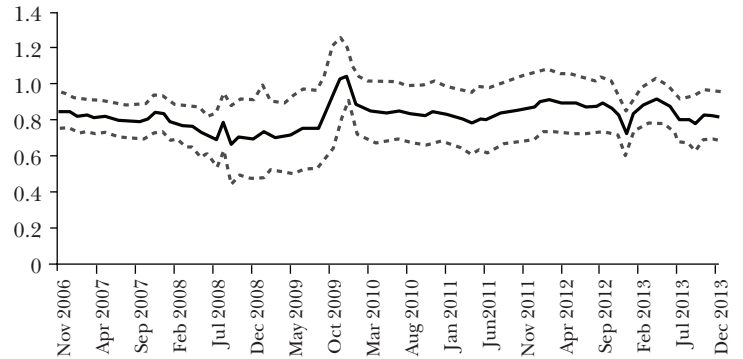
Figure 13

Inflation Expectations over the Next 12 Months
Constant Term (α) [1]
(36-month moving window)

Source: Banco de México and Banco de México Survey of Expectations.
[1] Confidence intervals at 90 percent.

Figure 14

Inflation Expectations over the Next 12 Months
Lag Coefficient (γ) [1]
(36-month moving average)

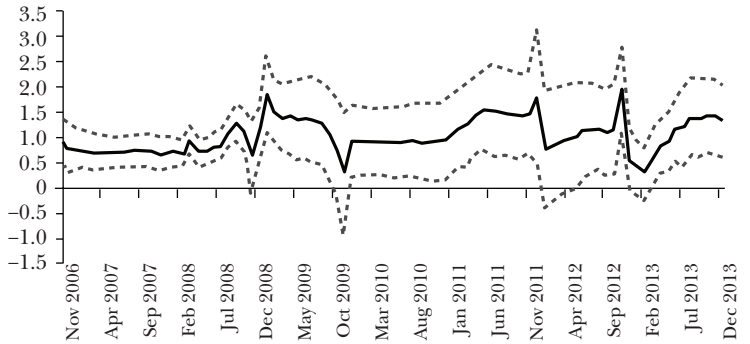


Source: Banco de México and Banco de México Survey of Expectations.
[1] Confidence intervals at 90 percent.

Figure 15

Inflation Expectations over the Next Four Years Constant Term (α)[1]

(36-month moving window)

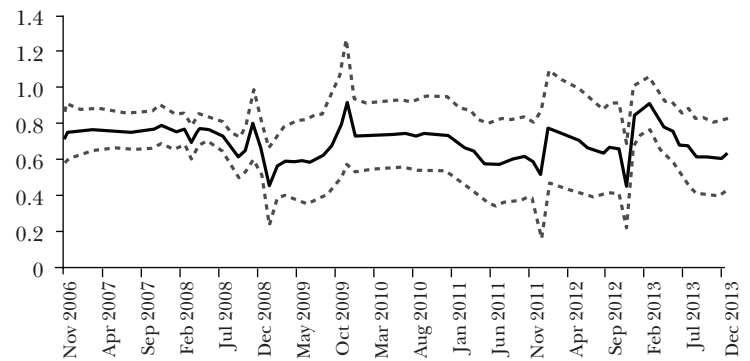


Source: Banco de México and Banco de México Survey of Expectations.
[1] Confidence intervals at 90 percent.

Figure16

Inflation Expectations over the Next Four Years Lag Coefficient (γ)[1]

(36-month moving average)



Source: Banco de México and Banco de México Survey of Expectations.
[1] Confidence intervals at 90 percent.

when the average of inflation expectations for the next four years was employed.

As can be seen, parameter takes positive values which, except in some periods, are generally statistically different from zero. Meanwhile, parameter always exhibits positive values, less than one and statistically different from zero. Moreover, when inflation expectations for the next four years are considered, the referred parameter tends to take values less than those corresponding to the calculation that considers expectations for the next 12 months. This seems to suggest that the persistence of inflation expectations tends to be lower when expectations for longer terms are considered. It is important to point out that a value of between zero and one for this parameter can be interpreted as additional evidence of the anchoring of inflation expectations. The latter is due to the fact that in presence of an inflation shock, the behavior of expectations exhibits mean reversion. Furthermore, although values of these parameters fluctuate throughout the sample period, no upward or downward trend is observed.

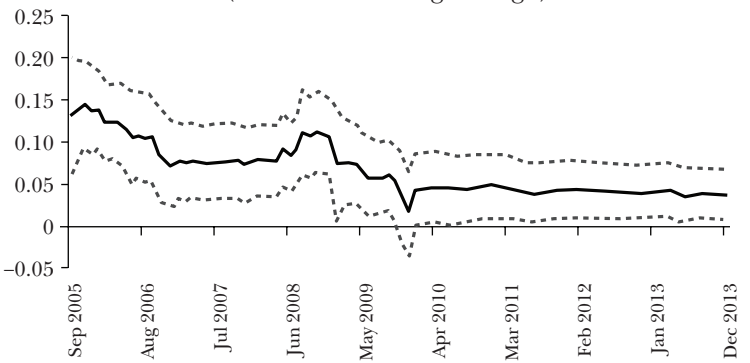
2.5 Robustness Tests

In order to verify the robustness of the results of the econometric exercise, this section presents three additional exercises: *i)* recursive estimation of the regression; *ii)* including deviations of inflation with respect to the variability interval instead of the precise target in the specification; and *iii)* estimating the original specification controlling for the phase of the economic cycle.

First, the same Equation presented previously is estimated but with a recursive regression, i.e., considering the available data regarding the expectations from September 2003 onwards, starting with a sample of 24 months and amplifying it by adding data throughout time until November 2013. As can be seen in Figures 17 and 18, the response of inflation expectations to deviations in inflation from its target has decreased over time.

Figure 17

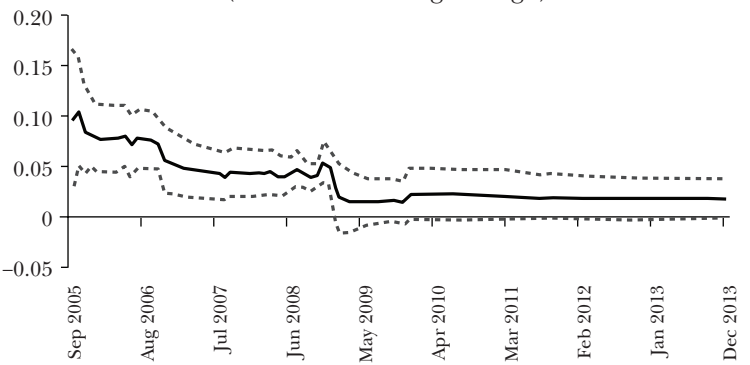
Average Inflation Expectations over the Next 12 Months
Coefficient (δ_E)[1]
(36-month moving average)



Source: Banco de México and Banco de México Survey of Expectations.
[1] Confidence intervals at 90 percent.

Figure 18

Average Inflation Expectations over the Next Four Years
Coefficient (δ_E)[1]
(36-month moving average)



Source: Banco de México and Banco de México Survey of Expectations.
[1] Confidence intervals at 90 percent.

Second, using the same sample as in the previous exercise, the following regression was estimated:

$$E_t\left(\pi_{t+i}\right)=\alpha+\gamma E_{t-1}\left(\pi_{t+i}\right)+\delta Max\left\{\pi_{t-1}-\pi^*,1\right\}+\epsilon_t\,.$$

In this Equation, parameter δ corresponds to the coefficient of a variable that takes the maximum value between the unit and the difference between the observed inflation in the previous period and the 3% inflation target. Thus, this variable captures the periods when inflation was above the upper bound of the variability interval around the 3% permanent target. When inflation expectations for the next 12 months and for the next four years are considered, the results show that parameter δ has decreased to values in the recent period that are not statistically different from zero, although it did exhibit positive values in some months during the middle of 2012 (Figures 19 and 20). This is in line with results obtained in the previous exercises.

Third, the original specification was estimated controlling for the phase of the cycle that the economy was undergoing. In this case the regression is as follows:

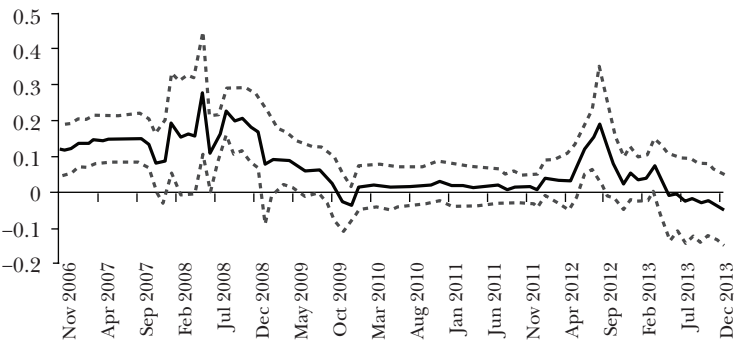
$$E_t\left(\pi_{t+i}\right)=\alpha+\gamma E_{t-1}\left(\pi_{t+i}\right)+\delta Max\left\{\pi_{t-1}-\pi^*,0\right\}+\beta X_{t-1}+\epsilon_t\,,$$

where parameter β corresponds to the coefficient associated to the lagged output gap $\left(X_{t-1}\right)$. This variable is controlled by the phase of the cycle the economy is undergoing because it could be argued that inflation expectations are affected not only by the performance of inflation itself, but also by the degree of slack in the economy. For instance, if the output gap is negative firms will find it more difficult to make upward adjustments in their prices in the event of a supply shock, meaning economic agents' inflation expectations would tend to be less affected by the same shock. However, after considering the average of inflation expectations for the next 12 months and for the next four years, the results show that, even when controlling for the output gap, parameter δ continues to decrease

Figure 19

AVERAGE INFLATION EXPECTATIONS OVER THE NEXT 12 MONTH COEFFICIENT (δ_E) [1]

(36-month moving window)

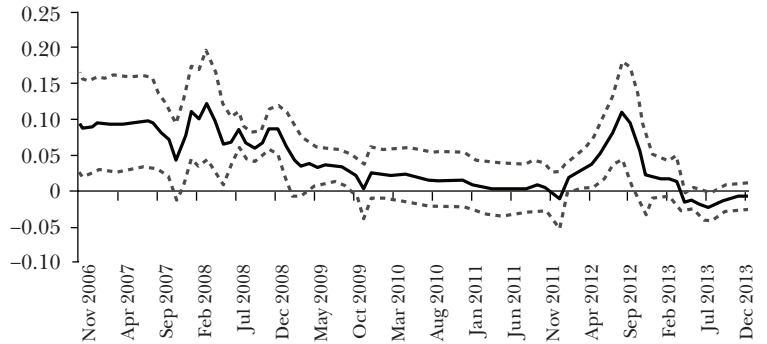


Source: Banco de México and Banco de México Expectations Survey.
[1] Confidence intervals at 90 percent.

Figure 20

AVERAGE INFLATION EXPECTATIONS OVER THE NEXT FOUR YEARS COEFFICIENT (δ_E)[1]

(36-month moving window)



Source: Banco de México and Banco de México Survey of Expectations.
[1] Confidence intervals at 90 percent.

over time to get to values that are not statistically different from zero in the recent period (Figures 21 and 22). This is in line with the previous results.

In general, the results would seem to suggest that the fact that the pricing process of the economy was not contaminated during the second episode of supply shocks helped to strengthen the anchoring of inflation expectations. They were therefore relatively less affected in the third episode of supply shocks. In light of such conditions, unlike in previous periods of supply shocks, when Banco de México responded by tightening the monetary policy stance in order to reinforce its commitment to price stability, during the last period analyzed, given the anchoring of inflation expectations, it was not necessary to raise the reference interest rate.

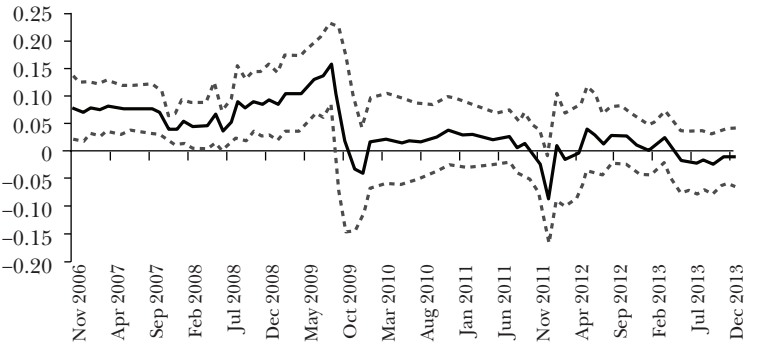
CONCLUSIONS

A framework for the conduction of monetary policy focused on procuring and maintaining an environment of price stability, along with sound public finances, has contributed to creating a stable macroeconomic environment in Mexico. Under this context, after describing the structural achievements to control inflation in Mexico, this paper shows empirical evidence in favor of the fact that the anchoring of inflation expectations has strengthened recently. A descriptive analysis was presented, in which three episodes when the Mexican economy was subject to different supply shocks were considered. It was shown that during the episode corresponding to 2011-2012 inflation expectations increased considerably less than in the other episodes analyzed. Moreover, the econometric results suggest that inflation expectations respond increasingly less to inflationary shocks. This could be attributed, to a great extent, to the credibility of monetary policy and to improvements in Banco de México's communication strategy with market participants and the public in general. The results of this paper therefore lend support to the idea that a virtuous cycle has been created between the environment of price stability achieved in Mexico,

Figure 21

Coefficient (δ_E) Controlling for Output Gap (Inflation Expectations over the Next 12 Months)[1]

(36-month moving window)

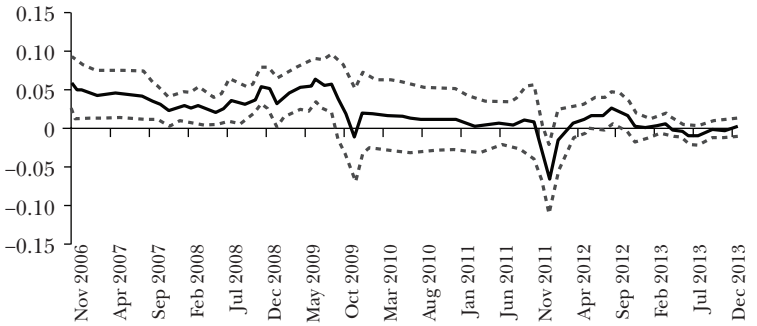


Source: Banco de México and Banco de México Survey of Expectations.
[1] Confidence intervals at 90 percent.

Figure 22

Coefficient (δ_E) Controlling for Output Gap (Inflation Expectations over the Next Four Years)

(36-month moving window)



Source: Banco de México and Banco de México Survey of Expectations.
[1] Confidence interval at 90 percent.

the anchoring of inflation expectations and a monetary policy conduction focused on procuring the stability of the domestic currency's purchasing power.

APPENDIX A

Table 1

PERFORMANCE OF INFLATION AND ITS EXPECTATIONS DURING THE EPISODES OF SUPPLY SHOCKS
(percent)

	Episode 3			*Episode 2*				*Episode 1*		
	(A)	*(B)*	*(B−A)*	*(C)*	*(D)*	*(E)*	*(E−C)*	*(F)*	*(G)*	*(G−F)*
Annual inflation	Sep. 2011	Sep. 2012	Change	Jul. 2006	Mar. 2007	Sep. 2008	Change	Dec. 2003	Nov. 2004	Change
Headline	3.14	4.77	1.63	3.06	4.21	5.47	2.41	3.98	5.43	1.45
Headline inflation expectations										
Next four years	3.56	3.60	0.04	3.47	3.48	3.66	0.19	3.57	3.98	0.41
End of 2004								3.86	5.36	1.50
End of 2005								3.53	4.29	0.76
End of 2007				3.43	3.68					
End of 2008				3.47	3.57	5.63	2.16			
End of 2009					3.50	4.07	0.57[a]			
End of 2012	3.66	4.15	0.49							
End of 2013	3.54	3.76	0.22							

Source: Banco de México.
[a] E−(D).

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The Determinants of Banks' Liquidity Buffers in Central America

Abstract

Banks' liquidity holdings are comfortably above legal or prudential requirements in most Central American countries. While good for financial stability, high liquidity may nonetheless hinder financial market development and monetary policy transmission. Using a panel of 96 commercial banks from Central America, Panama and the Dominican Republic for 2006-2010, we find that the demand for precautionary liquidity buffers is associated with measures of bank's size, profitability, capitalization, and financial development. Higher liquidity is also associated with deposit dollarization, reinforcing the monetary policy and market development challenges in

The authors would like to thank Miguel Savastano for his guidance, and two anonymous referees for their insightful comments. Przemek Gajdeczka, Fernando Delgado, Mario Mansilla, Stephanie Medina Cas, Andy Swiston, Camilo Tovar and other colleagues at the International Monetary Fund, as well as staff from the Central Bank of Guatemala, Rudy Loo-Kung and Mario Cuevas at the Inter-American Development Bank and Miquel Dijkman at the World Bank also provided valuable comments. The views expressed herein are those of the authors and should not be attributed to the IMF, its Executive Board, or its management. All remaining errors are our own.

highly dollarized economies. This is one of the first empirical studies to investigate the relation between degrees of dollarization and bank liquidity holdings. Its findings suggest that improvements in supervision and measures to promote dedollarization, including developing local currency capital markets, would help enhance financial systems' efficiency and promote intermediation in the region.

JEL classification: E44, G21, O16.

Keywords: Central America, bank liquidity, credit, dollarization, foreign banks.

1. INTRODUCTION

This paper studies the determinants of banks' liquidity buffers in Central America,[1] Panama and the Dominican Republic (CAPDR) using a panel of 96 commercial banks over 2006-2010. In particular, the paper examines whether CAPDR banks' liquidity buffers, defined as the liquid assets-to-deposits ratio, can be explained by bank and country-level characteristics as predicted by theory and presented in some empirical studies. Of particular interest for the region is whether liquidity holdings are related to bank ownership (public vs. private, foreign vs. domestic) or the banking systems' degree of dollarization.

CAPDR banking systems are highly liquid. As seen in Figure 1, holdings of liquid assets as a share of total deposits averaged about 28% for the region in 2010 while reserve requirements were set at about 17% on average.[2] Liquidity ratios are also high compared to larger South-American countries; liquidity ratios averaged about 15% for Brazil, Chile and Colombia in

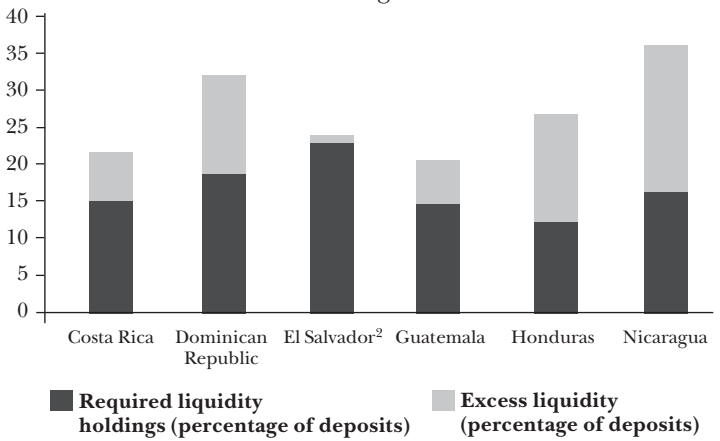
[1] Costa Rica, El Salvador, Guatemala, Honduras, and Nicaragua.

[2] The liquidity requirement for Panama is not strictly comparable to that of the other countries and is thus not included in Figure 1. It is defined as the ratio of liquid assets and securities and obligations payable to banks within 186 days, as a share of short-term deposits.

Figure 1

CAPDR: LIQUID ASSETS-TO-DEPOSITS RATIO[1]

Percentage, 2010



Sources: Central America, Panama and Dominican Republic central banks and superintendencies' websites, and authors' calculations.

[1] Liquid assets include cash central bank reserves and deposits abroad.

[2] Prudential liquidity requirement.

2010.[3] For monetary and supervisory authorities ensuring that banks hold adequate amounts of high-quality liquid assets is essential for financial stability, as highlighted during the recent global financial crisis. However, if liquidity holdings are much above legal requirements, this may be costly in terms of foregone financial intermediation. Excess liquidity also hinders the development of interbank and money markets and acts as *sand in the wheels* of the monetary transmission mechanism in countries with a monetary policy (Gray, 2011).

From individual banks' point of view, holding sufficient liquidity is necessary to insure against liquidity risk (Diamond and Dybvig, 1983; Diamond and Rajan, 2001 and 2005). Since loans are relatively illiquid, large and unexpected deposit

[3] These estimates are based on authors' calculations using data provided by IMF country teams and are available upon request.

withdrawals can lead to insolvency as it may be too costly or not possible to raise liquidity on short notice, especially if local capital markets are underdeveloped. Instead of self-insuring, banks could resort to other forms of financing, such as accessing interbank markets, central bank liquidity windows, or external credit lines. However, asymmetric information may lead to coordination failures on the interbank market and external credit lines may freeze, as seen during the recent financial crisis. Solvent but illiquid banks could still fail, absent a lender of last resort (LOLR; Rochet and Vives, 2004). Thus banks hold a buffer of liquid assets as self-insurance, equating the marginal benefit of holding liquid assets to the marginal cost of foregoing alternative investments.

A priori, one could expect the self-insurance motive to be especially important in CAPDR. Local capital markets are underdeveloped, interbank markets are thin, and LOLR arrangements remain limited or nonexistent. For the five partially-dollarized economies, the high share of foreign-currency assets and liabilities limits the ability of the central bank to act as LOLR. The two fully dollarized economies in the region, Panama and El Salvador, did not have a LOLR as of end-2010.[4] Furthermore, while the region's predominant reliance on customer deposits for funding is a likely reason for its resilience during the global financial crisis, it is also a vulnerability which calls for holding adequate liquidity buffers.

The remainder of the paper is structured as follows. Section 2 provides some background information on CAPDR banking systems. Section 3 briefly reviews the theoretical and empirical literature on the determinants of liquidity holdings. Section 4 describes the data and presents stylized facts on the distribution of banks' liquidity holdings. Section 5 presents the econometric methodology while Section 6 discusses the estimation results. Section 7 concludes.

[4] El Salvador formally approved the regulations to establish a liquidity facility in June 2012.

2. SOME BACKGROUND ON CENTRAL AMERICA, PANAMA & DOMINICAN REPUBLIC BANKING SYSTEMS

With the exception of Panama, the region's banking systems are relatively small, highly concentrated and dollarized to various degrees as seen in Tables 1 and 2. Panama's banking system stands out of the group in terms of its size, which is four times greater than the sample average measured by the ratio of total system's assets to GDP (Table 2).[5] In four countries (Honduras, Nicaragua, El Salvador and Panama) the share of foreign banks' assets in total assets is greater than 50%, suggesting higher potential vulnerabilities from cross-border linkages. While the presence of state banks is quite small in terms of number of banks and share of system's assets, state banks have a very strong presence in Costa Rica, where their assets account for 55% of total assets. Customer deposits are the main source of funding and show a high degree of dollarization, particularly in Nicaragua and Costa Rica. The share of short-term deposits is also relatively high in the region, with the exception of Panama. Table 2 shows that, compared with 2006, Panama's banking system has experienced significant consolidation as has Guatemala's, although to a more modest extent. Banking systems' size, measured by total assets as a share of GDP, expanded in Costa Rica, Guatemala, and Nicaragua but decreased in the other countries. During the period, private sector credit increased as a share of GDP in all countries but the Dominican Republic and El Salvador.

Reserve requirements are the amount of funds that a depository institution must hold as reserve at the central bank against specified deposit liabilities. The liquidity requirement obliges a bank to hold on its balance sheet sufficient high-quality liquid assets to cover short-term liabilities. Three different regimes

[5] This study does not include Panama's offshore banking sector. By law, Panama's offshore banks cannot take deposits from or lend to the domestic economy. Offshore banks' assets represented 50 percent of GDP at end-2010.

Table 1

CAPDR: BANKING SYSTEM INDICATORS, 2010

	Number of banks	*Number of state banks* [3]	*State bank assests in total assets*	*Number of foreign banks* [4]	*Foreign bank assets in total assets*	*Percent of assets in 5 largest banks*	*Assets in foreign currency in total assets*	*Credit in foreign currency in total credit*	*Foreign currency in total deposits*	*Demand deposits in total deposits*
Costa Rica	16	3	55	9	26	78	46	47	41	53
Guatemala	18	1	2	7	13	79	23	30	24	41
Honduras	17	1	1	9	50	75	24	28	30	22
Nicaragua	6	1	0.01	4	67	97	72	90	73	31
Dominican Republic	15	2	31	4	29	87	26	21	30	18
El Salvador [1]	12	2	6	10	83	85				26
Panama [1, 2]	49	2	14	28	57	57				15

Sources: Central American Monetary Council (SECMCA), International Financial Statistics, and authors' calculations.
[1] Officially dollarized economies. [2] Domestic banking system. [3] State share of more than 50%. [4] Banks with 50% of capital in foreign hands, excludes offshore.

Table 2

CAPDR: BANKING SYSTEM INDICATORS, 2006 AND 2010

	Number of banks		*Assets to GDP*		*Credit to GDP*	
	2006	*2010*	*2006*	*2010*	*2006*	*2010*
Costa Rica	17	16	57	60	39	46
Guatemala	23	18	39	44	27	30
Honduras	16	17	91	68	48	50
Nicaragua	7	6	57	62	33	34
Dominican Republic	13	15	33	32	19	18
El Salvador [1]	12	12	64	61	44	40
Panama [1, 2]	87	49	221	200	82	91

Sources: Central American Monetary Council (SECMCA), International Financial Statistics, and authors' calculations.
[1] Officially dolarized economies. [2] Domestic bank system.

for liquidity management are in place in CAPDR countries. Honduras and El Salvador apply both reserve requirements and prudential liquidity requirements. Costa Rica, Guatemala, Dominican Republic and Nicaragua only use reserve requirements, while Panama, in the absence of a central bank, uses exclusively prudential liquidity requirements, as presented in Table A1 of Appendix A.

Reserve requirements in CAPDR are in line with those in other Latin American countries, and average about 15% for local currency deposits and 15.5% for foreign currency deposits, as indicated in Figure 2. The two officially-dollarized economies rely on prudential liquidity requirements, held at the central bank in the case of El Salvador and held by individual banks in the case of Panama.[6] Although they are potentially useful policy instruments, reserve and liquidity requirements are not actively

[6] In addition to reserve requirements, Honduras also imposes liquidity requirements to avoid maturity mismatches.

jointly applied in most countries, with the exception of El Salvador and Honduras (see Appendix A, Table A1).[7]

Overall, banking sectors in the region are well capitalized, liquid and profitable. Figure 3 illustrates that financial systems remained resilient in the face of the 2009 global financial crisis, mostly due to their strong initial positions. Despite rapid credit growth, the region did not experience excessive credit booms and there was very limited exposure to toxic asset-backed securities or to wholesale funding. Stress tests of liquidity risk suggested that banks had adequate coverage of their liquid liabilities and could withstand deposit withdrawal shocks of 15%-20% during a 30 day period.[8] However, although banking supervision has improved over the past decade, compliance with Basel Core Principles remains uneven and below that of the six largest South American economies (Delgado and Meza, 2011). Financial safety nets remain incomplete and financial markets, including interbank markets, are underdeveloped.

3. DETERMINANTS OF BANKS' LIQUIDITY BUFFERS: LITERATURE REVIEW

The determinants of banks' liquidity buffers, as identified in the theoretical and empirical literature, can be classified into four broad categories. These are the opportunity costs of alternative investments and shocks to funding, bank characteristics, macroeconomic fundamentals, and moral hazard motives.

3.1 Opportunity Cost and Shocks to Funding

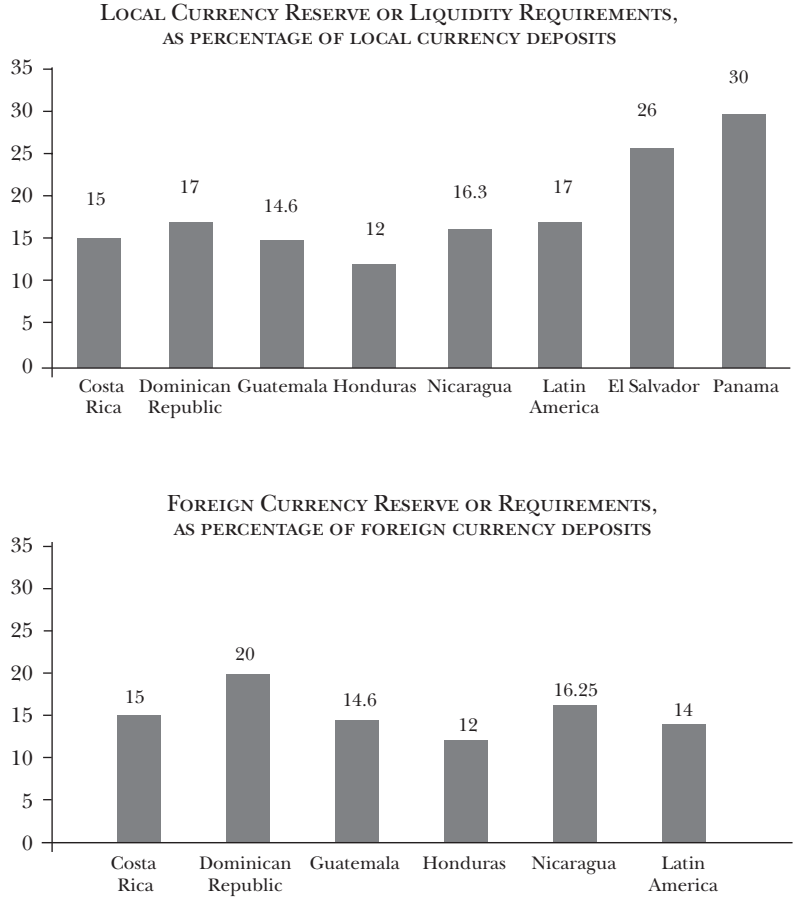
The early literature on bank liquidity uses the firm's theory of inventory decisions as a starting point. The cost of holding

[7] In this regard, excess liquidity is probably best analyzed in the context of single country time-series studies. In the panel context, our preferred definition of liquidity buffers for the empirical analysis in Section 4 is the liquid assets-to-deposits ratio.

[8] See *Financial System Stability Assessment* for the countries in the region, available at <www.imf.org>.

Figure 2

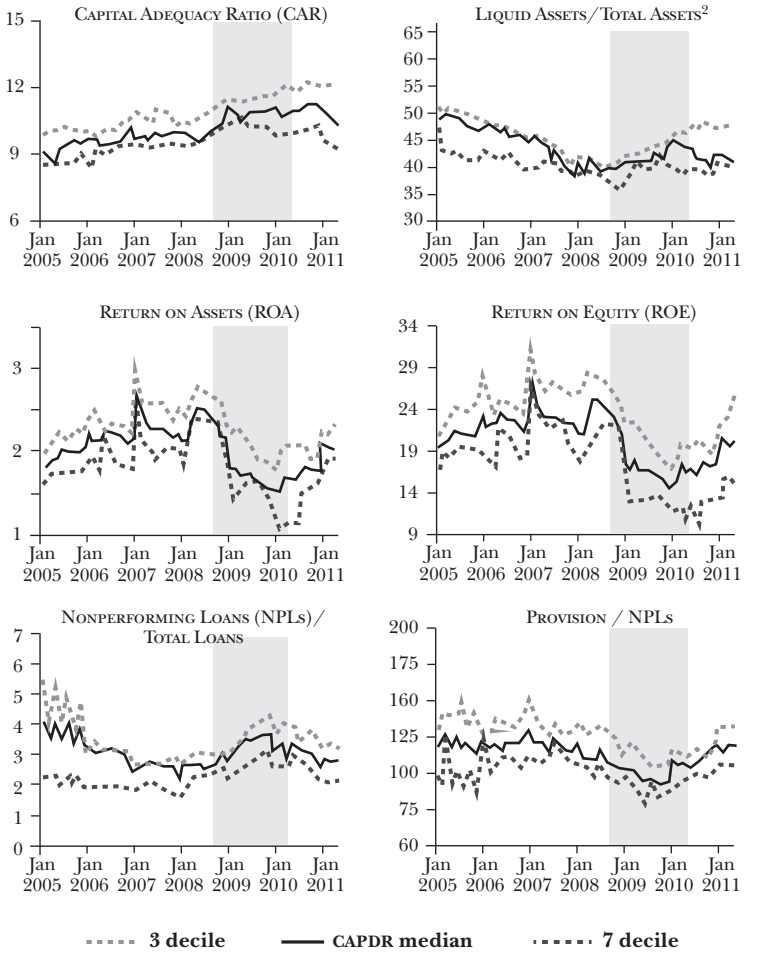
CAPDR: Statutory Reserves and Liquidity Requirements by Currency, 2010



Sources: Central banks and superintendencies.
Note: Reserve requirements for all countries excluding the fully dollarized economies, Panama and Salvador, which have prudential liquidity requirements. Liquidity requirement for Panama is defined as the ratio of liquid assets, including securities and obligations payable to banks within 186 days, as a share of short-term deposits.

Figure 3

CAPDR: Financial Stability Indicators



Source: Central American Monetary Council.

[1] Shaded area represents the 2008-2009 global financial crisis.

[2] Liquid assests include short-term investments.

liquid assets (with low returns compared with other types of investments) is compared to the benefits of reducing risks of *running out* (Baltensperger, 1980, and Santomero, 1984). Models testing these relations predict that the size of liquidity buffers should reflect the opportunity cost of holding liquid assets rather than loans. The size of liquidity buffers is also hypothesized to take into account the distribution of liquidity shocks that the bank may face. In particular, it should be positively related to the volatility of the funding base as well as to the cost of raising additional funds.

Using aggregate time-series data for banks in Thailand, Agénor et al. (2004) find that the demand for precautionary reserves (measured as the log of excess reserves over total deposits) is positively related to the penalty rate, proxied by either the discount or the money market rate, as well as to the volatility of the cash-to-deposit ratio. Dinger (2009) finds in a panel of Eastern European banks that liquidity buffers are negatively related to the real deposit rate, but positively related to the interbank rate.

3.2 Bank Characteristics

The newer generation of models explaining liquidity demand relies on some form of market imperfection to explain why firms (including banks) cannot raise unlimited amounts of liquidity instantaneously. The market imperfection is asymmetric information, either in the form of moral hazard (Holmstrom and Tirole, 1998) or adverse selection (Kiyotaki and Moore, 2008).[9]

[9] Holmstrom and Tirole (1998) and Kiyotaki and Moore (2008) make this argument for firms in general: liquidity constraints, together with liquidity shocks, result in entrepreneurs not being able to raise the entire cost of their desired investment externally, so that they have to hold enough liquid assets to make a down payment for each unit of investment (there are also limits on the amount of equity that can be resold). Therefore, although the rate of return on cash is very low, entrepreneurs will choose to hold some in their portfolio. Liquidity shocks reduce the price of equity and increase the desired holdings of liquid assets.

Financially-constrained banks would thus tend to hold more liquidity.[10]

These models highlight several characteristics affecting banks' ability to raise non-deposit forms of finance, and, thus, their precautionary demand for liquidity buffers. Among these are bank size (small banks have more difficulties in accessing capital markets), profitability (more profitable banks can more readily raise capital and thus are less liquidity-constrained), and ownership (both public banks and foreign banks should be less liquidity-constrained than private and domestic banks, respectively, because public banks may have an implicit guarantee while foreign banks would have access to support from headquarters).[11]

Aspachs et al. (2005) find that banks' liquidity buffers are negatively related to bank characteristics such as loan growth and net interest margins[12] and that the coefficients on size and profitability are not significant. Kashyap and Stein (1995, 2000) and Kashyap et al. (2002), using a large panel of US banks, find a strong effect of bank size on holdings of liquid assets, with smaller banks being more liquid as they face constraints in accessing capital markets. Dinger (2009) also finds that smaller Eastern European banks hold more liquidity, although this relation is non-linear, and that foreign banks hold less liquidity.

Bank ownership may not only exert a direct influence on liquidity holdings but may also interact with other explanatory variables. In particular, Aspachs et al. (2005) find that, for the United Kingdom, foreign banks' liquid asset holdings are not affected by the availability of a domestic LOLR while local banks are. Furthermore, in their sample, foreign banks'

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[10] See for example Almeida et al. (2004), Kashyap et al. (2002), Kashyap and Stein (1995, 2000), Repullo (2005), and Rochet and Vives (2004).

[11] Freixas and Holthausen (2005).

[12] The negative relation between liquidity and net interest margins only holds for domestic banks. By contrast, foreign-owned banks' liquidity holdings are positively related, which may reflect remittances of liquidity from abroad when UK interest margins are high.

liquidity holdings tend to react less to changes in the domestic policy rate and GDP growth, suggesting that foreign banks are subject to a somewhat different set of constraints than their local counterparts.

3.3 Macroeconomic Fundamentals

The models mentioned above also have implications for the cyclical behavior of liquidity demand. If capital markets are imperfect, the demand for liquidity should be countercyclical, as banks would hoard liquid assets during recessions and offload them in good times given more opportunities to lend. Liquidity buffers would thus be negatively related to measures of the output gap or real GDP growth, the credit cycle, and policy interest rates. For example, Almeida et al. (2004) develop and estimate on a large sample of US manufacturing firms a model where financially-constrained firms have a higher propensity to accumulate cash holdings.

These findings have important policy implications. The countercyclicality of liquidity buffers limits the effectiveness of monetary policy: liquidity injections to stimulate the economy in a recession would be used by banks to rebuild their liquidity buffers instead of being on-lent, and aggregate credit would not necessarily pick up. Aspachs et al. (2005) find that banks' liquidity buffers in the United Kingdom are negatively related to real GDP growth and the policy rate. Agénor et al. (2000) and Saxegaard (2006) find that excess reserves are negatively related to the output gap and the policy rate in Thailand and in sub-Saharan Africa, respectively. Dinger (2009) finds, using a sample of Eastern European banks, that liquidity holdings are negatively related to real GDP growth and real per capita gross domestic product.

3.4 Moral Hazard and Safety Nets

In theory, the strength of the financial safety net and, in particular, the availability of a LOLR arrangement, should reduce

banks' incentives to hold liquidity buffers (Repullo, 2003). Empirical studies of banks in the United Kingdom and Argentina, where LOLR support is measured, respectively, as the Fitch support rating and the availability of external credit lines in the context of the currency board, support this prediction (Aspachs et al., 2005, and González-Eiras, 2003).

High credit or deposit dollarization reduces the effectiveness of the domestic LOLR. Partially-dollarized economies are subject to currency and liquidity risks given that the central bank cannot issue foreign currency (Gulde et al., 2004, and Levy-Yeyati and Broda, 2002). Liquidity coverage should then be positively associated with the degree of deposit dollarization. However, the incentives to hold such buffers would diminish in the presence of a large stock of central bank international reserves or central bank access to external credit lines, as these would be a ready source of US dollar liquidity in the case of a run on US dollar deposits (Ize et al., 2005). Using a sample of about 100 countries, De Nicoló et al. (2005) find that deposit dollarization is associated with higher solvency and liquidity risk measured by deposit volatility. However, to our knowledge, no empirical study has focused on the effects of deposit dollarization on banks' liquidity.

4. TESTING FOR THE DETERMINANTS OF BANKS' LIQUIDITY BUFFERS

4.1 Data and Variable Definitions

Our sample combines annual data for 96 CAPDR banks over 2006 to 2010 from the BankScope database[13] with country-level macroeconomic fundamentals and structural variables drawn from regional monetary and supervisory authorities' websites and other publicly-available databases.[14] The sample covers 72%

[13] A financial database supplied by Bureau van Dijk.

[14] Please see Section 4.3 and Tables 1 and 2 in Appendix B for further details on data definition and sources, description as well as an indication for expected signs for the relation between different variables.

of all commercial banks in the region and about 80% of total banking system assets, though admittedly the coverage is not homogeneous across all the countries, as shown in Figure 4.[15]

The choice of the sample is constrained by data availability. The period 2006-2010, although not necessarily representative, constitutes the interval for which data for most CAPDR banks were available. Starting at an earlier date would have severely limited coverage for some countries, in particular Nicaragua, and since BankScope data is based on published bank statements, final data becomes available with a lag that varies across countries and banks. Individual bank data were picked in order to take into account the importance of regional conglomerates in the region.[16]

4.2 Definition of Liquidity Buffers

Liquidity buffers are measured by the ratio of liquid assets to customer deposits and short-term funding. Liquid assets include cash and cash-like assets,[17] quoted or listed government bonds, and short-term claims on other banks. Although the breakdown of the numerator components is not available, there are relatively few listed government securities in the region (Shah et al., 2007). The denominator includes banks' customer deposits and short-term interbank deposits. Customer

[15] The information on coverage is averaged over banks/years. A caveat is that the pattern of missing institutions may not be random.

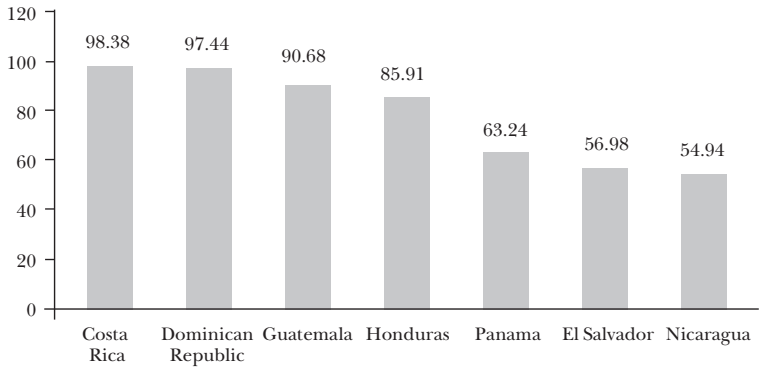
[16] We also selected banks that were active in 2010 to avoid bank attrition (due to acquisition or mergers) in the sample and we searched within the BankScope dataset for news of merger or acquisition deals for each bank. In a couple of cases, banks sold stakes in an existing bank, leading to changes in cross-ownership patterns, but not to the nature of ownership, hence we did not control for this in the econometric specification. However, we did check for large changes in asset ratios to make sure that there was no uncharacteristically large change from one year to another.

[17] These include cash in vault, liquid positions in foreign exchange held abroad, and reserves held at the central bank (except for Panama, as there is no central bank).

Figure 4

CAPDR: BANKSCOPE SAMPLE COVERAGE OF TOTAL BANKING SYSTEM'S ASSETS

2006-2010 average percent



Sources: BankScope database, CAPDR central banks and superintendencies' websites, and authors' calculations.

deposits are the main source of funding in the region; while the share of short-term funding is low (the share of customer deposits in the denominator is 93% for the whole sample). As seen in Figure 5, the ratio of liquid assets to customer deposits and short-term funding from the individual bank data is close to system-wide liquidity ratios, defined as liquid assets (cash and cash-like, excluding securities) to deposits. We use it as our main dependent variable and use the ratio of liquid assets to total assets for robustness checks.[18]

Our dependent variable captures highly liquid assets available on demand and, from a banking supervision's standpoint,

[18] Empirical studies use both ratios, see Aspachs et al. (2005) and Dinger (2009). The ratio of liquid assets to liabilities is the most consistent with the notion of CAPDR banks self-insuring against deposit shocks, though banking theory also emphasizes asset-side liquidity problems (Diamond and Rajan, 2005).

should ideally be measured at much more frequent intervals.[19] The two new minimum standards for liquidity defined by the Basel Committee on Banking Supervision explicitly take into account the time horizon dimension of adequate liquidity buffers. The *liquidity coverage ratio* aims at promoting short-term resilience of a bank's liquidity profile by ensuring that it has sufficient high-quality liquid assets (cash or cash-equivalent) to survive a significant stress scenario lasting for one month. The *net stable funding ratio* matches long-term assets with stable funding sources over a one-year horizon in order to promote resilience over a longer period (BIS, 2010).

4.3 Choice of Explanatory Variables

The choice of explanatory variables is guided by the theoretical and empirical literature reviewed in Section 3 and is summarized in Table B1, Appendix B.

4.3.1 Opportunity Cost, Liquidity Shocks and Bank Characteristics

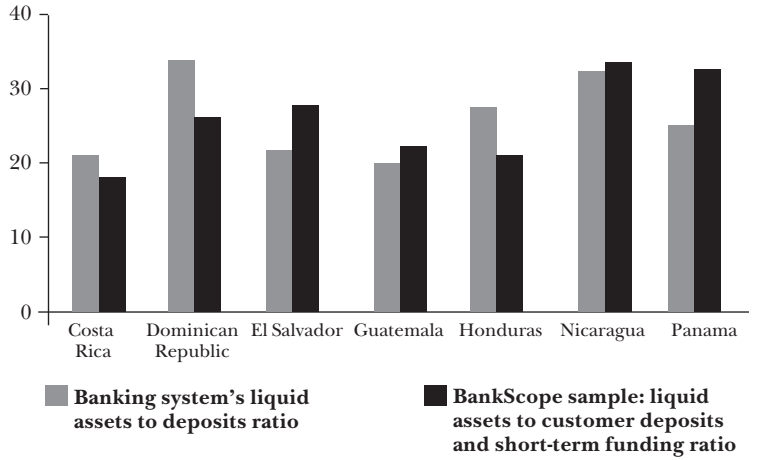
In line with the theory presented in Baltensperger (1980) and empirical results by Agénor et al. (2000) and Dinger (2009), we use the spread between the lending and the deposit rate as a measure of the opportunity cost of holding liquid assets. The probability of a liquidity shock can be proxied by a measure of the volatility of total deposits at the system level as in Agénor et al. (2000) –we can calculate a monthly coefficient of variation of total deposits for each country, but have only annual bank-level data– or by the volatility of inflation. Past liquidity shocks

[19] In particular, there could be large seasonal variations in banks' liquid assets holdings that could bias the regression estimates. Using monthly data at the country level collected by the monetary authorities and the Secretariat of the Central America Monetary Council, we were able to verify that, at the aggregate level at least, there is no evidence of systematic end-year seasonal bias (tabulations available on demand).

Figure 5

CAPDR: LIQUIDITY RATIOS AT SYSTEM LEVEL AND IN BANKSCOPE SAMPLE

2006-2010 average percent



Sources: BankScope database, CAPDR central banks and superintendencies' websites, and authors calculations.

may also matter: a history of banking crisis could lead banks to become more risk-averse and hold more liquidity.

Given the importance of public and foreign banks in Central America's banking systems, we are particularly interested in testing whether liquidity buffers vary systematically according to bank ownership (public/private and foreign/domestic). As noted before, Aspachs et al. (2005) find that foreign banks' preference for liquid assets differs from that of domestic banks in the case of the United Kingdom's banking system as they would have access to emergency liquidity from their headquarters. Public banks may similarly be less risk-averse than private banks because they may perceive that they have an implicit or explicit government guarantee. Indeed, in developing countries, the lending behavior of state-owned banks has been found to be less-procyclical than that of private banks (Micco and Panizza, 2006). Public banks also tend to be less efficient and less profitable than private banks (Micco et al., 2004).

We control for other bank characteristics such as size, measured by the log of total assets, as the work by Kashyap and Stein (1995, 2000) suggests that smaller banks may have less easy access to capital markets and thus be more liquidity constrained. The squared value of this variable captures possible non-linearities in the impact of bank size on liquid asset holdings (Dinger, 2009). Capitalization is expected to be positively related to liquidity demand as better capitalized banks may reflect more prudent business models (Dinger, 2009). Capitalization is measured by the ratio of equity to total assets. More profitable banks would be expected to hold less liquidity due to easier access to capital markets (Aspachs et al., 2005). Profitability is measured by the ratio of the net interest margin to interest-earning assets. The ratio of loan-loss reserves to gross loans should capture the banks' degree of risk aversion or the perceived riskiness of their loan portfolio.

4.3.2 Macroeconomic Fundamentals and Safety Nets

As described in Section 3, models with financial frictions imply that macroeconomic conditions and fundamentals would also affect precautionary liquidity demand (Aspachs et al., 2005; Dinger, 2009; Opler et al., 1997). We use output growth in CAPDR to capture the economic cycle: faster growth is expected to be related to lower liquidity buffers as banks would expand lending, while they would hoard liquidity in a downturn. Financial development is captured by the ratio of private-sector credit to GDP, a traditional proxy for financial depth: the more lending opportunities, the lower the precautionary liquidity buffers. The availability of safety nets is captured by the extent of deposit dollarization (which reduces the effectiveness of the central bank as LOLR) and the net international reserves holdings of central banks, a measure of the capacity of the central bank to provide liquidity support in foreign currency in partially dollarized banking systems. Dollarization is measured by the share of dollar deposits in total system deposits (no currency breakdown is available

for bank-level data in BankScope), and we use the log of each country's net international reserves.

4.4 Data and Stylized Facts

Overall there is significant variation in liquidity holdings in the sample as shown in Table B2 of Appendix B. Liquidity holdings in terms of customer deposits and short-term funding are on average 25% in our sample and represent about 19% of total assets. Average capitalization is relatively high at about 13%, as noted in Basso et al. (2012). Foreign banks represent 45% of observations, and private banks about 90%. Deposit dollarization amounts to about 50% though there are wide variations across countries.

Simple correlations, detailed in Table B3 of Appendix B, show that the main explanatory variables are related to banks' liquidity holdings as predicted by the theory and in line with empirical evidence, with a few exceptions.[20] In particular, foreign ownership, real GDP growth and financial depth are positively associated with liquidity holdings, whereas a negative relation was expected. At the same time, deposit dollarization is negatively related to liquidity holdings, while theory predicts a positive association. In addition to the effect of small sample size and outlier observations on simple correlations, several explanations can be put forward to explain these somewhat counterintuitive results. On foreign ownership, in particular, the overwhelming majority of foreign banks in the sample are subsidiaries rather than branches. The implied operational and financial independence relative to foreign branches may explain why these banks choose

[20] Another way to explore the relation between explanatory variables and liquidity buffers is to divide banks into quartiles based on the size of liquidity buffers and test whether the characteristics of banks with high liquidity buffers are significantly and statistically different from banks with low buffers. Results from such an analysis, which are available from the authors upon request, show that most of the explanatory variables exhibit the predicted relation with liquidity buffers.

to hold higher liquidity. The results on real GDP growth and financial depth are in part explained by the lack of variation in these macroeconomic variables across all banks for a given country and year. But, additionally, the results may reflect the fact that growth for two of the fastest growing economies during the sample period (Panama and the Dominican Republic) was not primarily led by private credit but by government demand. Similarly, these two countries have the most financially integrated banking systems, but Panama's large presence of foreign subsidiaries and the Dominican Republic's banking crisis in 2003 may have had effects on the risk aversion of banks and their preference for liquidity. As for the result on dollarization, the correlation could be spurious as the most dollarized countries are also the ones with the largest number of foreign subsidiaries.

Given the short time dimension of the panel and its coverage of crisis years, we are also interested in testing whether the behavior of the main explanatory variables was different during the global financial crisis (2008-2009). Restricting the quartiles analysis described in footnote 19 for the crisis years reveals that the relations observed in the full sample continue to hold (see Appendix B, Table B4). However, the relation between deposit dollarization and liquidity buffers is now negative and significant. This possibly reflects the fact that the most financially-integrated economies in the region (e.g., Panama, Dominican Republic), experienced a temporary sharp drop in foreign capital inflows in late 2008 and early 2009.

5. EMPIRICAL ANALYSIS

5.1 Baseline Specification

In line with the discussion in the previous section, we specify the determinants of banks' liquidity buffers as a combination of bank characteristics, macroeconomic fundamentals and country-specific characteristics. The baseline specification can be represented by Equation 1:

$$L_{it} = \beta_0 + \beta_1 L_{i,t-1} + \beta_2\ bank_{ijt} + \beta_3 macro_{jt} + \beta_4 country_{jt} + \\ + \mu * j + \nu * t + \xi_{ijt}, \quad (1)$$

where the subscripts i, j and t refer to bank, country and time (year) respectively. L represents bank-level liquidity buffers. We include a lagged dependent variable. If, as predicted by theory, banks target an optimum level of liquidity holdings then these holdings should be persistent over time as shown by Opler et al. (1997) for US firms. Bank denotes variables measuring bank fundamentals that are derived from banks' balance sheets. Macro represents the macroeconomic determinants of banks' liquidity buffers such as real GDP growth and interest rates, and country includes observable country-level characteristics, such as the moral hazard and safety net variables presented in the previous section and Table B1 of Appendix B. Unobservable country and time effects are captured by country (j) and time (t) dummy variables.

5.2 Hypotheses of Interest

Based on our review of the theoretical and empirical literature as well as stylized facts on liquidity data for CAPDR countries, we pay particular attention to the following:

i) Ownership. We test separately for the effect of private vs. public, and domestic vs. foreign ownership. As discussed in Sections 3 and 4, ownership may not only exert a direct influence on liquidity holdings but may also affect the regression slope through interactions with other explanatory variables. To test this hypothesis, we interact the relevant ownership dummy variable (own_{ijt}) with the other explanatory variables as shown in Equation 2:

$$L_{it} = \beta_0 + \beta_1 L_{i,t-1} + \beta_2\, bank_{ijt} + \beta_3 macro_{jt} + \beta_4 country_{jt} + \\ + (\beta_5 bank_{ijt} * own_{ijt}) + (\beta_6 macro_{jt} * own_{ijt}) + \\ + (\beta_7 country_{jt} * own_{it}) + \mu * j + \nu * t + \xi_{ijt}. \quad (2)$$

ii) Dollarization. We use the same framework to test whether liquidity buffers are higher in countries with more dollarized banking systems as measured by the share of foreign currency deposits in total deposits.

5.3 Estimation Methodology

Equations 1 and 2 are estimated using the *generalized methods of moments* (GMM) methodology developed by Blundell and Bond (2000) and Bond (2002). GMM estimators are particularly appropriate to address the dynamic panel bias that arises in the presence of lagged dependent variables in samples with a large number of groups (N) and a relatively small number of time periods (T). Given the persistence of liquidity ratios, Systems GMM is the preferred estimator as it helps overcome the weak instrument problem (past changes do contain information about current levels), and results in improvements in the efficiency of the estimates (Arellano and Bond, 1991; Roodman, 2006).[21]

To avoid instrument proliferation, the number of lags for the GMM instruments is restricted to two (Roodman, 2009).[22] Specification corrections are applied to the two-step covariance matrix (Windmeijer, 2005). In addition, tests for second-order serial correlation (first-order correlation is expected given the design of the method) and for independence between the residuals and the instruments are applied.[23]

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[21] Blundell and Bond (2000) show that when the dependent variable is highly persistent, the first-differenced GMM estimator has been found to have poor finite sample properties (bias and imprecision), particularly as the time dimension gets shorter. The Systems GMM estimator relies on both lagged differences (as per Arellano and Bover, 1995) and levels of the endogenous variables as instruments. They show that this results in significant improvements in precision and allows overcoming the small sample bias.

[22] As a rule of thumb, it is desirable to keep the number of instruments to no more than the number of groups (Roodman, 2006).

[23] The tests for second-order correlation and independence of residuals and instruments are based on the Arellano-Bond (AB) and

For robustness, Equations 1 and 2 are also estimated using ordinary least squares (pooled OLS), and by robust fixed effects (FE). As shown in Rodman (2006) the OLS estimate of the lagged dependent variable coefficient is biased upward, while with robust FE the coefficient on the lagged dependent variable is biased downward. Therefore, the GMM coefficient on the lagged dependent variable is expected to lie between the two, as shown in Table C1 of Appendix C.

6. RESULTS

Table 4 presents GMM estimation results from a robust specification of Equations 1 and 2 above, using the ratio of liquid assets to customer and short-term funding as a dependent variable.[24]

6.1 Baseline Specification

Estimation results from the baseline specification (Table 3, columns 1 and 2) show that liquidity buffers in CAPDR are persistent: the coefficient on the lagged dependent variable is positive and significant. This result is consistent with the view that banks target an optimal or desired level of precautionary liquidity holdings, although it could also be attributed to the presence of structural obstacles to credit that lead banks to hold higher liquidity buffers.

Hansen statistics, respectively. The estimation was implemented in Stata using Roodman's (2006) xtabond2 routine. Bank size and the country and year dummy variables were treated as predetermined and the other variables as endogenous.

[24] The coefficients on the macroeconomic variables (real GDP growth, interest rate spread) were consistent with predictions but neither significant nor very robust. Given the limited time span of our panel, part of the effect of these variables on liquidity buffers was likely captured by the country and time dummies. GMM estimation of the full model also became difficult as the number of instruments was becoming too large relative to available observations.

Liquidity ratios are related to bank size, though with nonlinearities: liquidity holdings increase with bank size, but there is a point at which bank size begins exhibiting a marginal decreasing effect on liquidity. This result is the opposite of what is found by Dinger (2009) in Eastern Europe, and may be explained by differences in the distribution of bank size in both regions. In CAPDR, the distribution of banks is highly skewed with a high concentration of assets in a few large banks, as indicated in Table 1 in Section 2.[25]

Liquidity holdings are also negatively related to the loan-loss reserve ratio, indicating that banks with higher savings against potential losses or riskier loan portfolios tend to have lower liquidity buffers in CAPDR. Liquidity holdings are negatively associated with the net interest margin (as expected), though the relation is not as robust as for the previous two variables. The coefficient on capitalization is negative and significant in the baseline, so that better capitalized banks would tend to hold less liquidity (the coefficient remains negative but is no longer significant in the specifications with interaction terms). As mentioned in the previous section, this finding is counterintuitive, as the expectation would be that better capitalized banks would also hold more liquidity buffers if higher capitalization is indicative of a prudent business model. The credit-to-GDP ratio is negatively related to liquidity buffers, in line with predictions (though the coefficient is not significant).

6.2 Specifications with Interaction Terms: The Role of Bank Ownership

Results indicate that ownership has some effect on liquidity holdings, though mostly through the interaction terms. Our results do not show any significant evidence that private

[25] In estimations without the quadratic term the coefficient on bank size is negative and robust across specifications as expected from theory and as found in related empirical studies (results available upon request).

Table 3

CAPDR: DETERMINANTS OF BANKS LIQUIDITY BUFFERS – GMM ESTIMATES

Dependent variable is the ratio of total liquid assets to customer deposits and short-term funding	*Baseline (1)*	*Private ownership (2)*	*Foreign ownership (3)*	*Dollarization (4)*
Liquid assets ratio (−1)	0.189[c]	0.218[a]	0.231[b]	0.223[b]
	(0.044)	(0.114)	(0.099)	(0.092)
Bank size	7.994[c]	8.545[c]	10.381[b]	5.639[b]
	(1.875)	(2.299)	(4.137)	(2.635)
Bank size squared	−0.371[c]	−0.392[c]	−0.483[b]	−0.244[a]
	(0.092)	(0.126)	(0.203)	(0.129)
Capitalization	−0.321[b]	−0.505	−0.316	−0.017
	(0.123)	(0.336)	(0.305)	(0.542)
Net interest margin	−0.123	−0.089	−0.593	0.404
	(0.076)	(1.067)	(1.199)	(0.331)
Loan-loss reserve ratio	−0.282	−0.035	−0.550	−0.799
	(0.252)	(0.588)	(0.506)	(0.624)
Credit to GDP ratio	−0.323	0.404	−0.441	−0.041
	(0.292)	(0.664)	(0.344)	(0.679)
Variable		42.500	−13.249	*1.491*[c]
		(36.406)	(18.512)	(0.470)
Capitalization * variable		0.077	0.161	−0.001
		(0.616)	(0.647)	(0.014)
Net interest margin * variable		0.036	0.309	−0.022
		(1.128)	(1.058)	(0.015)
Loan-loss reserve ratio * variable		−0.077	*2.858*[b]	0.027
		(0.827)	(1.291)	(0.022)
Credit to GDP ratio * variable		−1.283	0.169	−0.012
		(0.880)	(0.282)	(0.009)
Observations	321	321	321	321
R^2				
No. of groups	96	96	96	96
No. of instruments	64	54	54	64
Hansen test *p*-value	0.348	0.192	0.132	0.232

A-B AR(2) test	1.283	1.027	1.040	1.562
A-B AR(2) test *p*-value	0.199	0.305	0.298	0.118

Source: Authors' calculations.
Notes: Robust standard errors in parentheses. [a] Coefficient significant at the 10% level; [b] at the 5% level; [c] at the 1% level. Dependent variable is the ratio of liquid assets to total assets. GMM is two-step system GMM estimator with Windmeijer standard error correction. Columns 2 through 4 test the hypotheses that ownership (foreign/domestic and public/private), and degree of dollarization affect banks' liquidity buffers. Ownership is captured by dummy (=1 if the bank is private, =1 if the bank is foreign), dollarization by the share of dollar deposits in total deposits at the country level. All regressions include time and country dummies. Constant estimated but not reported.

ownership does affect liquidity buffers, though the coefficient on private ownership is positive. Foreign banks tend to hold less liquidity, but the coefficient on ownership is not statistically significant either. Foreign banks with riskier loan portfolios or which are more conservative regarding expected loan losses do tend to have higher liquidity buffers (Table 3, column 3). This finding is consistent with results obtained by Detragiache et al. (2008), who show that foreign banks tend to be more prudent and lend to less risky customers.

6.3 Specifications with Interaction Terms: Deposit Dollarization

As indicated in Table 3, column 4, deposit dollarization is robustly and significantly associated with higher liquidity buffers. The individual effect is quite large: a one standard deviation (34%) increase in deposit dollarization leads to a 150% increase in the liquidity to deposit ratio.[26] The strong positive

[26] Given that reserve requirements are set at the same rate for local and foreign currency deposits in most countries and that actual liquidity holdings are held above requirements, it is unlikely that this result is driven mechanically by reserve requirements. However, the large standard deviation is in part due to the fact that the share of foreign deposits in total deposits is 100 percent in El Salvador and Panama.

association between deposit dollarization and liquidity buffers may not necessarily imply a direct causal relation. The same factors that cause households and firms to hold more dollar deposits could very well also lead banks to hold more precautionary liquidity.[27] Nonetheless, the positive relation between dollarization and high liquidity holdings would help explain why the monetary transmission mechanism is slower in more dollarized economies (as discussed in Medina Cas et al., 2011).

The interaction with the loan-loss reserve ratio also indicates that prudent banks or banks with risky loan portfolios in dollarized economies tend to hold more liquidity (though the coefficient is not significant in the GMM specification). More profitable banks in dollarized economies tend to hold less liquidity.

6.4 Robustness Checks

As a main robustness check, we estimate our model using the ratio of liquid assets to total assets as our dependent variable. The results, which are presented in Table 4, are broadly consistent with those in Table 3 in terms of signs of coefficients. The coefficient on the lagged dependent variable is about twice as large and the coefficient of the dollarization variable remains significant and close to unity.

Table C1 in Appendix C presents further robustness checks. These include showing both the results of the pooled OLS and the fixed effects regressions as discussed above (columns 1-3), and looking into the interactions of foreign ownership and dollarization only for the private banks of the sample (columns 4-5). One caveat is that limiting the number of observations increases the risk of over-fitting the model with too many instruments. Nonetheless, the Hansen statistic's *p*-value remains reasonable for all specifications.

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[27] De Nicoló et al. (2005) find in a large cross-country sample that the credibility of macroeconomic policy and the quality of institutions are key determinants of deposit dollarization.

Table 4

CAPDR: DETERMINANTS OF BANKS LIQUIDITY BUFFERS – GMM ESTIMATES

Dependent variable is the ratio of liquid assets to total assets	*Baseline (1)*	*Private ownership (2)*	*Foreign ownership (3)*	*Dollarization (4)*
Liquid assets ratio (−1)	0.557[c]	0.567[c]	0.483[c]	0.519[c]
	(0.098)	(0.089)	(0.101)	(0.093)
Bank size	3.861[c]	4.077[c]	5.484[c]	3.815[c]
	(0.866)	(1.048)	(1.908)	(1.257)
Bank size squared	−0.180[c]	−0.197[c]	−0.262[c]	−0.179[c]
	(0.044)	(0.056)	(0.085)	(0.061)
Capitalization	−0.211[c]	−0.192	−0.175[a]	−0.063
	(0.070)	(0.124)	(0.099)	(0.215)
Net interest margin	−0.037	−0.799	−0.593[a]	0.216
	(0.033)	(1.193)	(0.311)	(0.151)
Loan-loss reserve ratio	−0.036	0.277	−0.292[a]	−0.178
	(0.145)	(0.280)	(0.166)	(0.395)
Credit to GDP ratio	−0.181	0.117	−0.295	0.249
	(0.181)	(0.355)	(0.251)	(0.553)
Variable		16.285	−5.554	*1.336*[c]
		(24.600)	(7.717)	(0.346)
Capitalization * variable		−0.071	−0.161	−0.003
		(0.251)	(0.212)	(0.004)
Net interest margin * variable		0.756	0.487	−0.012
		(1.186)	(0.328)	(0.008)
Loan-loss reserve ratio * variable		−0.291	1.340	0.005
		(0.456)	(0.903)	(0.017)
Credit * variable		−0.444	0.100	−0.013
		(0.424)	(0.130)	(0.009)
Observations	321	321	321	321
R^2				
No. of groups	96	96	96	96
No. of instruments	64	67	67	77

Hansen test *p*-value	0.337	0.267	0.283	0.448
A-B AR(2) test	1.075	1.152	0.891	1.427
A-B AR(2) test *p*-value	0.282	0.249	0.373	0.154

Source: Authors' calculations.
Notes: Robust standard errors in parentheses. [a] Coefficient significant at the 10% level; [b] at the 5% level; [c] at the 1% level. Dependent variable is the ratio of liquid assets to total assets. GMM is two-step system GMM estimator with Windmeijer standard error correction. Columns 2 through 4 test the hypotheses that ownership (foreign/domestic and public/private), and degree of dollarization affect banks' liquidity buffers. Ownership is captured by dummy (=1 if the bank is private, =1 if the bank is foreign), dollarization by the share of dollar deposits in total deposits at the country level. All regressions include time and country dummies. Constant estimated but not reported.

These additional regressions support our main findings. The relative size of the coefficient on the lagged dependent variable in the pooled OLS, fixed effects and GMM is consistent with expectations: in OLS this coefficient is correlated with the error term and biased upward, while in the fixed effects specification it is the opposite. Good estimates of the true parameter should lie in between or near these values, which is the case here (see column 2 of Appendix C, Table C1). Previous results on ownership and dollarization hold in the sample of private banks.

7. CONCLUSIONS AND POLICY LESSONS

Our study finds that liquidity buffers in CAPDR are comfortably above legal and prudential requirements. With average liquidity at about 25% of deposits (during 2006-2010), banks in the region have handled and are able to handle historic deposit volatility outside of crisis episodes.

A closer look at the reasons for which banks would want to hold liquidity buffers above legal or prudential requirements indicates that CAPDR banks appear to be guided at least in part by rational precautionary motives. One of our main findings and contribution of this paper is that, in the sample, banks' precautionary demand for liquidity is positively related to the degree

of deposit dollarization. Other results are in line with previous studies and show that bank characteristics that influence their ability to raise additional funding on demand play an important role. Smaller, less efficient and less profitable banks tend to hold higher liquidity buffers. Foreign banks tend to hold less liquidity, although this result is not statistically significant. This possibly reflects the preponderance of foreign subsidiaries in the pool of foreign banks sampled. Surprisingly, banks with riskier loan portfolios also hold less liquidity overall, though this is not the case for foreign banks and banks in highly dollarized economies.

Our results still need to be considered against the caveat of data limitations. The uneven coverage of individual countries' banking systems, short estimation time frame and small cross-section dimension may affect the coefficient estimates from the regressions. Nevertheless, some useful policy lessons already emerge from our analysis.

A first policy lesson would be to continue with ongoing efforts to strengthen financial sector supervision and develop financial markets. Greater confidence in the system and more opportunities for investment and intermediation (through stronger credit institutions) could help lower banks' precautionary liquidity buffers without compromising financial stability.

Strengthened supervision would help address the issue of the negative relation between the loan-loss ratio and liquidity buffers, which may indicate that domestic banks may not fully internalize the costs of riskier lending practices. In contrast, foreign banks may be subject to stricter internal guidelines. As mentioned, further progress in risk-based supervision would be especially warranted: despite notable progress, CAPDR countries still do not meet minimum international standards and lag behind larger South American countries.

Another important lesson relates to the dollarization of CAPDR economies and banking systems and calls for strengthening the credibility of macroeconomic policy and institutions as well as the coverage of financial safety nets. Our findings show that, in the sample, banks' precautionary demand for liquidity is associated with the degree of deposit dollarization. Given the lack

of US dollar LOLR facilities in all countries, and in particular the absence of LOLR facilities in the two fully dollarized economies, our findings suggest that continuing with ongoing efforts to strengthen financial safety nets (as in El Salvador) would be necessary.

Furthermore, maintaining higher liquidity buffers because of dollarization also has negative implications for the development of financial markets, and for the adequate functioning of the monetary policy transmission mechanism. For the countries in the region that aim at transitioning to inflation targeting, tackling the root causes of deposit dollarization should be an important part of their strategy.

With causality likely running from policies to dollarization and back, measures that would help create a *virtuous cycle* of dedollarization and lower precautionary liquidity holdings could be informed by the experience of dedollarization in South America. In a study of financial dedollarization in Bolivia, Paraguay, Peru and Uruguay, Garcia-Escribano and Sosa (2011) find that successful, market-driven dedollarization was associated with *i)* stronger macroeconomic policies and institutions, credible and consistent implementation of policies over time, *ii)* active management of reserve requirement differentials and introduction of other prudential measures, and *iii)* development of domestic currency capital markets. As discussed in this paper, there is ample room for more active liquidity management on the part of CAPDR monetary and prudential authorities. In addition, measures to develop local currency capital markets, starting with domestic public debt markets, would enhance financial systems' efficiency and help diversify sources of funding and investment opportunities.

Finally, further research could usefully look into the relation between high or excessive liquidity and financial depth. If there are indications that liquidity holdings in excess of what would be demanded by banks for precautionary motives are associated with lower bank lending, measures to promote more active bank liquidity management and reduce macroeconomic volatility would be warranted.

Appendix A

Apéndice A

Cuadro A1

ACPRD: REQUERIMIENTOS LEGALES DE RESERVAS Y DE LIQUIDEZ, 2010

País	*Requerimiento de reservas*		*Remuneración (porcentaje)*	*Requwerimiento de líquidez (porcentaje)*	*Pasivos computables*	*Activos de cumplimiento*	*Promedio*	*Penalidad*	*Finalidad/ último cambio*
	Moneda nacional (porcentaje)	*Moneda extranjera (porcentaje)*							
Costa Rica	15	15	n.d.		Demanda, moneda extranjera, tiempo, interbancarios, gobierno. Se excluyen los depósitos interbancarios.	Depósitos en el banco central (sólo aquellos en la cuenta de reservas) en la misma moneda que los depósitos.	Periodo de conservación de 15 días.	Tasa de interés de ventana de descuento sobre la deficiencia de reservas.	Política monetaria
Guatemala	14.6	14.6	0.6	n.d.	Todos los depósitos	Efectivo en bóveda y depósitos en el banco central en la misma moneda que los depósitos.	Mensual	n.d.	Política monetaria
Honduras	6 (no remunerados), 12 (remunerados)	12 (no remunerados), 10(remunerados)	Sólo inversiones obligatorias se remuneran a ½ de la tasa de interés.	Sí [1]	Depósitos, depósitos a plazo vencidos, contratos reducidos de capital y estampillas de ahorro y otros.	Efectivo en bóveda, depósitos en el banco central y bonos del gobierno en el caso de inversiones obligatorias en moneda nacional en la misma moneda que los depósitos.	Durante un periodo de dos semanas	Las penas dependerán de la moneda de denominación y del tipo de institución.	Política monetaria, 2008-2009
República Dominicana	17	20	Las reservas en moneda extranjera son remuneradas a la tasa de un día al otro de la Reserva Federal– 200 bps	n.d.	Demanda, moneda extranjera, tiempo, interbancario, gobierno. Se excluyen los depósitos interbancarios.	Permitido 18% en depósitos con el banco central y 2% en efectivo en bóveda.	Semanal, el periodo de tenencia termina el viernes	n.d.	Política monetaria, 2009
Nicaragua	16.25	16.25	n.d.	Sobre excesos de reserva (n.d.)	Todos los depósitos	Efectivo de títulos del BC.	n.d.	Interés cobrado con base en la tasa de interés interbancaria (mayor a 1%)	Política monetaria, 2005-2006
El Salvador	23	n.d.	n.d.	3	Todos los depósitos	25% para depósitos a la vista en el BC o en banco extranjero, 25% en depósitos o títulos del BC, 50% en títulos del BC emitidos con fines de liquidez.	Durante un periodo de dos semanas	n.d.	Prudencial
Panamá	n.d.	n.d.	n.d.	30; 20 (se aplica para todos los bancos con licencia general en territorio y bancos propiedad del estado a 30.0 para los bancos con licencia general; 20.0 para bancos con licencia general que mantienen depósitos promedios interbancarios trimestrales que exceden el 80 por ciento del total de los depósitos)	Demanda, depósitos a plazo de hasta 186 días (salvo que la parte que garantiza los préstamos en el banco mismo), depósitos de ahorro. Están excluidos los depósitos recibidos de la casa matriz, sucursales, subsidiarias o afiliadas en el exterior.	Moneda de curso legal en Panamá, depósitos bancarios en Panamá, depósitos bancarios en el extranjero, obligaciones emitidas por gobiernos extranjeros, obligaciones emitidas por agencias privadas extranjeras y del gobierno, obligaciones bancarias pagaderas en Panamá hasta en 186 días, cuotas de obligaciones pagaderas hasta 186 días, otros activos líquidos.	n.d.	n.d.	Prudencial

Fuentes: sitios web de los bancos centrales y superintendencias de ACPRD.
Nota: [1] Honduras también impone requerimientos de liquidez específicos, con base en bandas temporales por descalce de vencimientos. Para la primera banda, el descalce de vencimientos en flujos de caja para el próximo mes debe ser inferior a la cantidad de activos líquidos, mientras que para la segunda banda el descalce del vencimiento en flujos de caja para los próximos tres meses debe ser inferior a 1.5 veces los activos líquidos. n.d. indica que los datos no están disponibles.

Appendix B

Table B1

CAPDR: VARIABLES USED IN EMPIRICAL ESTIMATION

Variable name (expected sign)	*Concept*	*Measurement*	*Data source*
	Dependent variable		
Liquidity ratio	Liquid assets to customer deposits and short-term funding.	Cash, short-term claims on other banks (including CDs) and where appropriate the trading portfolio/customer deposits and short-term funding	BankScope
	Liquid assets to total assets.	Cash, short-term claims on other banks (including CDs) and where appropriate the trading portfolio/total assets	BankScope
	Explanatory variables		
	Bank characteristics		
Lagged liquidity ratio (+)	Liquidity buffers should be persistent over time.	See above for definition	BankScope
Capitalization (+)	Better capitalized banks should have more prudent business models.	Ratio of equity to total assets	BankScope

Net interest income to average earning assets (−)	Profitability: more profitable banks should hold less liquidity.	(Interest income−interest paid)/ interest earning assets	BankScope
Loan−loss reserves ratio (+)	Perceived riskiness by banks of their loan portfolio: banks anticipating higher losses should hold higher liquidity buffers.	Ratio of loan−loss reserves to gross loans	BankScope
Size (−)	If small banks are financially constrained, then they should hold more liquidity.	Natural logarithm of total assets	BankScope
Private ownership (+)	Private banks are expected to be more prudent and hold more liquidity than public banks, which can rely on implicit or explicit state guarantees.	Dichotomous variable (1 for private; 0 for public)	BankScope
Foreign ownership (−)	Foreign banks should be less financially−constrained than domestic banks and thus hold lower levels of liquid assets.	Dichotomous variable (1 for foreign; 0 for domestic). A distinction is also made between foreign subsidiaries and branches	BankScope
		Macroeconomic fundamentals	
Real GDP growth (−)	Imperfect capital markets imply that liquidity buffers should be countercyclical.	Annual growth rate of real GDP per capita	International Financial Statistics (IFS)
Interest rate spread (−)	Measure of the opportunity cost of holding liquid assets.	Difference between average lending and deposit rate	IFS

		Country characteristics	
Deposit volatility (+)	Higher aggregate deposit volatility forces banks to hold more liquid assets to hedge against unanticipated deposit withdrawals.	Coefficient of variation of monthly system–wide deposits during one year	Executive Secretariat of the Centroamerican Monetary Council <www.secmca.org>
Inflation volatility (+)	High inflation volatility is a proxy for macroeconomic instability.	Coefficient of variation of monthly inflation during one year	IFS
Credit to GDP ratio (−)	Captures financial development. More developed economies should have less financial constraints.	Total credit to the private sector as percent of GDP	Executive Secretariat of the Centroamerican Monetary Council <www.secmca.org>
		Moral hazard and safety nets	
Deposit dollarization (+)	The higher the dollarization, the lower the effectiveness of the domestic lender of last resort.	Share of foreign-exchange deposits in total deposits (system-wide)	Executive Secretariat of the Centroamerican Monetary Council <www.secmca.org>
Net international reserves (−)	In partially dollarized economies, NIR capture the capacity of the central bank to act as a lender of last resort in case of a foreign currency shock.	Natural logarithm of net international reserves	IFS

Table B2

CAPDR: DESCRIPTIVE STATISTICS

Variable	*No. observations*	*Mean*	*Std. dev.*	*Min.*	*Max.*
Liquid assets to customer deposits and short-term funding ratio	448	25.3	18.3	2.0	191.0
Liquid assets to total assets ratio	448	18.9	10.4	0.9	75.6
Capitalization (equity to asset ratio)	448	13.2	9.3	2.6	83.0
Loan loss reserves to gross loans	417	3.2	3.1	0.0	25.0
Net interest income to average earning assets	428	8.8	10.5	1.0	87.0
Loan to asset ratio	448	58.9	17.1	3.3	90.6
Loan growth (y/y, percent)	350	24.0	55.6	−66.2	594.5
Bank size (log of total assets)	448	12.8	1.7	4.1	16.5
Foreign ownership dummy (=1 if foreign bank)	480	0.4	0.5	0.0	1.0
Private ownership dummy (=1 if private bank)	480	0.9	0.3	0.0	1.0
Interest rate spread	480	8.3	2.9	3.1	16.8
Real GPD growth	384	3.9	5.7	-7.9	15.3
Net international reserves	480	7.9	0.4	6.7	8.6
Deposit dollarization	480	50.2	34.2	13.5	100.0
Credit to GPD (%)	480	48.8	25.9	17.2	93.7

Sources: International Financial Statistics, World Economic Outlook Database, BankScope Database, CAPDR central banks and banking supervision websites; authors' calculations.

Table B3

CAPDR: PAIRWISE CORRELATIONS

	Liquid assets to customer deposits and short-term funding ratio	*Capitalization*	*Loan-loss ratio*	*Net interest income*	*Bank size*	*Foreign ownership dummy*	*Private ownership dummy*	*Interest rate spread*	*Real GDP growth*	*Net international reserves*	*Deposit dollarization*	*Credit to GDP ratio*
Liquid assets to customer deposits and short-term funding ratio	1											
Capitalization	0.426[c]	1										
Loan-loss ratio	−0.011	0.027	1									
Net interest income to average earning assets	−0.077	0.244[c]	0.275[c]	1								
Bank size	−0.186[c]	−0.372[c]	−0.189[c]	−0.286[c]	1							

Foreign ownership dummy	0.097[b]	0.055	−0.083[b]	0.194[c]	0.067	1						
Private ownership dummy	0.124[c]	−0.116[b]	−0.137[b]	0.0723	−0.198	0.272[c]	1					
Interest rate spread	−0.194[c]	0.120[b]	0.155[b]	0.195[c]	−0.123[b]	0.044	−0.068	1				
Real GDP growth	0.052	0.029	−0.158[b]	−0.129[a]	0.032	−0.0838	0.025	−0.32[c]	1			
Log of net international reserves	−0.134[b]	−0.002	−0.071	0.054	0.078[a]	−0.08[a]	−0.18[c]	0.003	−0.041	1		
Deposit dollarization	−0.151[b]	0.098[a]	0.059	0.111[a]	−0.041	0.119[b]	−0.189[c]	0.808[c]	−0.323[c]	0.035	1	
Credit to GDP ratio	0.157[c]	−0.0181	−0.391[c]	−0.288[c]	0.227[c]	0.07	0.099[a]	−0.536[c]	0.362[c]	−0.209[c]	−0.462	1

Sources: IMF staff calculations, International Financial Statistics, World Economic Outlook Database, BankScope Database, CAPDR central bank and banking supervision websites.

[a] Coefficient significant at the 10 percent level; [b] at the 5 percent level; [c] at the 1 percent level.

Table B4

DEPENDENT VARIABLES' MEANS BY LIQUIDITY QUARTILES
(2008-2009)

	1st quartile of liquidity ratio	*2nd quartile of liquidity ratio*	*3rd quartile of liquidity ratio*	*4th quartile of liquidity ratio*	*p-value*
Mean of liquidity to customer and short-term funding ratio	*11.94*	*18.88*	*25.68*	*47.88*	
Loan loss reserves to gross loans	3.50	3.44	3.12	2.38	0.03
Net interest margin	10.31	8.92	9.95	8.30	0.39
Bank size (log of total assets)	12.83	13.13	13.12	12.37	0.21
Foreign ownership dummy (=1 if foreign bank)	0.38	0.41	0.52	0.47	0.36
Private ownership dummy (=1 if private bank)	0.88	0.92	0.89	0.98	0.05
Real GDP growth	−0.56	−0.13	0.09	2.44	0.00
Inflation volatility	2.72	2.16	2.14	2.00	0.01
Interest rate spread	10.07	8.60	8.36	7.44	0.00
Deposit volatility	3.30	3.22	2.92	3.68	0.25
Deposit dollarization	27.20	20.49	19.50	18.29	0.03
Credit to GDP ratio (%)	42.49	44.48	50.83	59.49	0.00
Number of observations	48	41	47	52	

Source: authors' calculations.
Note: *p*–value from a test of statistical difference of the means of the 4th quartile versus the 1st quartile.

Appendix C

Table C1

CAPDR: ROBUSTNESS CHECKS, DETERMINANTS OF BANKS' LIQUIDITY

Dependent variable is the ratio of liquid assets to customer deposits and short-term funding	*Baseline*[1]			*Foreign ownership*[2]	*Dollarization*[2]
	(1)	*(2)*	*(3)*	*(4)*	*(5)*
	Pooled OLS	*GMM*	*Fixed effects*		
Liquid assets ratio (−1)	0.347[c]	0.189[c]	0.169[c]	0.164[b]	0.227[c]
	(0.064)	(0.044)	(0.025)	(0.069)	(0.072)
Bank size	7.401[c]	7.994[c]	16.804	11.172[b]	7.848[b]
	(1.448)	(1.875)	(10.703)	(5.221)	(3.038)
Bank size squared	−0.350[c]	−0.371[c]	−0.886[a]	−0.553[b]	−0.381[b]
	(0.064)	(0.092)	(0.476)	(0.218)	(0.152)
Capitalization	−0.355[c]	−0.321[b]	−0.502[c]	−0.453	−0.424
	(0.060)	(0.123)	(0.184)	(0.516)	(0.477)
Net interest margin	−0.156[b]	−0.123	0.011	−1.169	0.332
	(0.064)	(0.076)	(0.325)	(0.833)	(0.335)
Loan-loss reserve ratio	−0.224	−0.282	0.221	−0.984	−1.032
	(0.160)	(0.252)	(0.290)	(0.810)	(0.704)
Credit to GDP ratio	−0.213	−0.323	−0.337[a]	−0.904[b]	−0.860
	(0.272)	(0.292)	(0.199)	(0.387)	(0.675)
Variable				−18.363	1.201[c]
				(15.445)	(0.412)

Capitalization * variable				−0.070	0.000
				(0.711)	(0.008)
Net interest margin * variable				0.973	−0.021
				(0.891)	(0.015)
Loan-loss reserve ratio * variable				3.021[a]	0.036
				(1.552)	(0.022)
Credit to GDP ratio * variable				0.212	−0.003
				(0.214)	(0.009)
Observations	321	321	321	289	289
R^2	0.55		0.19		
No. of groups		96	96	88	88
No. of instruments	.	64		67	77
Hansen test *p*-value		0.348		0.117	0.135
A-B AR(2) test		1.283		0.770	1.574
A-B AR(2) test *p*−value		0.199		0.442	0.116

Source: Authors' calculations.
Notes: Robust standard errors in parentheses. [a] Coefficient significant at the 10 percent level; [b] at the 5 percent level; [c] at the 1 percent level. Dependent variable is the ratio of liquid assets to customer deposits and short-term funding. Two-step system GMM estimator with Windmeijer standard error correction. Ownership is captured by dummy variables (=1 if the bank is private, =1 if the bank is foreign), dollarization by the share of dollar deposits in total deposits at the country level. All regressions include time and country dummies. Constant estimated but not reported. [1] Baseline specification as in column (1) of Table 4. [2] Columns 4-5 show GMM estimation results for the sample of private banks (excluding public banks).

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Analysis of the Real Exchange Rate in the Dominican Republic: A Study Based on the International Monetary Fund's Assessment Methodologies

Abstract

This paper employs the International Monetary Fund's Consultative Group on Exchange Rate Issues' (CGER) methodologies to determine the real exchange rate misalignment: i) the macroeconomic balance (MB) approach, ii) the external sustainability (ES) approach, and iii) the equilibrium real exchange rate (ERER) approach. Additionally, we analyze the advantages and disadvantages of estimating disequilibrium with different filters, including the Hodrick-Prescott (HP) and trend-cycle filters. Results indicate that, both at the short-run and the medium-run, Dominican Republic's real exchange rate is slightly appreciated with respect to its estimated equilibrium level.

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The opinions expressed in this paper are those of the authors and do not necessarily reflect the views of the Banco Central de la República Dominicana. We would like to thank José M. Mota Aquino for his comments and suggestions. Please contact Rafael A. Rivas Cueto with any comments at <r.rivas@bancentral.gov.do>. Any errors are the exclusive responsibility of the authors.

Keywords: RER, CGER-IMF, imbalance.
JEL classification: F31, F32.

1. INTRODUCTION

This paper is aimed at determining the degree to which the Dominican Republic's real exchange rate (RER) is misaligned from its estimated equilibrium value. To achieve this we employ three methodologies of the International Monetary Fund's (IMF) Consultative Group on Exchange Rate Issues' (CGER): *i)* the macroeconomic balance (MB) approach, *ii)* the external sustainability (ES) approach and *iii)* the equilibrium real exchange rate (ERER) approach. In the first case, the MB focuses on determining the RER adjustment required to close the gap between the ratio of the current account balance to gross domestic product (GDP) (or the underlying current account) and the ratio of the medium-term equilibrium current account to GDP determined by the economy's fiscal, real, demographic and external sector variables. In order to calculate the underlying current account this approach assumes that, with the current exchange rate, the Dominican Republic and its trading partners are economies in their stationary state. The second methodology, the ES approach, estimates the rer adjustment that would close the gap between the current account to underlying GDP ratio and a current account to medium-term equilibrium GDP ratio consistent with a reference volume of net foreign assets. Finally, the ERER approach calculates the equilibrium relation between the RER and the fundamentals that determine it, such as government consumption, gross capital formation, trade openness and interest rates, to then compare the estimated equilibrium RER with its actual value.

It is important to mention that when applying the ERER approach we deviate from the steps taken by the CGER for calculating the RER misalignment as compared to its equilibrium level. Firstly, while the CGER focuses on medium-term misalignment, our paper focuses on misalignment in the short-run. Secondly, when applying the ERER approach we employ

time series models with economic data for the Dominican economy as opposed to employing panel data models with information of several countries. Thirdly, we estimate various equilibrium RERs for calculating misalignment. The first of these is constructed using original series of fundamentals that determine the RER, while the second is constructed using the trend-cycle component of said series. Finally, we estimate the equilibrium RER using a series smoothed with Hodrick and Prescott filter (1997).

In general, the results of the study show that for the second quarter of 2013 there is a positive, though not significant, misalignment of the Dominican Republic's RER as compared to its equilibrium value. This result also applies to the medium-term analysis of the MB approach. In terms of the medium-term current account, the results of the MB approach indicate that the underlying current account, which is assumed as the most recent projection for the current account available in the IMF's World Economic Outlook (WEO) database of October 2013, exhibits a larger deficit than that shown by the estimated medium-term equilibrium current account to GDP ratio. As a consequence, a real depreciation of the exchange rate is necessary to close the gap between the underlying current account and the medium-term equilibrium current account. However, this result should be taken with caution because the year 2012 provided unusual public and external deficits.

With the ES approach, the results indicate that the underlying current account exhibits a smaller deficit than the medium-term equilibrium current account, meaning an appreciation of the real exchange rate is required. According to the estimation specification and the trade balance elasticity value with respect to the RER that is chosen, the RER misalignment obtained through the MB approach is estimated to be within a range of −1% to 7.1%, while the misalignment obtained from the ES approach is estimated to be within a range of −2% to −0.6%. Finally, according to the ERER methodology, the RER misalignment as of the second quarter of 2013 is 2.6%. Although the degrees of misalignment obtained by applying the three approaches

are not of significant size, two of them do indicate that the RER is slightly appreciated as compared to its equilibrium level (ERER and MB), while the other shows a depreciated real exchange rate (external sustainability).

It is important to mention that Vásquez-Ruiz and Rivas (2012) estimate the equilibrium RER for the Dominican Republic employing various measures of the RER index. By employing time series econometrics, the research places average RER misalignment during 2011 at 1.4% and estimates it was 0.9% in the first quarter of 2012. Moreover, using a similar methodology to that of Vásquez-Ruiz and Rivas (2012), Medina (2007) estimates that for the fourth quarter of 2006 the RER was appreciated 11.8% with respect to its equilibrium level. For the same period Vásquez-Ruiz and Rivas (2012) estimate the appreciation of the RER at 2.6%, i.e., in the same direction as Medina (2007), but smaller. The contributions of this paper to the literature that already exists on estimating the misalignment of the Dominican Republic's RER from its equilibrium level are: first, besides obtaining RER misalignment by employing time series econometric models in the same way as Medina (2007) and Vásquez-Ruiz and Rivas (2012), this research also obtains measures of the misalignment of the Dominican economy's RER by employing econometric panel data using data from 35 emerging economies, as well as that of the Dominican Republic; second, when applying the ERER approach, we use various statistical filters for estimating the equilibrium RER; and third, our analysis incorporates the MB and ES approaches, which obtain the RER misalignment implied by the misalignment of the Dominican Republic's current account with respect to its medium-term equilibrium level.

It is important to point out that in order to be consistent with the IMF's CGER methodologies, the analysis is made around the multilateral RER, which we refer to simply as the RER throughout the paper. For a study that includes, besides the multilateral RER multilateral, the bilateral RER vis-à-vis the United States, see Vásquez-Ruiz and Rivas (2012).

The rest of the paper is organized as follows: Section 2 briefly describes the relation between the performance of the Dominican economy and the RER; Section 3 describes the empirical methodology employed to make the estimations and the data used in the study; Section 4 presents the results; and finally, Section 5 gives the conclusions.

2. PERFORMANCE OF THE DOMINICAN ECONOMY AND THE REAL EXCHANGE RATE

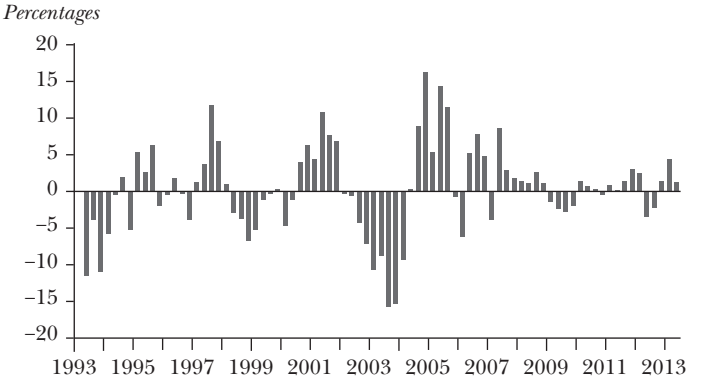
From 1995 to the end of 2002, the Dominican Republic experienced one of the most significant economic miracles in all Latin America, with average real GDP growth of 6%, inflation considerably below double digits, and relatively low levels of public indebtedness of around 25% of GDP. During said period, RER misalignment remained within a range of ±10% with respect to its estimated equilibrium value (see Figure 1). During the last decade, however, the Dominican Republic suffered a series of internal and external shocks that led to significant misalignments of the RER with respect to its equilibrium level, as well as the fundamentals that determine it. These shocks, which changed the behavior of domestic consumption and investment, resulted in substantial appreciations and depreciations of the RER and also had considerable repercussions on the equilibrium values of the public deficit, the balance of payments, and indebtedness, forcing policymakers to respond in order to steer the economy back onto the path of equilibrium and stability. The most important external and internal shocks that have hit the Dominican economy over the last decade can be linked to three main events: *i)* the banking crisis of 2003, *ii)* the increase in commodity prices during 2008, and *iii)* the second-round effects of the international financial crisis of 2007-2009.

Between 2002Q3 and 2004Q3, the Dominican economy underwent the worst financial crisis in its entire history. The increasing rumors about the potential collapse of one of financial system's largest banks unleashed a series of mass withdrawals

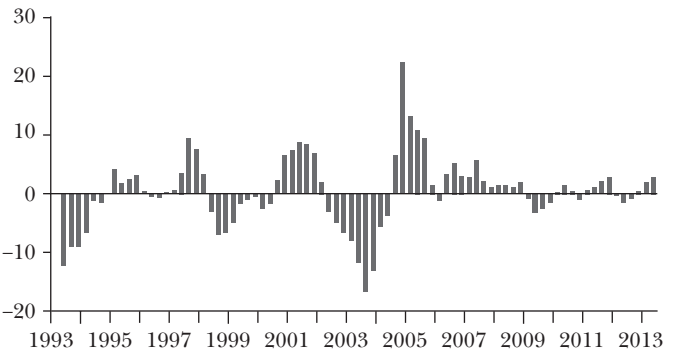
Figure 1

Misalignment of the Real Exchange Rate

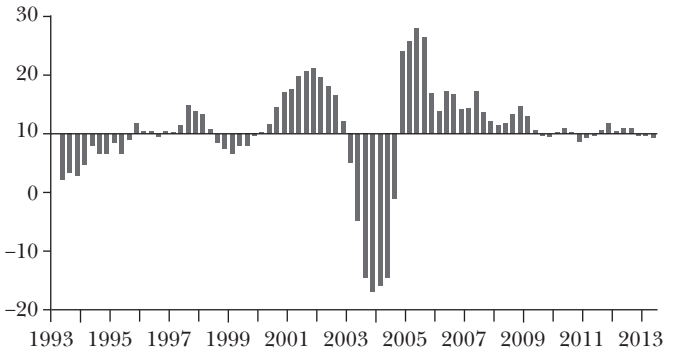
Original Series, Fundamental Variables



Trend-cycle Version, Fundamental Variables



Hodrick-Prescott Version, Fundamental Variables



by depositors, who changed their liquid resources into United States dollars. The financial crisis represented a turning point in the stability of the Dominican economy: The nominal exchange rate depreciated by around 67%, and real GDP contracted approximately 1.9% within a period of one year. In nominal US dollar terms, GDP fell by 20% (i.e., 4,000 million US dollars) as a result of the exchange rate depreciation. In that period, RER misalignment was above 20% and led to significant movements in the trade balance and the capital account of the balance of payments.

The period of stability began when new authorities took over at the Central Bank and reoriented monetary and exchange rate policies. Policymakers responded by selling certificates of deposit or central bank notes to the general public in order to reduce the money supply. As a result, annualized inflation fell from 139.3% in 2004Q1 to −7% in 2004Q4, before reverting to its long-term growth rate of around six percent.

The stabilization program had a high cost in terms of the Dominican economy's debt levels. In the period 2002-2004, the external public debt rose from 14.7% to 24.5% of GDP (1,800 million dollars), while the Central Bank had to issue some 3,000 million dollars (14% of GDP) in debt instruments as a result of open market operations that were carried out to reduce the inflationary spiral affecting the economy. In the period 2005-2008, the debt-to-GDP ratio reverted to normal values (20.7% of GDP) as a consequence of the low average growth of debt levels (9.2%) and the significant average growth of nominal GDP (20.4%), both measured in dollars. At the same time, RER misalignment recorded very low and stable values, less than five percent with respect to its estimated equilibrium level.

In 2008, food and oil prices recorded historically high levels (the WTI crude oil FOB price was 143.3 dollars per barrel in July 2008), which, combined with the effects of the international financial crisis, had a negative impact on the Dominican trade balance and economy. Moreover, just like all small open economies, the Dominican Republic did not avoid suffering the shocks from the international financial crisis. Between

2007 and 2009, Dominican exports recorded a significant drop of 23.4%, which was accompanied by small decreases in inflows from tourism and remittances. As a result, in October 2009 the Dominican government signed a *stand-by* arrangement with the IMF for a total of 1,700 million dollars, of which 320.6 million were drawn on during November 2009. These events reversed the downward path followed by the government debt-to-GDP ratio, which increased from 18.2% in 2007 to 28.4% in 2009.

Since 2009, the RER has remained very close to its equilibrium level. The latter is shown in all the tests carried out with different methodologies, which indicate the absence of significant misalignments. Such behavior has continued despite the unfavorable international economic environment and adverse domestic conditions due to pressures stemming from the fiscal imbalances caused by the strong political-economic cycle that occurred during the last presidential elections (Guzmán and Lizardo, 2003; Vásquez-Ruiz, Rivas and Díaz, 2013).

3. METHODOLOGY

This section describes the steps carried out in line with each of the three methodologies of the IMF's CGER for determining RER misalignment based on the IMF paper elaborated by Lee et al. (2008).

3.1 Macroeconomic Balance Approach

The macroeconomic balance approach (MB) requires three items for calculating RER misalignment with respect to its equilibrium level: *i)* an underlying current account to GDP ratio; *ii)* a medium-term equilibrium current account to GDP ratio; and *iii)* the elasticity of the Dominican Republic's trade balance with respect to its RER. The underlying current account assumes, with the current exchange rate, that the local economy and the economies' of its trading partners are

in their stationary state. The latter is consistent with the most recent projection of the current account as a percent of GDP for 2018 available in the October 2013 WEO database. To obtain the medium-term equilibrium current account to GDP ratio, we first calculate the following equation for a panel of 35 countries with emerging economies (31 if we only consider oil importing countries):[1]

$$y_{it} = \alpha_i + X_{it}^T \delta + \mu_{it} \,. \qquad (1)$$

Dependent variable y_{it} represents the current account balance as a percentage of GDP; X_{it} contains independent fiscal, real, demographic and external sector variables for the economy; μ_{it} is the error term, while α_i represents characteristics or effects that vary between countries but not over time. Note that i represents each country in the cross section and t represents time.

Just as Lee et al. (2008), for estimating Equation 1 we use four-year averages of the annual variables for the period 1975 to 2011.

Based on the literature, the variables that determine the current account included in vector are:

- *Old age dependency ratio.* It is the ratio of the number of people above 64 to the number of people between 15 and 64. The larger the share of the population that depends on the savings of the economically active population, the smaller the country's available savings and, therefore, the lower the current account balance. We expect a negative ratio.
- *Young age dependency ratio.* It is the ratio of the number of people under 15 to the number of people between 15 and 64. As in the case of old-age dependency, the higher the ratio, the lower the current account balance. We expect a negative ratio.
- *Population growth rate.* High population growth rates imply an increase in the future workforce, allowing larger current

[1] Net oil-exporting countries in the database are: Algeria, Ecuador, Mexico and Venezuela.

account deficits to be maintained in the future. We expect a negative ratio.

- *Net foreign assets (NFA).* The volume of a country's NFA can affect the current account balance in opposite directions. On the one hand, countries whose foreign assets surpass their international liabilities (i.e., a positive NFA balance) are capable of financing current account deficits over the medium-run, potentially leading to a negative association between the current account balance and the level of NFA. On the other hand, countries with a positive nfa balance benefit from higher foreign income flows, which lead to a positive association between the current account balance and the level of NFA. In light of the aforementioned we expect an ambiguous ratio. As in Lee et al. (2008), we use the first lag of NFA data for the estimation.
- *Investment.* Investment is a variable of aggregate demand. An increase in investment leads to a deterioration in the current account balance. We expect a negative ratio.
- *Real economic growth.* An economy that grows in real terms generates more consumption, increasing aggregate demand and lowering the current account balance. We expect a negative ratio.
- *Relative income.* Developing countries usually finance their investment with external resources, which deteriorates the current account balance. As an economy reaches higher levels of development and closes the gap with more advanced economies, its current account balance improves. We estimate this variable as the ratio of per capita GDP in each country to per capita GDP in the United States, measured in real terms. We expect a positive ratio.
- *Squared relative income.* This avoids linearity between relative income and the current account balance. We expect an ambiguous ratio.
- *Trade openness.* Measured as the sum of exports and imports as a percentage of GDP. We use this variable as a substitute

variable that reflects barriers to external trade. We expect an ambiguous ratio.

- *Financial development.* Measured as domestic credit granted by the banking sector. Greater availability of credit in the economy could be explained by higher previous saving, which positively contributes to the current account balance. Meanwhile, more available loans can discourage saving. We expect an ambiguous sign.
- *Central government balance.* A smaller fiscal balance deficit contributes to domestic saving and, therefore, raises the current account balance. We expect a positive ratio.
- *Oil balance.* A negative oil balance, i.e., higher oil exports than imports, deteriorates the current account balance. We expect a positive ratio.

After carrying out the estimation of Equation 1, the next step for obtaining the medium-term equilibrium current account (as a percent of GDP) is to apply the estimated ratios to the projected medium-term values of the independent variables described above. The limited availability of projections for these variables meant that in some cases we were forced to use the most recent available data instead. We used projections from the October 2013 WEO for the following variables: population growth, real economic growth, relative income, central government balance and the oil balance. Meanwhile, for the variables old age and young age dependency, projections were taken from the US Census Bureau's International Data Base (USA). For the variables investment, trade openness and domestic credit granted by the banking sector, the most recent data available, which corresponded to 2012, was used. In the case of net foreign assets, we used the most recent available data for the Dominican Republic's net international investment position as a substitute variable.

The next step is to obtain the misalignment of the underlying current account with respect to the medium-term equilibrium current account. The fact that the underlying current account takes the current exchange rate as given means the misalignment

between it and the medium-term equilibrium current account allows us to infer the RER adjustment necessary to close the gap between the underlying current account and its estimated medium-term equilibrium level. Finally, the RER adjustment, or in other words, the misalignment with its estimated medium-term equilibrium level, is obtained as follows:

$$D_{RER} = \frac{1}{\sigma} D_{CA}, \quad (2)$$

that is, ER misalignment, D_{RER}, is equal to current account misalignment, D_{CA}, multiplied by the inverse elasticity of the trade balance with respect to the RER, σ. In the case of the Dominican Republic, we obtain σ from Tokarick (2010), who offers three alternatives for it: *i)* a calculation of elasticity based on the IMF's CGER methodology, which assumes that both the export supply curve and the import supply curve of the country in question are perfectly elastic; *ii)* the general elasticity, which assumes that the elasticity of export and import demand curves is negative, while the elasticity of export and import supply curves is positive; and *iii)* the small country elasticity estimation based on the assumption that export and import volumes of the country in question do not have any effect on international prices, i.e., it assumes that both export demand elasticity and import supply elasticity are infinite.

3.2 External Sustainability Approach

The only difference between the MB and the external sustainability approach (ES) is the way in which the medium-term equilibrium current account is estimated. In this case, we use projections for the Dominican economy's inflation rate and real growth rate, as well as a reference level for net foreign assets, to construct the medium-term equilibrium current account. We take the projections from the October 2013 WEO database and we use the most recent data available on the Dominican Republic's net international investment position as a reference volume of net foreign assets. The medium-term equilibrium current account (in percent

of GDP) consistent with a reference volume of net foreign assets is calculated as follows:

$$CA_S = \frac{g + \pi(1+g)}{(1+g)(1+\pi)} NFA \,, \tag{3}$$

where CA_S is the medium-term equilibrium current account, g is the projected real growth rate of the economy, π is the projected inflation rate and *NFA* is the reference volume of net foreign assets. After calculating Equation 3, we use the WEO projection for 2018 of the Dominican Republic's current account balance (in percent of GDP) as the underlying current account and the elasticities of Tokarick (2010) to calculate RER misalignment, D_{RER} , using Equation 2.

It is important to point out that both approaches, the MB and ES, have several disadvantages. First, given that the RER variable is not used explicitly in the analysis, both methodologies provide an indirect estimate of RER misalignment with respect to its medium-term equilibrium level. Second, both methodologies depend on projections for the variables used in the analysis that, by nature, are uncertain. Moreover, the fact that the ES approach does not have a clear rule on how to choose the reference volume of net foreign assets is a shortcoming. The ERER approach, shown below, corrects the first problem by explicitly using the RER as an endogenous variable in the analysis. Regarding the disadvantage of inaccuracy involved in the use of projections, when applying the ERER approach we deviate from the steps the CGER takes for calculating RER misalignment; while the CGER focuses on RER misalignment with respect to its medium-term equilibrium value, our work focuses on short-run misalignment; i.e., we eliminate the use of projections.

3.3 Equilibrium Real Exchange Rate Approach

The equilibrium real exchange rate (ERER) methodology consists of estimating the relation between the RER and a set of fundamentals determining it, such as government consumption, gross capital formation, trade openness, interest rates and export

growth, in order to then compare the estimated equilibrium value of the RER with its actual value. The relation is calculated with ordinary least squares and using quarterly data, as follows:

$$RER_t = \beta^T X_t + \gamma_t \,, \tag{4}$$

where RER_t is the real exchange rate in t; X_t contains the set of fundamentals that determine the exchange rate and γ_t is the error term.[2] The variables contained in are:

- *Government consumption*. The RER might respond to an increase in government consumption in two different ways: *i)* if the increase in government consumption mostly fell in the economy's nontradable sector, we would have an appreciation of the real exchange rate due to the rise in domestic demand; *ii)* nevertheless, if it occurred in the tradable sector, the current account would weaken and lead to pressure for a depreciation in the RER. Given that we do not have data for discriminating which sector, tradable or nontradable, raises government consumption more, we expect an ambiguous ratio.
- *Gross capital formation*. As in the previous case, the effect of an increase in gross capital formation depends on the economic sector, tradable or nontradable, where it occurs. An increase of gross capital formation in the nontradable goods and services sector tends to lead to an appreciation in the real exchange rate. The opposite takes place if it occurs in the economy's tradable sector. We expect an ambiguous coefficient.
- *Trade openness*. A reduction of trade restrictions tends to decrease the prices of tradable goods, which in turn reduces

[2] The standard error for each of the estimated ratios is given by the Newey and West (1987) methodology, which provides a consistent estimation of the variance-covariance matrix. This ensures that the parameters and their respective standard errors are calculated consistently.

an economy's general level of prices. Thus, greater trade openness leads to a depreciation of the real exchange rate, i.e., we expect a negative ratio.

- *Real rate of return differential.* A higher rate of return differential causes appreciation of the real exchange rate given that an increase in capital productivity would lead to larger capital flows toward the Dominican Republic. As a consequence, we expect a positive ratio.
- *First difference of logarithm of exports.* Given that there is no data on the terms of trade variable for the Dominican Republic, we use the export growth as a substitute variable in order to reflect changes in the international economic environment. As an increase in export growth can lead to an appreciation of the RER, the ratio is expected to be positive.

The multilateral RER index we use for estimating Equation 4 was taken from the IMF's International Financial Statistics (IFS) and is based on 2005. It is important to mention that the ERER approach is the only one of the three methodologies that explicitly uses the RER index in the estimation process.

After calculating Equation 4, the estimated ratios are applied to the trend-cycle, filtered according to Hodrick-Prescott (1997) and original set of fundamentals versions for constructing several measures of equilibrium RER. Then, RER misalignment is calculated as:

$$D_{RER\,ERER} = \frac{RER_{Obs} - RER_{eq}}{RER_{eq}}, \tag{5}$$

where RER_{Obs} is the observed RER series and RER_{eq} is the estimated equilibrium RER series.

3.4 Equilibrium Real Exchange Rate Approach: Measures

The construction of the three measures of the equilibrium RER we use for calculating misalignment with the ERER approach are described below.

To construct the first measure of equilibrium RER, we take ratios calculated through Equation 4 and apply them to the trend-cycle component of the set of fundamentals, i.e., the version that eliminates the seasonal component and irregular component of the fundamental variables leaving just its trend and the fluctuations around the trend. Although the long-term behavior that captures the trend of a series is associated to an equilibrium behavior, we believe that the trend smooths the behavior of the fundamentals and therefore decided not to extract its cyclical component for estimating the equilibrium RER. Following previous works, such as that of Iossifov et al. (2007) and Medina (2007), we construct a second measure of the RER by applying the ratios estimated in Equation 4 to the fundamentals smoothed by the Hodrick-Prescott (HP) filter, which extracts the cyclical component of the series it is applied to. Use of this filter is justified by the fact that the original series of fundamentals contain *noise* or short-run fluctuations that do not correspond to the behavior a variable should exhibit when it is at its equilibrium level. Said justification also turn into criticism of our first measure of equilibrium RER given that, although the trend-cycle version of the series eliminates its seasonal and irregular components, it does not eliminate the short-run cyclical behavior that the HP filter extracts. Finally, we construct a third measure of the equilibrium real exchange rate by simply applying the ratios estimated in Equation 4 to the original set of fundamentals that determine the real exchange rate.

4. RESULTS

Table 1A of the Annex shows the estimation of Equation 1 divided into two groups: One group that includes all the countries and another that only includes oil importing countries.[3]

[3] It is important to point out that Table 1A includes Equation 1 specifications that instead of including fixed effects are estimated through clustered ordinary least squares.

All the ratios, except the one that identifies the effect of relative income on the current account, show the expected signs in the majority of specifications. These panel estimates are just the first step for determining the RER misalignment with respect to its estimated medium-term equilibrium level using the MB methodology. As explained in Section 3, in order to calculate the medium-term equilibrium current account we take the estimated coefficients shown in Table 1A and apply them to the projections for the fundamentals that determine the current account balance, while the underlying current account to GDP ratio corresponds to the projection for 2018 from the October 2013 WEO database and is the same value for all the estimation specifications of Equation 1. Table 2A compares the estimated medium-term equilibrium current account to GDP ratio with the underlying current account to GDP ratio in order to obtain the misalignment of the latter with respect to the former. We can see that in seven out of eight cases the underlying current account has a larger deficit than the medium-term equilibrium current account and that, besides this, there is no significant difference between the estimates that use the 35 countries of the sample and those only using oil importing countries. In general, the aforementioned points to the need for a depreciation of the real exchange rate to close the gap between both current account to GDP ratios. Table 3A shows the results of the Dominican Republic's RER misalignment employing the MB approach. As mentioned earlier, we use three different values for the elasticity of the Dominican Republic's trade balance with respect to the RER obtained from Tokarick (2010). Focusing on an elasticity value that assumes the country in question, in this case the Dominican Republic, has a small economy with no influence on tradable goods prices in international markets (small country elasticity, last line of Table 3A), we see that the RER misalignment based on estimations using all the countries of the sample is 0.8% on average, while the misalignment which only takes into account oil importing countries is 0.7% on average. The aforementioned shows that the Dominican Republic's medium-term RER is above

its equilibrium value, implying a real depreciation is necessary. When different values of trade balance elasticity with respect to the RER are assumed we arrive at the same conclusion, i.e., with the MB methodology, a depreciation of the real exchange rate is necessary to bring the current account (as a percent of GDP) to its estimated medium-term equilibrium level. Nonetheless, it is important to point out that the size of the necessary RER adjustment is not significant.

Table 4A shows the results of the Equation 3 estimation. When using the ES methodology, we see that the underlying current account exhibits a smaller deficit than that indicated by the medium-term equilibrium current account to GDP ratio consistent with a reference volume of net foreign assets. The 0.5% misalignment of the current account with respect to its estimated medium-term equilibrium level implies an appreciation of the real exchange rate is necessary in the Dominican Republic. This result coincides with those of the MB methodology in the sense that the size of the required RER adjustment is not significant. With the ES methodology, the estimated RER misalignment consistent with the small country trade balance elasticity with respect to the RER is −0.6%, indicating that with this methodology the RER is below its medium-term equilibrium value and that an appreciation of the exchange rate is necessary. This conclusion remains unchanged if we take into account the other two values of trade balance elasticity with respect to the real exchange rate.

After applying the MB and ES methodologies we obtain that the average RER adjustment necessary for eliminating misalignment is less than 1%, in absolute value. We therefore consider that the Dominican Republic's RER is practically aligned with its medium-term equilibrium level.

Finally, the ERER methodology (Table 7A) shows real exchange rate misalignment from its estimated equilibrium value as of the second quarter of 2013. If the unfiltered version of the fundamentals determining the RER is used to calculate its equilibrium value we obtain a misalignment of 1.2%. Meanwhile, the misalignment estimation that uses the trend-cycle

version of the fundamentals is 2.6%. And, misalignment with the version of the fundamentals smoothed through the HP filter is −0.9%. Two of the three estimations indicate that the RER is appreciated with respect to its estimated current equilibrium level, although the size of this deviation is not significant. It is important to mention that the misalignment estimation using the trend-cycle version of the set of fundamentals is between the smoothed-out (Hodrick and Prescott) estimation and that using the original set of fundamentals. While it is true that there are no significant differences among the three RER misalignment estimations according to the ERER approach, we are inclined to choose the estimation obtained when using the trend-cycle component of the set of fundamentals because it does not smooth-out but does eliminate seasonality and irregularity from the behavior of said series.

In sum, the two methodologies that aim to close the gap between the Dominican Republic's projected medium-term current account and the equilibrium value of said current account indicate that the RER is practically aligned with its medium-term equilibrium level. Moreover, the methodology that explicitly models the current RER according to its fundamentals and compares it with the RER observed in the short-run points to a positive RER misalignment, implying the need for a depreciation of the real exchange rate. We consider that the RER adjustment necessary for reaching the equilibrium value in each of the methodologies is not very significant given that the RER misalignment obtained through the MB methodology is estimated to be within a range of [−0.5%, 3.4%] if general elasticity is used. When the IMF's CGER elasticity is employed, the misalignment falls within a range of [−1%, 7.1%]. Moreover, if the small country elasticity is used, RER misalignment is estimated to be within a range of [−0.3%, 2.1%]. The misalignment obtained through the ES methodology is estimated at −1% when using the general elasticity, at −2% when using the CGER elasticity, and at −0.6% when using the small country elasticity. Finally, according to the ERER methodology, the RER misalignment as of 2013Q2 is 2.6 percent.

5. CONCLUSION

This paper estimated the degree of misalignment of the Dominican Republic's RER with respect to its equilibrium level. Based on the results of employing the International Monetary Fund's Consultative Group on Exchange Rate Issues' methodologies we can state that, both at the short-run and the medium-run, the RER has no significant misalignments.

The macroeconomic balance methodology indicates that the RER misalignment with respect to its medium-term equilibrium level is estimated to be within the following range: [−1%, 7.11%]; while with the external sustainability methodology this estimation is within the range of: [−2%, −0.6%]. These two methodologies calculate RER misalignment through the medium-term misalignment of the current account to GDP ratio. The equilibrium real exchange rate methodology estimates RER misalignment as of the second quarter of 2013 at 2.6%. It is important to point out that for the MB methodology we calculate the medium-term equilibrium current account based on a panel estimation that employs fixed effects. For the ERER methodology we estimate a time series model that relates the RER to its fundamentals.

Annexes

Annex A. Results

Table 1A

MACROECONOMIC BALANCE APPROACH REGRESSIONS

	All the countries				*Oil importing countries*			
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
	Dependent variable: current account balance/GDP							
Constant	0. 085[a]	0. 070[c]	0. 014	−0. 012	0. 046[c]	−0. 037	0. 017	−0. 017
	(0. 023)	(0. 040)	(0. 019)	(0. 041)	(0. 025)	(0. 048)	(0. 021)	(0. 047)
Older dependents	−0. 333[b]	−0. 141	−0. 057	0. 324	−0. 155	0. 222	−0. 026	0. 276
	(0. 136)	(0. 305)	(0. 115)	(0. 313)	(0. 137)	(0. 316)	(0. 121)	(0. 336)
Young dependents	−0. 071[b]	−0. 076[c]	−0. 024	−0. 019	−0. 034	−0. 001	−0. 029	−0. 019
	(0. 031)	(0. 043)	(0. 027)	(0. 044)	(0. 033)	(0. 047)	(0. 028)	(0. 048)
Population growth	−0. 842	−1. 484[c]	−0. 395	−0. 479	−1. 010	−1. 211	−0. 219	−0. 326
	(0. 647)	(0. 869)	(0. 544)	(0. 819)	(0. 634)	(0. 852)	(0. 562)	(0. 841)
Net foreign assets (−1)	0. 045[a]	−0. 003			0. 037[a]	−0. 011		
	(0. 009)	(0. 013)			(0. 009)	(0. 014)		
Current account (−1)			0. 441[a]	0. 266[a]			0. 463[a]	0. 264[a]
			(0. 052)	(0. 066)			(0. 058)	(0. 073)
Investment	−0. 021[c]	−0. 026[b]	−0. 016[c]	−0. 019[c]	−0. 019[c]	−0. 023[b]	−0. 015	−0. 019[b]
	(0. 012)	(0. 011)	(0. 009)	(0. 010)	(0. 011)	(0. 010)	(0. 009)	(0. 010)
Real growth	−0. 111	−0. 1277[b]	−0. 082	−0. 099	−0. 101	−0. 127	−0. 131	−0. 144
	(0. 090)	(0. 095)	(0. 076)	(0. 089)	(0. 093)	(0. 098)	(0. 082)	(0. 097)

Relative income	−0. 056	−0. 053	−0. 044	−0. 174	−0. 119	0. 104	−0. 083	−0. 086
	(0. 079)	(0. 285)	(0. 068)	(0. 277)	(0. 086)	(0. 283)	(0. 077)	(0. 293)
Relative income^2	0. 177	0. 109	0. 086	−0. 059	0. 249[c]	−0. 233	0. 137	−0. 173
	(0. 142)	(0. 551)	(0. 0119)	(0. 519)	(0. 147)	(0. 540)	(0. 130)	(0. 536)
Trade openness	0. 024[a]	0. 027	0. 005	0. 014	0. 025[a]	0. 028	0. 004	0. 012
	(0. 008)	(0. 018)	(0. 007)	(0. 017)	(0. 008)	(0. 018)	(0. 007)	(0. 018)
Financial deoth	0. 003	−0. 016	0. 022[a]	0. 018	0. 012	0. 001	0. 022[a]	0. 018
	(0. 008)	(0. 014)	(0. 007)	(0. 014)	(0. 009)	(0. 015)	(0. 008)	(0. 015)
Central government balance	0. 218[a]	0. 028	0. 089	0. 040	0. 227[a]	0. 067	0. 091	0. 031
	(0. 067)	(0. 087)	(0. 059)	(0. 083)	(0. 071)	(0. 092)	(0. 065)	(0. 090)
Oil balance	0. 071[a]	0. 026	0. 148[a]	0. 072	0. 149[b]	−0. 059	0. 131[b]	0. 008
	(0. 022)	(0. 025)	(0. 035)	(0. 068)	(0. 059)	(0. 076)	(0. 054)	(0. 075)
Observations	276	276	260	260	246	246	234	234
Countries	35	35	35	35	31	31	31	31
Adjusted R^2	0. 22	0. 40	0. 38	0. 40	0. 17	0. 35	0. 32	0. 35

Notes: The sample contains data on 35 countries. Period: 1970-2011. The countries: Algeria, Ecuador, Mexico and Venezuela, are considered oil exporters and are excluded from specifications (5) to (8) which only include oil importing countries. Specifications (1), (3), (5) and (7) are calculated through clustered least squares. Specifications (3) and (7) substitute lagged net foreign assets with lagged current account. Specifications (2), (4), (6) and (8) are calculated through ordinary least squares and include a fictitious country fixed effect variable. In (4) and(8) lagged net foreign assets are substituted by lagged current account. [a] indicates a significance of up 1%, [b] up to 5% and [c] up to 10%. The standard error is shown in parenthesis.

Table 2A

DOMINICAN REPUBLIC: MEDIUM-TERM CURRENT ACCOUNT NORM AND UNDERLYING CURRENT ACCOUNT. MACROECONOMIC BALANCE APPROACH

	All the countries				*Oil importing countries*			
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Underlying current account	−3. 934	−3. 934	−3. 934	−3. 934	−3. 934	−3. 934	−3. 934	−3. 934
Medium-term current account norm	−2. 651	−2. 857	−3. 460	−4. 197	−3. 807	−2. 208	−3. 531	−3. 645
Misalignment	−1. 283	−1. 076	−0. 473	0. 263	−0. 127	−1. 849	−0. 403	−0. 288

Notes: The dependent variable is the current account to GDP ratio. The sample contains data from 35 countries. The countries: Algeria, Ecuador, Mexico and Venezuela, are considered oil exporting countries and are excluded from specifications (5) to (8), which only include oil importing countries. Specifications (1), (3), (5) and (7) are calculated using clustered least squares. In specifications (3) and (7), lagged net foreign assets are substituted by lagged current account. Specifications (2), (4), (6) and (8) are calculated through least ordinary squares and include a fictitious country fixed effect. In (4) and (8) lagged net foreign assets are substituted by lagged current account. Misalignment = underlying current account – medium-term current account norm.

Table 3A

Dominican Republic: RER Misalignment (in percent) with Respect to Its Medium-term Equilibrium Level. Macroeconomic Balance Approach

	All the countries				*Oil importing countries*			
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
	RER misalignment with respect to its medium-term equilibrium level							
CGER elasticity	4. 936	4. 141	1. 819	−1. 011	0. 487	7. 112	1. 551	1. 107
General elasticity	2. 333	1. 957	0. 860	−0. 478	0. 230	3. 362	0. 733	0. 524
Small country elasticity	1. 442	1. 209	0. 531	−0. 296	0. 142	2. 077	0. 453	0. 324

Notes: The dependent variable is the current account to GDP ratio. The sample contains data from 35 countries. The countries: Algeria, Ecuador, Mexico and Venezuela, are considered oil exporters and are excluded from specifications (5) to (8) that only include oil importing countries. Specifications (1), (3), (5) and (7) are calculated using clustered least squares. In specifications (3) and (7), lagged net foreign assets are substituted by lagged current account. Specifications (2), (4), (6) and (8) are calculated through least ordinary squares and include a fictitious country fixed effect. In (4) and (8) lagged net foreign assets are substituted by lagged current account. Elasticities for Dominican Republic taken from Tokarick (2010). CGER elasticity = −0.26; general elasticity = −0.55; small country elasticity = −0.89. Positive RER misalignment indicates it is overvalued with respect to its equilibrium level, implying a real depreciation is necessary.

Table 4A

DOMINICAN REPUBLIC: EXTERNAL SUSTAINABILITY APPROACH ESTIMATES

Variables	*Percentages*
Real growth (WEO 2018)	5
Inflation (WEO 2018)	4
Reference of net foreign assets (% of GDP)	−53
Underlying current account (% of GDP)	−3. 934
Medium-term current account norm (% of GDP)	−4. 465
Misalignment (%)	0. 531

Notes: WEO refers to the World Economic Outlook. In this case the medium-term current account norm is determined coincidentally with the reference volume of net foreign assets. Misalignment = underlying current account – medium-term equilibrium current account.

Table 5A

DOMINICAN REPUBLIC: RER MISALIGNMENT (%) WITH RESPECT TO ITS MEDIUM-TERM EQUILIBRIUM LEVEL. EXTERNAL SUSTAINABILITY APPROACH

RER misalignment with respect to its medium-term equilibrium level	
CGER elasticity	−2. 042
General elasticity	−0. 965
Small country elasticity	−0. 597

Notes: Elasticities for Dominican Republic were taken from Tokarick (2010). CGER elasticity = −0.26; general elasticity= −0.55; small country elasticity = −0.89. Positive RER misalignment indicates overvaluation with respect to its equilibrium level, implying a real depreciation is necessary.

Table 6A

DOMINICAN REPUBLIC: ESTIMATION OF THE RELATION BETWEEN RER AND THE SET OF FUNDAMENTALS. EQUILIBRIUM REAL EXCHANGE RATE APPROACH

Constant	5. 229[a]
	(0. 233)
Government consumption (% GDP)	−0. 042
	(0. 095)
Gross capital formation (% GDP)	0. 219[a]
	(0. 071)
Trade openness	−0. 295[a]
	(0. 086)
Rate of return differentials	0. 006[a]
	(0. 001)
Export growth rate	0. 174[b]
	(0. 087)
Observations	81
Adjusted-R^2	0. 60

Notes: The dependent variable is the RER. All variables measured in logarithm. Trade openness defined as the sum of exports and imports as a percentage of GDP. [a] means significance of up to 1% and [b] up to 5%. Newey-West standard error in parenthesis.

Table 7A

DOMINICAN REPUBLIC: MISALIGNMENT (IN PERCENT) WITH RESPECT TO THE EQUILIBRIUM RER AT THE SECOND QUARTER OF 2013. EQUILIBRIUM REAL EXCHANGE RATE APPROACH

With respect to unfiltered equilibrium RER	1. 196
With respect to trend-cycle version equilibrium RER	2. 595
With respect to Hodrick-Prescott filtered version equilibrium RER	−0. 942

Note: Positive RER misalignment indicates overvaluation with respect to its equilibrium level, implying a real depreciation is necessary.

Annex B. Sources of the Variables

Table 1B

VARIABLES OF THE MACROECONOMIC BALANCE APPROACH METHODOLOGY

Variable	*Source*
Current account/GDP	WDI-WB
Older dependents	WDI-WB
Young dependents	WDI-WB
Population growth	WDI-WB
Net foreign assets	Updated Milesi-Ferretti and Lane (2007) database
Investment	WDI-WB
Real economic growth	WDI-WB
Relative income	WDI-WB
Trade openness	WDI-WB
Financial depth	WDI-WB
Central government balance	Medina et al. (2010), WEO (IMF), October 2013
Oil balance	Medina et al. (2010), WEO (IMF), October 2013

Notes: WDI-WB refers to the World Bank's World Development Indicators. WEO (IMF) refers to the International Monetary Fund's World Economic Outlook.

Table 2B

VARIABLES OF THE EXTERNAL SUSTAINABILITY APPROACH METHODOLOGY

Variable	*Source*
Real economic growth	WEO (FMI) October 2013
Inflation	WEO (FMI) October 2013
Net foreign assets	Net international investment position of the BCRD

Notes: WEO (IMF) refers to the International Monetary Fund's World Economic Outlook; and BCRD to the Banco Central de la República Dominicana.

Table 3B

Variables Employed in the Equilibrium Real Exchange Rate Approach Methodology

Variable	*Source*
Government consumption	BCRD
Gross capital formation	BCRD
Trade openness	BCRD
Real rate of return differentials	BCRD, FRED
RER index	IFS (IMF)

Notes: IFS (IMF) refers to the International Monetary Fund's International Financial Statistics; BCRD to the Banco Central de la República Dominicana; and FRED to Federal Reserve Economic Data.

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Monetaria is published twice a year (Spring, Autumn) in Spanish and English (two volumes) by the Centro de Estudios Monetarios Latinoamericanos, Durango 54, colonia Roma Norte, delegación Cuauhtémoc, 06700 México, D. F. Printed in Master Copy, S. A. de C. V., avenida Coyoacán núm. 1450, 03220 México, D. F. (400 copies).

CENTER FOR LATIN AMERICAN MONETARY STUDIES
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Monetaria

ISSN: 0185-1136