Inflation Targeting in Latin America

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Abstract

In this paper we analyze the implementation of inflation targeting in Brazil, Chile, Colombia and Peru. First we undertake OLS estimations of conventional Taylor rules and show that in all four countries the central bank increases its repo rate of interest in response to increases in the output gap and, except in the case of Peru, also to deviations of inflation expectations from established targets. Second, using a Markov-Switching methodology that allows the data to "speak for itself", we find that in Chile, Colombia and Peru there is evidence that, in the presence of severe external financial shocks, central banks temporarily abandoned their conventional reaction function. Third, we expand the conventional Taylor Rule so as to include variables related to exchange rate misalignments and to developments in domestic credit markets. We argue that this inclusion is merited on account of the potential for these variables to anticipate episodes of financial fragility, not because they might contribute to explain output and/or inflation gaps. Interestingly, there is only limited evidence that the countries in our study have actually used some form of expanded or integrated inflation targeting framework. Finally, we analyze the determinants of central bank intervention in foreign exchange markets and find strong evidence that, contrary to official statements, intervention seems to be explained to a great extent by concerns with regard to exchange rate misalignments rather than to exchange rate volatility. We also find evidence that, with the exception of Brazil, countries seem to be more preoccupied with a strong domestic currency than with a weak one. In all, we provide evidence that central banks appear to have pursued two distinct objectives with two distinct instruments: an inflation objective using a mostly standard Taylor rule and an exchange rate objective through interventions in the F/X market. At least to date, there does not seem to have been an inconsistency in the pursuance of these two objectives.

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1. Introduction

In the last decade and a half several Latin American countries have adopted inflation targeting (IT) as their monetary framework. In most instances, this process was accompanied by a shift towards significantly more flexible exchange rate regimes. Judged by overall macroeconomic performance, IT has proved to be beneficial to the countries that have adopted it. Inflation has declined significantly and has broadly stabilized at reasonably low levels; growth has been relatively high by historical standards; and what is maybe more significant, CBs are now in a position to actively engage in counter-cyclical policies (Federico *et al*, 2012).

While certain features of the IT framework – including the use of a repo rate as the policy instrument, the announcement of medium-term inflation targets and a comprehensive communications strategy – have remained in place since the moment of its adoption, it is quite likely that IT implementation has evolved through time. Plausible changes in the framework include consideration of policy goals other than delivering low and stable inflation, and the use of additional policy instruments other than the repo rate --including FX market intervention, reserve requirements on domestic financial liabilities and regulations on foreign capital flows. Following the 2008-9 global financial crises, the view has emerged that the priority attached to achieve a low and stable inflation might have played a role in creating the conditions for severe financial sector imbalances. Consequently, there now seems to be broad agreement that financial stability is a policy goal as important as macroeconomic stability. That being the case, the use of macro prudential policy instruments –such as, for example, dynamic provisioning and loan-to-value limits— is now widely advocated. There is much less agreement, however, as to whether or not concerns for financial stability should be explicitly taken into consideration by inflation targeting central bank´s when setting interest rates.

The resilience of several Latin American economies during the recent global financial crises has been ascribed to strong monetary and fiscal policy frameworks (see, for example, Vegh *et al*, 2013), many of them in place since the late 1990s, following the dire consequences of the financial crises engulfing emerging markets, first in East Asia, then in Russia, and eventually in Latin America. While (largely independent) central banks using IT as their monetary framework and different varieties of fiscal rules –including explicit fiscal targets--

stand out as the key features characterizing macroeconomic policy in several of the largest Latin American economies, it is worth exploring the extent to which these countries have already been implementing some of the less conventional policies now being advocated as necessary complements to the more conventional IT frameworks.

This paper focuses on the experience of Brazil, Chile, Colombia and Peru. These four countries, together with Mexico, constitute the group of original inflation targeting countries in Latin America. Table 1 summarizes the main features of their IT frameworks. Following the transition to a floating exchange rate in January 1999, Brazil adopted an IT framework in June 1999. In June of every year, the National Monetary Council (i.e. the Minister´s of Finance and of Planning and the Governor of the central bank) sets the inflation target and the tolerance range for the next two years. It is worth highlighting the fact that the central bank has no statutory independence. With regard to Chile, there is a debate as to the date when IT was officially implemented. While Schmitt-Hebbel *et al* (2002) state that Chile was the second country to implement IT in September 1990, Hammond (2012) argues that IT was implemented in September 1999, when the crawling exchange rate band was abandoned. Since September 1999 the BCdC established a 2 year target horizon for inflation of 3% with a tolerance range of 1%. Colombia formally adopted an IT regime with a flexible exchange rate in September 1999, in the context of an IMF-supported program. The Banco de la Republica (BdR), already having been granted legal, operational, and financial independence in 1991, established a medium-term target for CPI inflation which is 2 to 4% since January 2011. The Banco Central de Reserva del Peru (BCdlRP) officially adopted IT in January 2000. Notably, this country was the first financially dollarized economy which adopted this policy framework[2]. In September 2002 the BCdlRP incorporated a medium term target horizon for inflation of 2.5% - reduced to 2% in 2007- with a tolerance of 1%. In all four cases the overnight repo rate is the policy instrument and all central banks have a comprehensive communications strategy.

[2] As of end-2012, dollar-denominated loans still accounted for 45% of total loans.

Table 1. Main features of IT frameworks

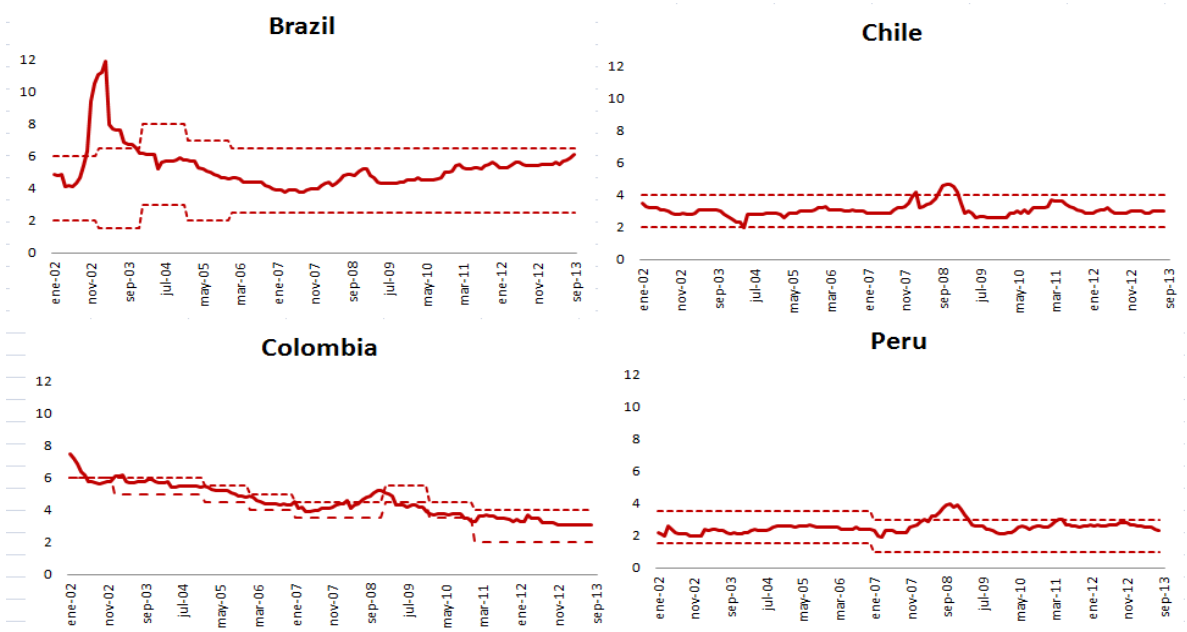
Country	Date IT adopted	Target set by	Target 2013	Target Horizon	Transparency & Reports
Brazil	June 1999	National Monetary Council (CMN)	4.5% ± 2 percentage points.	Medium Term	• Four Inflation Reports per year • Public minutes, eight days after each meeting • Six parliamentary hearings • It does not have statutory independence • Press releases
Chile	September 1999	Central Bank	3% ±1 pp	Medium Term	• Monthly Inflation reports • Bi – annual Financial Stability Reports • Minutes of monthly BCdC Board meetings • Bi-annual Reports to Congress • Press Releases
Colombia	September 1999	Central Bank (MoF is voting member of the board)	3% ±1 pp	Medium term	• Quarterly Inflation Reports • Bi-annual Financial Stability Reports • Public minutes for every Central Bank Council meeting • Bi-annual reports to Congress • Press releases
Peru	January 2002	Central Bank (Board is not independent of the Government)	2% ±1 pp	Medium Term	• Inflation Reports: Three times a year until 2008. From 2009 to the current date four times a year • Informative note every month • No public minutes • Press releases

Note: Here we follow Hammond (2012) who argues that IT was officially implemented in Chile when the exchange rate band and capital controls were finally dropped.

In all four countries central banks have generally been successful in setting expectations within the established inflation target (Figure 1), and they have achieved this together with reasonably strong economic growth –with average rates of 4% in Brazil, 4.2% in Chile, 4.7% in Colombia and a remarkable 7.1% in Peru over 2005-2011.[3] Furthermore, with varying degrees of intensity, all four countries have used so-called macro-prudential policies since even before the advent of the global financial crisis (Table 2).

[3] Our own calculations based on World Bank data.

Figure 1. Expected Inflation and Inflation Target Range



Source: Central Banks inflations reports, Latin Focus Consesus Forecast and author´s calculations

Table 2: Macro prudential measures since IT adoption [4]

Policy tool	Country	Motivation and objective
Capital Requirements	Brazil (long Term consumer loan market – 2010)	Slow down credit growth
Dynamic Provisioning	Colombia (2007), Peru , (2008), Chile (2010, based on expected loans)	Countercyclical buffers
Liquidity Requirements	Colombia (2008), Peru (1997)	Manage liquidity risk
Reserve Requirements on bank deposits	Peru (2011), Brazil (2010)	Limit credit growth
Reserve Requirements on short-term external liabilities of banking institutions	Peru (2010, 2011)	Shifting the funding structure towards the long term
Tools to manage foreign exchange credit risk	Peru (2010)	Help financial institutions internalize foreign exchange credit risk
Limits on foreign exchange positions	Colombia (2007), Chile, Brazil (reserve requirements in short spot dollar position, 2011), Peru (on net FX derivate position)	Manage foreign exchange risk
Reserve Requirements on Domestic Currency	Colombia, Brazil, Peru and Chile (March 2007 and December 2010)	Limit credit growth
Capital controls	Brazil and Colombia	Reduce exposure to speculative capital inflows

Source: Agénor and Pereira da Silva (2013); originally taken from Tovar *et al* (2013); Montoro and Moreno (2011); Original series from Bloomberg; CEIC; National Data.

Our main objective is to provide a better understanding of the monetary policy framework implemented during 2000–2012, a period in which there is evidence that these countries presumably moved towards the use of non-conventional policy instruments in order to meet both the inflation target and other objectives as well. First, we estimate a conventional Taylor Rule for each country and then use a Markov-Switching Methodoloy in order to assess whether the conventional reaction function has experienced significant structural shifts over time. Although the methodology allows the data to "speak for itself" and does not require us to determine the

[4] In Appendixes E-H we report policy actions in addition to conventional IT for each country.

dates of these shifts ex ante, we believe that it is quite plausible that during periods of significant financial turmoil central banks might have departed from their business-as-usual monetary stance. Second, we briefly review the literature and argue that on account of financial stability considerations, it is plausible that the Taylor Rule might include variables other than the output and inflation gap on account of their potential effect not on inflation and on the output gap but rather because of their direct impact on financial stability. We then test whether it is the case that the policy rate responds to variables other than the output and inflation gaps. Finally, we turn our attention to central bank intervention in foreign exchange markets. We are particularly interested in testing whether or not such intervention is, as claimed by most central banks, determined by concerns with exchange rate volatility or whether there is evidence of central bank´s having goals other than maximizing sustainable growth while meeting their inflation targets.

2. Characterizing Monetary Policy in Four Latin American Countries

2.1. Estimating conventional Taylor Rules

At its most basic, a conventional Taylor Rule summarizes the monetary reaction function under IT as follows:

$$i_t = \alpha + \beta_1 i_{t-1} + \beta_2 x_t + \beta_3 (E_t \pi_{t+1} - \pi_t^T) + \varepsilon_t \quad (1)$$

That is, the policymaker would be expected to adjust the policy rate in response to the differential in the expected inflation rate $E_t\pi_{t+1}$ over the inflation target π^T_t—i.e., "the inflation gap"— and to the output gap x_t. In addition, since there may be costs involved in introducing too much variability in the policy rate, interest rate smoothing is incorporated through the lagged interest rate term i_{t-1}. In this "plain vanilla" reaction function, these are the only variables that should be considered, and for a traditional or "strict IT country" one could reasonably expect the sensitivity parameters β_1, β_2 and β_3 to remain stable over time. Table 3 presents the definitions of all variables used in the regressions in this paper.

Table 3. Definition of variables[5]

Policy variable	Right-hand side variables	Name	Description
Policy rate		I	Country policy rate
	Output gap	x_t	$(У - У\,hp) / У\,hp$, where $У\,hp$ is trend GDP obtained from an H-P filter
Inflation	Inflation Gap 1	π^1	Inflation expectations (from Latin Focus Consensus Forecast) minus the inflation target
	Inflation Gap 2	π^2	Inflation (CPI) minus the inflation target
	Inflation Gap 3	π^3	Inflation expectations
	Inflation Gap 4	π^4	Inflation
Exchange rate	Percentage RER deviations from trend	$RER_d hp$	$(RER - RER\,hp) / RER\,hp$, where $RER\,hp$ is trend RER obtained from an H-P filter
	Credit gap	$C1$	$\Delta RC - \Delta x_t$ where RC is real gross loans and x_t is real output gap
	Financial deepening	$C2$	RC/GDP
	Non-performing loans	$C3$	Non-performing Loans/ RC

The OLS estimation of (1) is reported in Table 4 (short-term coefficients) and in Table 5 (long-term coefficients, equal to the short-term coefficients divided by 1 minus the sum of the coefficients of the lagged dependent variable). Results are as expected for all countries except Peru. In particular, in all 4 countries the repo rate reacts positively and significantly to the output gap, but the response to the inflation gap is positive and significant in all but Peru. Interestingly, the estimated long-term coefficient for the inflation gap is greater than 1 both in Chile and in Colombia, providing evidence that in these two countries central banks actually increase the real rate of interest in response to positive inflation gaps.

[5] In the country data appendix we report the exact definition and source of each variable in each country.

Table 4. Taylor Rule estimation (OLS) –short-term coefficients

	Brazil	**Chile**	**Colombia**	**Peru**
Intercept	0.31* (0.05)	0.36*** (0.00)	0.15** (0.04)	0.38*** (0.00)
$\sum_{0}^{4} i_{t-1}$	0.91*** (0.00)	0.93*** (0.00)	0.95*** (0.00)	1.02*** (0.00)
x_t	0.09*** (0.00)	0.05* (0.06)	0.03*** (0.00)	0.10*** (0.00)
π^1	0.08* (0.05)	0.22** (0.03)	0.12** (0.04)	0.04 (0.45)
R^2	0.97	0.94	0.98	0.93
Observations	152	152	152	130
D-W test (χ2)	1.9 (0.16)	0.03 (0.85)	0.88 (0.34)	0.75 (0.24)

Source: Author´s calculations.
Note: *p*-values are in the parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. We also undertook this exercise using quarterly data (Appendix I). Results are consistent with those using monthly data.

Table 5. Taylor Rule estimation (OLS) –long-term coefficients

	Brazil	**Chile**	**Colombia**	**Peru**
x_t	0.89***	0.85*	0.6***	0.05***
π^1	0.78**	3.14***	2.4**	0.03

Source: Author´s calculations.
Note: p-values are in the parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

These results are similar to those obtained in previous studies (Table 6). In general, in Colombia and Chile the repo rate reacts positively and significantly to the output and the inflation gap. Consistently, Chile reports the highest response to inflation gap among the four countries while in Peru the estimated Taylor Rule parameters change visibly from study to study.

Table 6. Taylor Rule: long-term responses

	Brazil	Chile	Colombia	Peru
OLS- IT (2000 – 2012)				
Output Gap	0.89***	0.85*	0.6***	0.05***
Inflation Gap	0.78**	3.02***	2.4**	0.03
OLS- IIT (2000 – 2012)				
Output Gap	0.63***	0.55****	0.6***	0.6***
Inflation Gap	0.36	2.33***	3.2**	0.1
Exchange Rate	0.007	0.04	0.08*	0.035
Credit gap	-0.009	0.03	-0.06	0.035
Mehotra *et al* (2011) (1999 - 2007, GMM) [6]				
Output gap	n.a	1.18***	1.28***	0.27**
Inflation	n.a	1.43***	-0.03	-0.73**
Exchage Rate	n.a	-0.006	0.09**	-0.09**
Moura *et al* (2009) (1999 - 2008, OLS) [7]				
Output Gap	0.18	0.26**	0.35**	0.64
Inflation Gap	0.62***	3.05***	0.76	0.34
Exchange Rate	-0.62	-0.15	0	228
Mello *et a*l (2011) (1999 – 2006, SVAR)				
Output Gap	0.03**	-0.05	0.00	n.a.
Inflation Gap	0.56**	0.30**	-0.38	n.a
Exchange Rate	0.06	-0.43	-0.41	n.a

Note: *p*-values are in the parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1

[6] GMM generalized method of moments. The instruments are lags 2 and 3 of the interest rate, and lags 1 and 2 of the inflation gap, the output gap and the exchange rate.

[7] Authors estimated Taylor Rule by OLS with Newey- West robust standard error. They used the HP filter for each variable definition.

2.2. Markov-Switching estimation of Taylor Rules

In order to capture possible changes in the policy rule over time, as well as additional variables being considered in the rule (X_t, see next section), we propose an extension of the reaction function (1) which allows sensitivity parameters to change over time: a Markov Switching methodology based on Hamilton (1994)[8]. It has the following form:

$$i_t = \alpha^{S_t} + \beta_1^{S_t} i_{t-1} + \beta_2^{S_t} x_t + \beta_3^{S_t} (E_t \pi_{t+1} - \pi_t^T) + \gamma^{S_t} X_t + \sigma^{S_t} \varepsilon_t \qquad (2)$$

Now each sensitivity parameter—as well as the residual variance σ—will be allowed to vary across states *S.* The Markov-Switching (MS) approach to the monetary reaction function has been applied primarily in industrialized countries. Assenmacher-Wesche (2006) used it for the US, UK and Germany, and Creel and Hubert (2009) conducted a similar exercise for Canada, Sweden and the UK. Both studies were able to discern periods in which monetary policy was relatively more "hawkish" or "dovish" on inflation—i.e. reacting more (less) vigorously to the inflation differential and less (more) to the output gap. To the best of our knowledge, our study will be among the first that applies this methodology to emerging IT economies, where the case for a more flexible IT regime is stronger, and where it seems likely that, as the regime matured and macroeconomic conditions evolved, the rule itself changed as well[9].

This approach has the appealing feature that it "lets the data speak"; we do not impose our ex ante views on when the changes in IT practice were likely to occur. The methodology sorts out where the statistical behavior of the variables changes significantly, providing us with dates at which the structural breaks actually occur. We can then contrast these results with observed shocks and identified announcements of policy changes to give an intuitive sense of the effective changes in policy behavior. It is important to note that rather than a small change in the relative response of the policy rate to the different signals, there may be extreme periods in

[8] It is assumed that $S_t \in S = \{1, \dots, n\}$, where S is the set of states. It is also assumed that $\varepsilon_t \sim$ i.i.d $N(0,1)$, and S_t is independent of ε_τ for all t and τ. A time-homogenous Markov chain of order 1 governs the probability of changes in regime S_t, where $p_{ij} = P(S_t = i | S_{t-1} = j)$ is the probability of being in state i at time t given that state j was present at time $t-1$. These probabilities are assumed to be independent of past values of i_t (policy rate) and current and past values of exogenous variables.

[9] In a related forthcoming study, Barajas, *et. al* (2012) explore a simplified version of the above model, focusing on reactions to the exchange rate in a sample of emerging IT countries.

which the policy rule is abandoned altogether in favor of discretion or in response to changes in the broader macroeconomic environment that are not easily captured by the reaction function.

Results of the MS estimations are reported in Table 7 (short-term coefficients) and in Table 8 (long-term coefficients). In Table 7 there are two columns for each country, one for each regime identified by the econometric procedure. The bottom part of the table shows the frequency of observations in which each regime is most likely[10], showing that all four countries spend most of the time in Regime 1. L is the final value of the log likelihood function maximization; $p=P^{11}$ is the probability of staying in Regime 1 in period t, given that the economy is in that state in $t-1$, while σ is the model residual variance. Switching in the residual variance is relevant for all countries and contributes significantly to an improved fit as compared to a simple linear model. We identify low and significant residual variance for all countries in Regime 1, which indicates low volatility throughout these periods and better predictive power. Additionally, with four lags of the interest rate, a Ljung-Box-Pierce Q-Test test indicates that there is no first- to tenth-order autocorrelation in any country. Although the econometric procedure identifies two regimes for each country, in all four cases none of the parameters of the Taylor Rule are significant in Regime 2. Thus, Regime 2 corresponds to a sporadic and short-lived abandonment of the normal reaction function. In Regime 2 the policy rule is not easily understood, given that the determinants of the policy rate are not captured by the conventional variables. Finally, the MS results indicate that the policy rule was remarkably stable in Brazil, as Regime 1 dominates all observations in the period[11].

[10] That is, when the estimated probability of being in a given regime is at least 90%.

[11] Although the procedure forcefully estimates an alternative regime, for all intents and purposes Regime 2 is irrelevant in this specification for Brazil. This result is corroborated in Figure 2 (below), where the probability of being in Regime 2 is 0- i.e. Regime 2 never "occurs" at any probability cut-off.

Table 7. Markov-Switching estimation of Taylor Rule (short-term coefficients) [12]

	Brazil		**Chile**		**Colombia**		**Peru**	
	IT	**IT**	**IT**	**IT**	**IT**	**IT**	**IT**	**IT**
Regime	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
intercept	0.31**	-0.95	0.13***	0.13	0.17***	-0.16	0.17***	-0.15
	(0.05)	(1.00)	(0.00)	(0.99)	(0.00)	(0.82)	(0.00)	(0.94)
$\sum_{0}^{4} i_{t-1}$	0.88***	5.4	0.97***	0.88	0.92***	0.84**	0.95***	0.82
	(0.00)	(0.89)	(0.00)	(0.78)	(0.00)	(0.03)	(0.00)	(0.11)
x_t	0.08***	-0.65	0.03*	-0.03	0.03***	-0.03	0.02*	-0.05
	(0.00)	(1.00)	(0.06)	(0.99)	(0.00)	(0.83)	(0.06)	(0.85)
π^1	0.07**	-0.76	0.09***	-0.35	0.07*	-0.20	0.05**	0.11
	(0.05)	(1.00)	(0.00)	(0.95)	(0.05)	(0.60)	(0.04)	(0.95)
σ^2	0.23***	491.1	0.02***	49.1	0.02***	0.75	0.01***	1.8
	(0.00)	(1.00)	(0.00)	(1.00)	(0.00)	(1.00)	(0.00)	(1.00)
$p=p^{11}$	1.00		0.97***		0.97***		0.98***	
	(0.83)		(0.00)		(0.00)		(0.00)	
Number of months in each regime	152	0	142	10	137	15	121	8
L	104.16		51.12		10.34		59.51	

Source: Author´s calculations.

Note: p-values are in the parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

The long-term coefficients of Regime 1 are reported in Table 8. With respect to the OLS coefficients reported in Table 7, two points are worth highlighting: (i) once the possibility of structural change is allowed for, there is now evidence of a standard Taylor Rule operating in the case of Peru, with positive and significant coefficients for both the output and the inflation gap; (ii) there is an important reduction in the coefficient measuring then response of the repo rate to the inflation gap in the case of Colombia.

[12] Results are robust to different definitions of the "inflation gap" variable. This estimation is available upon request.

Table 8. Markov-Switching estimation of Taylor Rule (long-term coefficients)

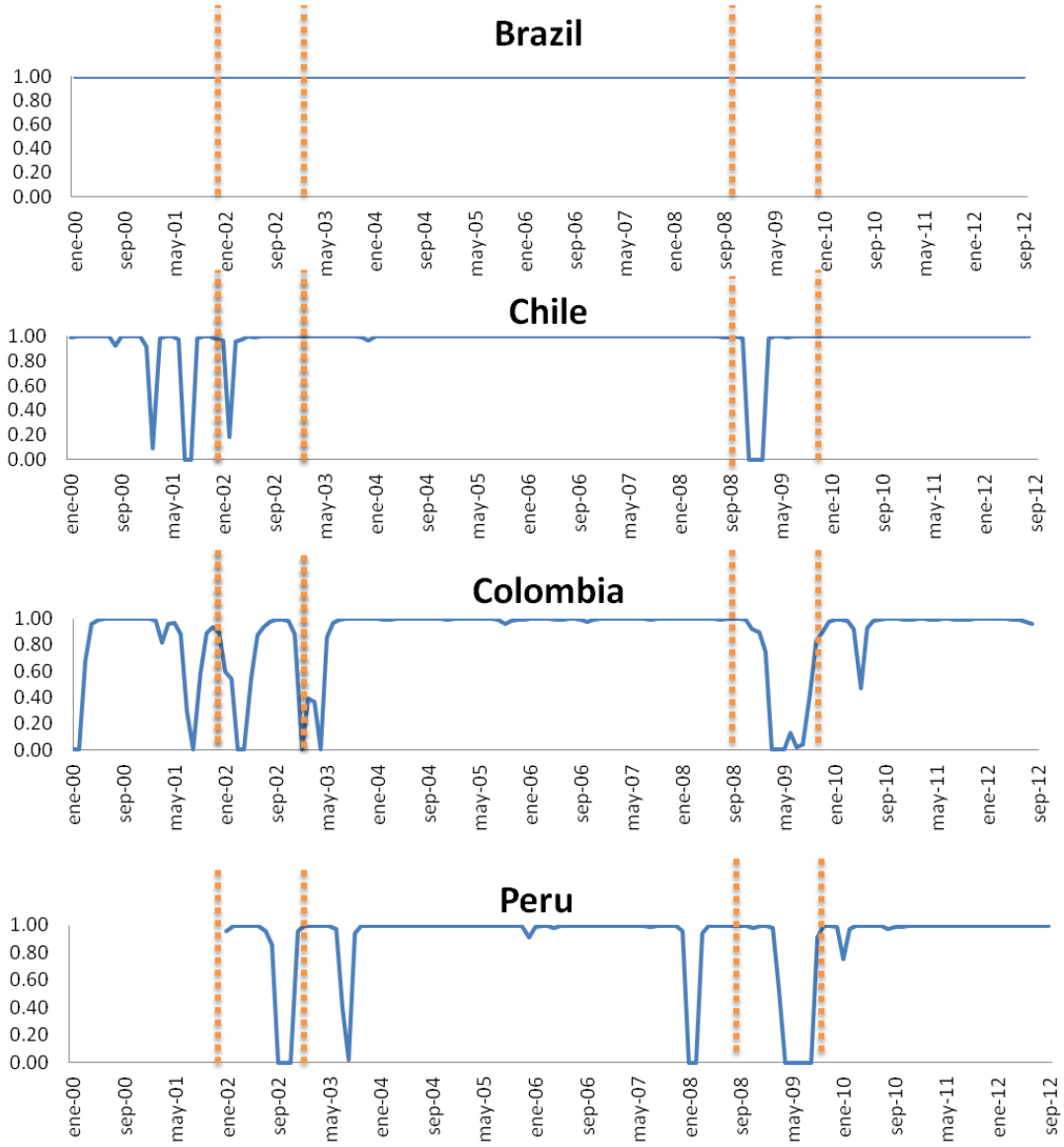
	Brazil	Chile	Colombia	Perú
Regime	**1**	**1**	**1**	**1**
x_t	0. 75***	0.85*	0.39***	0.4*
π^1	0.68**	3.25***	0.95*	1**

Source: Author´s calculations.

Note: p-values are in the parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

In Figure 2 one can observe that the Regime 2 periods greatly coincide across the countries. In particular, two episodes stand out, where there was significant turmoil in international financial markets: (i) in 2001and 2002, when markets became very hostile towards emerging markets, in part due to the Argentinean crisis of 2001 and also as a consequence of the very negative expectations surrounding the possibility of Lula da Silva's election in 2002; and (ii) in late 2008, following the collapse of Lehman Brothers. In both instances the results indicate that central banks of Chile, Colombia and Peru abandoned the policy rule that we have already described by a well-behaved conventional Taylor Rule.

Figure 2: Regime Switching



Source: Author´s calculations. The figure reports probabilities of being in Regime 1 for the specifications in Table 7.

We now turn to a more detailed description of the main episodes of regime change in each country, as reported in Figure 2.

Chile. First episode (May to September 2001). The peso depreciated 20% between December 2000 and September 2001. This exceptional event was linked to the significant increase in risk

perceptions with regard to Argentina and to a persistent decline in the price of copper. In this context, the BCdC lowered the repo rate from 5.25% in February 2001 to 3.5% in July 2001 to prevent further deterioration in domestic spending and reductions in inflation below the target range. Moreover, in August 2001 it announced that it would sell up to US$2 billion of international reserves in the spot market for the rest of the year. Finally, the repo rate was gradually increased from 3.5% in August 2001 until reaching 6.5% in January 2002.

Second episode (January 2009 to May 2009). This episode is related to the collapse of Lehman Brothers and the increase from 189 to 307 bps in the sovereign spread between September and October 2008. At the end of September the BCdC announced the end of a US$8 billion international reserve accumulation program announced in April 2008 and began a program of repos and swaps to provide domestic and foreign liquidity. In October 2008 it extended the range of collateral accepted in its domestic operations, established a liquidity term facility, adjusted its note issuance plan and suspended for the rest of 2009 the issuance of debt instruments with maturity beyond 1 year. When non-conventional policies proved insufficient, it drastically lowered the repo rate, from 7.25% in February 2009 to 0.5% in August 2009.

Colombia. First episode (mid-2001 to mid-2002) characterized by inflationary pressures coupled with supply-side weakness and adverse TOT shocks. This period corresponds to the end of Pastrana's presidency and the failure of a peace process with leftist guerrillas. By the end of June 2002, inflation was above target due to bad weather conditions while GDP was 3% below potential on account of weak investment and falling exports. Between June 2001 and July 2002, BdR cut the repo rate seven times, from 11.5% to 5.25%. In parallel, it injected liquidity with purchases of foreign reserves (US$650 million) and of public debt (US$300 million) in the secondary market. Thus, Regime 2 was associated with additional monetary loosening to provide a boost to a slumping economy, even as inflation was hovering above its target.

Second episode (late-2002 to mid-2003). This period included two major events. First, in what came to be known as the "domestic public debt crisis", during the first week of August 2002 the interest rate on 10-year domestic public debt went up 280 bps. The amount of public debt placed in the domestic capital market touched bottom in September 2002 –and would only recover its April 2002 level by May 2003—and in August a public debt auction had to be

declared void for lack of demand. Debt prices collapsed and regulatory forbearance was required, in particular to shield institutional investor portfolios that otherwise would have had to be marked-to-market. Second, in the second half of 2002, when polls predicted the victory of Lula da Silva in the Brazilian presidential election, markets became extremely nervous, with spillover effects on Colombia. The EMBI for Colombia reached 1,084 bps in late September, a 70% increase from the average of the previous year. In these circumstances, in August 2002 BdR brought forward its pre-announced permanent purchases of public debt in the secondary market and authorized stockbrokers and trust companies to undertake monetary operations with the central bank. The repo rate remained unchanged throughout the second half of 2002 while the central bank sold US$545 million of NIR in order to stem the weakening of the peso.

Third episode (January 2009 to August 2009). Following the collapse of Lehman brothers, Colombia's GDP contracted 0.6% in 2009:Q1. A trade embargo by Venezuela and Ecuador contributed to a sharp export contraction between January and May. The BdR responded by removing all controls on capital inflows in September 2008 and reducing reserve requirements in October, after having increased them in 2007. Three months later the BdR decided to aggressively decrease the repo rate which went from 10% in December 2008 to 4% in October 2009. Finally, the central bank decided that most of the additional liquidity to be provided towards the end of 2009 would be instrumented through NIR purchases (NIR increased almost US$2 billion between May and September 2009) and purchases of public debt.

Peru: First episode (September 2002 to December 2002): This event was also linked to uncertainty surrounding the outcome of the Brazilian election. The BCdlRP raised the interbank rate from 2.9 % in July to 5.4 % in September as a preventive action. In addition, in response to this critical situation, it sold US$127 million in the open market in September 2003.

Second episode (May 2009 to August 2009). According to the June 2009 inflation report, the economy expanded only 1.8% in the first quarter of 2009 with a 3% decline in exports and of 0.8% in domestic demand. In March 2009 the EMBI was almost 200 points above the level a year back. In these circumstances, the BCdlRP decided to use conventional and non-conventional instruments. Firstly, in September 2008 it lowered reserve requirements on short-term bank deposits held by foreign residents from 120% to 35%. Secondly, it sold US$6.8 billion

NIR between September 2008 and March 2009. Thirdly, between September 2008 and February 2009 it lowered to 6% the marginal reserve requirements on domestic currency bank deposits, later totally eliminated in June 2009. When these policies where no longer sufficient, the central bank lowered the repo rate almost 500 basis points between February and August 2009.

Across all three countries, several of the episodes just described correspond to central bank policy going beyond what the usual (Regime 1) reaction function would have called for, maintaining a looser stance and complementing low interest rates with other tools (i.e. liquidity injections and exchange market intervention). In Chile's first episode, the copper price may have been giving signals of a stronger downturn than those reflected in the output gap, while in Colombia's first episode political turmoil and its possible effects on output led the central bank to loosen further, even as inflation was surpassing the target. The Lehman bankruptcy and uncertainties surrounding the impending Lula presidency seem to have led central banks to consider potential spillovers which had not yet materialized in the output gap, thus spurring them to respond more aggressively than usual. Table 9 illustrates the relative looseness of the Regime 2 episodes following the Lehman bankruptcy, where the actual policy rate was kept below the predicted (Regime 1) level in all three countries, particularly in Chile and Peru.[13]

Table 9. Actual vs. estimated repo rate during the Lehman Crisis

	Period	Actual average	Regime 1 policy rule
Chile	January to May (2009)	4.85	6.21
Colombia	January to June (2009)	7.80	7.99
Peru	May to August (2009)	2.77	3.69

Source: Author´s calculations. The period for the average was chosen according to the Regime Switching results.

[13] Two episodes stand out as being different, however. Colombia's second episode contained an element of fiscal dominance, in which the monetary objective was temporarily superseded by fiscal concerns. Finally, Peru's central bank appeared to respond differently to the Lula da Silva episode, abandoning its usual rule in order to tighten and therefore stem a capital outflows.

2.3. Integrated Inflation Targeting?

Following the recent financial crisis, increased attention is being placed on the need for policy to focus not only on macroeconomic stability but also on financial stability. In fact, the view has been expressed that success with regard to macroeconomic stability –in particular, success in achieving low and stable inflation—might have led to complacency with regard to the monetary policy stance, in effect creating the conditions for severe financial imbalances. This concern has clearly led to the promotion of macro-prudential policies that complement the more traditional monetary frameworks.

In particular, increased attention to the potential disruptive effects of excessive credit growth has led to a push to design macro-prudential policies that seek to smooth out credit cycles (Dell Ariccia, *et a*l, 2012). Along these lines, many countries in recent years have adapted their supervisory and regulatory frameworks to introduce countercyclical provisioning, among other actions. It is quite conceivable that, in tandem, central banks have broadened their focus to include financial stability concerns, and that credit growth is being monitored and incorporated into monetary policy decisions as well.

Agénor and Pereira da Silva (2013) have recently promoted the idea that central banks should follow an Integrated Inflation Targeting framework (IIT) that, among other features, allows for the possibility that, in setting its repo rate, central banks should consider not only the output and inflation gaps, but also variables that might pre-empt problems with regard to financial stability (i.e. excessively rapid credit expansion). One such variable is the rate of growth of credit, whose inclusion in the reaction function can be derived from an optimization problem –that is, the minimization of a policy loss function that explicitly takes into account a financial stability objective—in which expectations with regard to asset prices depend on credit growth[14]. A second additional variable is the exchange rate or, more specifically, a measure of exchange rate misalignment. The introduction of an exchange rate variable in the augmented Taylor Rule was considered by Taylor himself (Taylor, 2001) on account of its possible effect on inflation and output. The exchange rate was also incorporated in the IT policy rule for open economies proposed by Svensson (2000). However, the IIT framework that we discuss here,

[14] Recent theoretical work has shown how central banks might operationalize the use of financial stability indicators in their reaction function (Woodford, 2012). See, also Agénor and Pereira da Silva (2012) and Disyatat (2010).

following Agenor *et al*. (2012), does not only include an exchange rate variable on account of its impact on aggregate demand but on account of its implications on financial sustainability, which can be related to the negative wealth effects of a currency depreciation when there are high levels of liability dollarization as in Calvo and Reinhart (2002) or on account of the Dutch Disease effects of a currency appreciation as in Levy-Yeyati, and Sturzenegger (2001).[15]

Needless to say, there are serious challenges in implementing IIT, including prominently the fact that credibility is a central element of any IT framework, and credibility could be compromised with a proliferation of goals to be pursued by the central bank. While IIT can be understood as a policy proposal for the future, it is worth asking whether or not there is evidence that the countries in our sample –which certainly did not observe the kinds of financial sector disruptions that characterized several more mature economies—have, in fact, been operating as if under an IIT framework in the recent past. While it is evident that many macro-prudential policies had been put in place well-ahead of the 2008 financial crisis in the four countries under study, an additional issue worth exploring has to do with the possibility that, in practice, expanded Taylor Rules have also been in place.

We therefore turn to estimating equation (2) above in a specification in which a vector of additional variables *Xt* is incorporated to reflect the central bank's possible response to the exchange rate and to credit growth. With regard to the exchange rate, we will test for the possibility that, the interest rate may respond to deviations of the real exchange rate from its (HP) trend ($RER_d hp$). This variable provides an easily observable and measurable proxy for exchange rate misalignment. We also test whether there is a response of the repo rate to real credit growth C as a proxy for signals regarding financial stability. OLS estimations using monthly data for 2000-2012 are reported in tables 10 and 11. It is quite evident from the results that whatever its merits going forward, there is little evidence in the data that the countries in our sample have been following an IIT framework in which variables other than the output and inflation gaps have played a role in the determination of the repo rate. In particular, in none of the countries is there a significant response either to the deviation from trend in real exchange rate or in the real credit gap.

[15] See Aizenman *et al*. (2011) for a policy reaction function in which the loss function incorporates concerns with regard to the volatility of the exchange rate. See Roger, *et a*l, 2009).

Table 10. Integrated Inflation Targeting (Short-term OLS estimations)

	Brazil	Chile	Colombia	Peru
Intercept	0.48**	0.37***	0.21**	0.40***
	(0.03)	(0.00)	(0.01)	(0.00)
$\sum_{0}^{4} i_{t-1}$	0.89***	0.91***	0.95***	1.2***
	(0.00)	(0.00)	(0.00)	(0.00)
x_t	0.07***	0.05***	0.03***	0.12***
	(0.01)	(0.00)	(0.00)	(0.00)
π^1	0.04	0.21***	0.15**	0.02
	(0.33)	(0.00)	(0.02)	(0.66)
$RER_d hp$	0.008	0.004	0.004	0.007
	(0.15)	(0.55)	(0.35)	(0.22)
$C1$	-0.001	0.003	-0.003	0.007
	(0.16)	(0.71)	(0.25)	(0.22)
R^2	0.97	0.94	0.97	0.94
Observations	152	152	152	130
D-W test	0.16	0.02	0.59	0.67
(χ2)	(0.69)	(0.89)	(0.44)	(0.75)

***Source*: Author´s calculations.**

Note: p-values are in the parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table 11. Integrated Inflation Targeting (Long-term OLS estimations)

	Brazil	Chile	Colombia	Perú
Regime	**1**	**1**	**1**	**1**
x_t	0.63***	0.55****	0.6***	0.6***
π^1	0.36	2.33***	3.2**	0.1
$RER_d hp$	0.007	0.04	0.08	0.035
$C1$	-0.009	0.03	-0.06	0.035

Source: Author´s calculations.

Note: p-values are in the parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Interestingly, we obtain similar results using the Markov Switching procedure for the same specification, as reported in Table 12 (short-term coefficients) and Table 13 (long-term

coefficients). Once more, the bottom part of the table shows the frequency of observations in which each regime prevails;[16] again all four countries spend most of the time in Regime 1. For this case, the misalignment of the real exchange rate has a positive and significant effect on the repo rate in the case of Colombia, while the credit gap is positive and significant in the case of Chile. Nevertheless, these coefficients are only marginally relevant in economic terms. As an example, while in the short run for Colombia an increase of one percent in the output gap represents a 0.04% increase in the repo rate, this same response for the real exchange misalignment is only 0.006%. Thus, there does not seem to be support for a widespread IIT framework operating in these countries, in which the policy rate is highly sensitive to either real exchange rate movements or credit growth[17]. Finally, once again in all four cases none of the parameters are significant in Regime 2. Importantly, this result also holds in estimations in which additional explanatory variables such as each country´s EMBI and the VIX volatility index were introduced in the estimation[18]. Thus, Regime 2 again corresponds to a sporadic and short-lived abandonment of the normal reaction function.

[16] That is, when the estimated probability of being in a given regime is at least 90%.
[17] These results are robust to different definitions of the "credit" variable (see Appendix J).
[18] We report these results in Appendix K. Results are consistent with those using only credit and real exchange rate deviations from trend.

Table 12: Integrated Inflation Targeting (Short-term MS estimations)

	Brazil		Chile		Colombia		Peru	
	IIT	**ITT**	**IIT**	**ITT**	**IIT**	**ITT**	**IIT**	**ITT**
Regime	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
intercept	0.46**	0.93	0.24***	0.28	0.18***	-0.36	0.17***	-1.05
	(0.03)	(0.97)	(0.00)	(0.95)	(0.00)	(1.00)	(0.00)	(1.00)
$\sum_{0}^{4} i_{t-1}$	0.91***	0.88**	0.95***	0.8	0.93***	0.94***	1.2***	0.71
	(0.00)	(1.00)	(0.00)	(0.37)	(0.00)	(0.00)	(0.00)	(0.46)
x_t	0.07**	-0.26	0.03***	-0.08	0.04***	0.04	0.03**	0.17
	(0.03)	(1.00)	(0.00)	(0.97)	(0.00)	(0.88)	(0.01)	(0.64)
π^1	0.03	-0.13	0.09	-0.26	0.16***	-0.12	0.04*	0.18
	(0.35)	(1.00)	(1.00)	(0.86)	(0.00)	(1.00)	(0.07)	(0.96)
$RER_d hp$	0.008	0.09	0.001	-0.01	0.006*	0.005	0.002	-0.07
	(0.14)	(0.99)	(0.62)	(0.97)	(0.07)	(0.93)	(0.69)	(0.931)
$C1$	-0.01	0.003	0.004*	-0.01	-0.0002	0.005	0.002	-0.02
	(0.17)	(1.00)	(0.05)	(0.99)	(0.92)	(0.95)	(0.22)	(0.94)
σ^{S_t}	0.22***	0.00	0.01***	20.4	0.02***	0.61	0.01***	4.01
	(0.00)	(1.00)	(0.00)	(1.00)	(0.00)	(1.00)	(0.00)	(1.00)
p=p11	1.00***		0.97***		0.98***		0.96***	
	(0.00)		(0.00)		(0.00)		(0.00)	
L	-102.53		28.88		7.89		59.34	

Source: Author´s calculations.

Note: p-values are in the parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

L is the value of the log likelihood function. Furthermore, the probability (p=P11) of staying in regime 1, given that the economy is in the same state at time (t −1). σ is the Model's Variance

Table 13. Integrated Inflation Targeting (Long-term MS estimations)

	Brazil	**Chile**	**Colombia**	**Perú**
Regime	**1**	**1**	**1**	**1**
x_t	0.77***	0.6***	0.6***	0.15***
π^1	0.33	1.8	2.2***	0.2*
$RER_d hp$	0.09	0.02	0.08*	0.1
$C1$	-0.11	0.08*	-0.002	0.1

Source: Author´s calculations.

Note: p-values are in the parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

3. Exploring the determinants of central bank intervention in the foreign exchange market

Although the previous section provides evidence that in most cases the central bank apparently has not taken exchange rate considerations into account when setting interest rates, it is plausible that the countries analyzed have, at one time or another, intervened directly in the F/X market to defend or target a certain level of the exchange rate or to moderate extreme fluctuations. After all, the region has had a justifiable history of concern over potential "Dutch Disease" effects of large terms of trade shocks, and over the potential destabilizing effects of sizable influx and outflows of foreign capital. Thus, even under IT, one might expect some degree of exchange rate targeting, especially in the face of large external shocks[19].

Interestingly, central banks consistently argue that if and when they intervene in the F/X market, they do so either as a prudential measure to replenish international reserves or on account of concerns for exchange rate volatility. For all four countries we have thoroughly reviewed the minutes of the monetary policy committee and the inflation report and in the case of Colombia also the reports to Congress. With the notable exception of a 2003 statement by the Banco de la República de Colombia according to which the sale of reserves in 2003 was prompted by the need to reduce inflationary pressures coming from the evolution of tradable goods prices, to the best of our knowledge there is no mention of concerns with the level of the exchange rate as a motive for central bank intervention in the F/X market. The Peruvian authorities claim to intervene on account of two objectives: to improve the level of NIR and to control exchange rate volatility. Based on its inflation reports, the BCdlRP intervened in the F/X markets to alleviate real exchange rate volatility during the market uncertainty in 2002 and just after the Lehman Crisis. In the case of Chile, in addition to these two objectives, reference is made to stabilization of financial markets, especially during the Lehman Crisis when the Central Bank decided to introduce a set of non-conventional measures. Interestingly, the central bank of Brazil provides no explanation for its intervention in the F/X market. This is in line with Chang

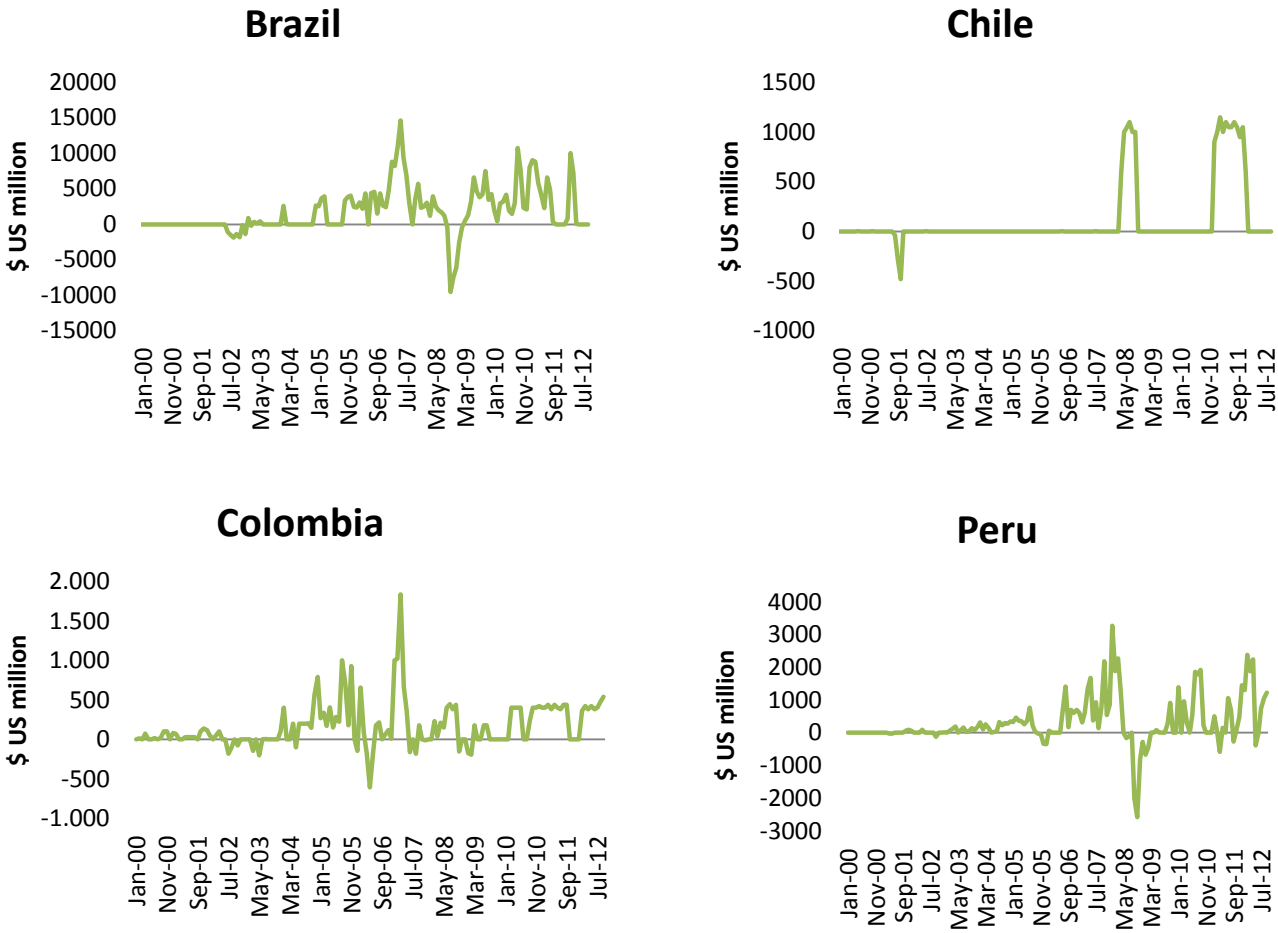
[19] Capital markets appear to recognize the advantages of intervention; one empirical study shows that, regardless of the stated or de jure regime, emerging economies displaying greater intervention are rewarded in the form of lower sovereign spreads (Barajas, *et al* 2008).

(2007), according to whom "in contrast to the other cases discussed in this paper, the Banco Central do Brasil has refrained from any explicit claims to any "right to intervene" in the foreign exchange market".

In what follows we show how large these interventions have been and then identify their main determinants. In Figure 3 we report monthly data on net central bank purchases of foreign exchange (i.e. purchases minus sales), the FCL variable in what follows. From the figure it is quite evident that intervention was not very large nor common at the beginning of IT –a behavior that is consistent with the view expressed in Barajas *et al*. (2008) in the sense that in the initial years of the IT regime central banks were particularly concerned with establishing and consolidating credibility in a monetary regime that, in its purest form, calls for a floating exchange rate regime.[20] A salient feature of Figure 3 refers to the fact that most interventions have been on the upside, in order to purchase NIR. Regardless of the motive for doing so, central banks in our sample have almost consistently built up their NIR stocks, which is consistent with the "NIR replenishment motive" frequently argued by monetary authorities.

[20] A caveat is in order. In this paper we only analyze F/X intervention by central banks although intervention may at times take place either through sovereign wealth funds and or SOEs.

Figure 3. Net Foreign Exchange Purchases by the Central Bank



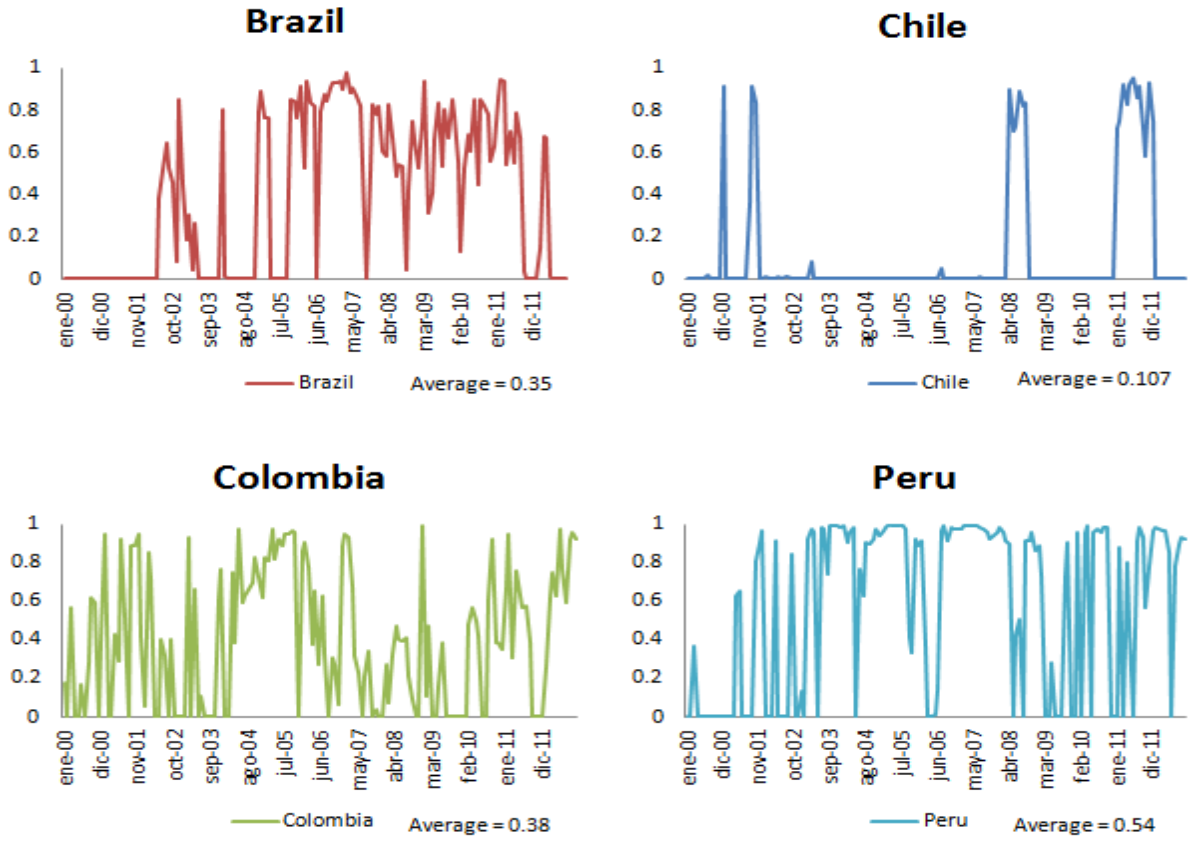
Source: The series for Peru, Colombia and Chile were originally taken from Central Bank data. In Brazil data was kindly provided by BTG Pactual.

Following Levy-Yeyati and Sturzenegger (2001) and Barajas *et.al* (2008) we also construct the following "intervention index" (INTERV) to get a better feeling on the relative magnitude of F/X intervention:

$$INTERV_t = \frac{|FCI_t e_t / BM_{t-1}|}{|\Delta E_t / E_{t-1}| + |FCI_t e_t / BM_{t-1}|}$$

Where FCI are central bank purchases and sales in the F/X market[21] (Figure 3, in U.S. dollars), BM is base money and e is the nominal U.S. dollar exchange rate. The numerator measures monthly FCI expressed in domestic currency and scaled by the previous end-month base money stock. In a country with a pure exchange rate float, in which FCL is zero, the index will be zero. In case of a fixed exchange rate, $INTERV$ equals one, as all of the action in the exchange market would occur on changes in quantities rather than in the exchange rate. Also note that *INTERV* is always positive, making no distinction between purchases or sales of the same magnitude.

Figure 4. Intervention Index



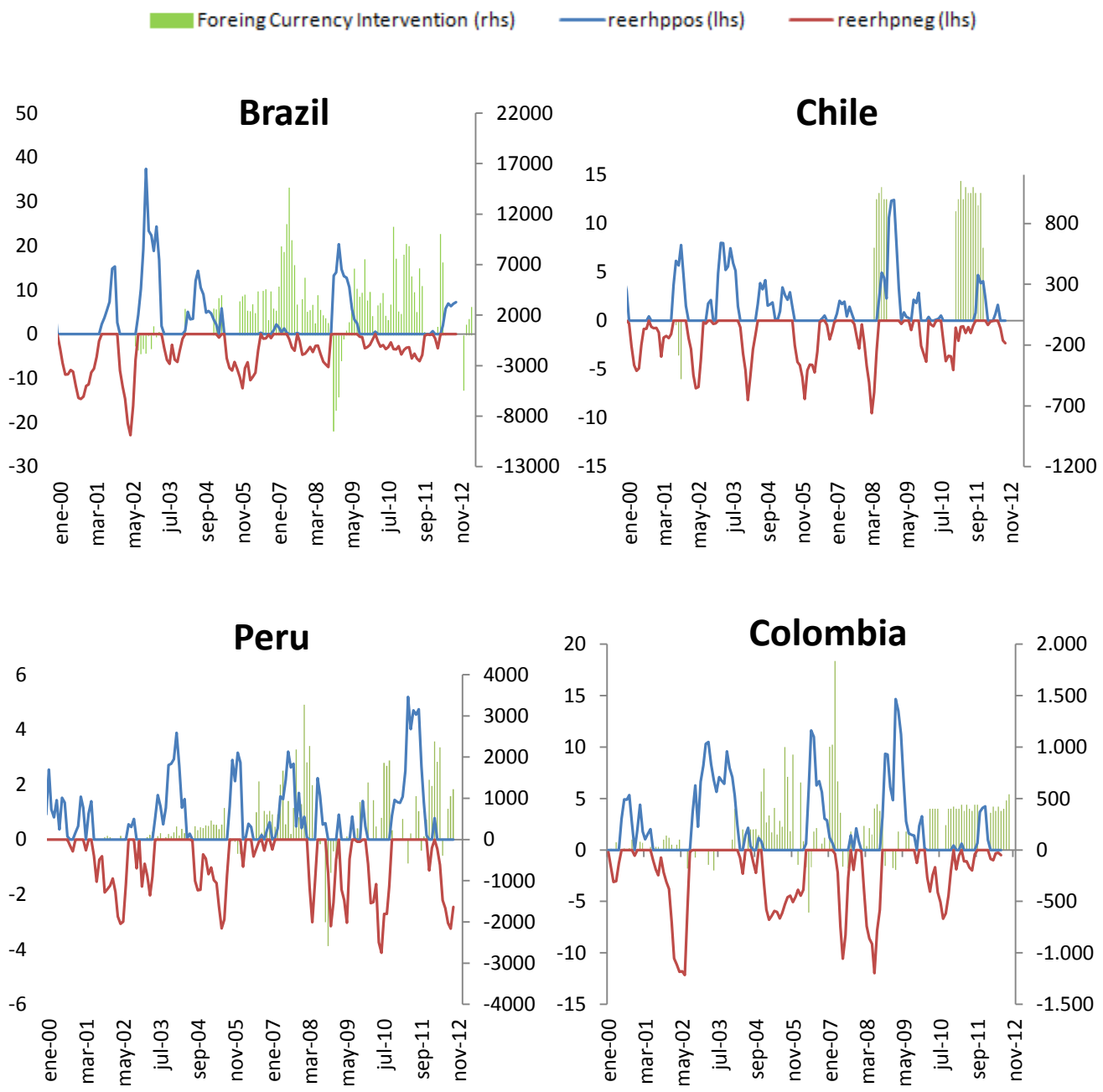
Source: Author´s calculations

[21] Prior estimations of INTERV have generally used changes in NIR instead of purchases and sales in the F/X market. That approach is problematic for many reasons, including the fact that, because of valuation issues, international reserves can change (in US dollar terms) in spite of the fact that no F/X market intervention has taken place. Likewise, reserves may increase as a consequence of the interest payments received on account of their investment. In the country data appendix we report the exact definition and source of purchases and sales.

Figure 4 shows *INTERV* for Brazil, Chile, Colombia and Peru, from January 2000 to September 2012. Three aspects are worth highlighting: (i) all four countries intervene, and quite substantially at times; (ii) the monthly average of *INTERV* suggests that Peru (at 0.54) is the country that intervenes the most, and Chile the least (0.107) with Brazil (0.35) and Colombia (0.38) somewhere in between. (iii) With the exception of Chile, the other countries intervene quite often. (iv) in all four countries there are instances in which the exchange rate regime behaves as if it were a fixed exchange rate.

Figures 5 reports three series for each country: (i) FCL, net foreign currency purchases; (ii) RER*hpp* are the positive deviations of the RER from its HP trend, indicating that the RER is *weaker* (more depreciated) than its long-run trend level; (iii) *RERhpn*, the negative deviations when the RER is *stronger* (more appreciated) than its trend level. Deviations in the RER are measured in percentage terms on the left hand axis and, by definition, average to 0. *FCL* is measured on the right hand axis (US million). Figure 6 plots the level of *RERhp* together with the rolling volatility of the RER. Figures 5 and 6 support the following stylized facts: i) in almost all cases there is a visible asymmetry, as central banks purchased reserves more aggressively when the currency was strong in comparison to selling reserves when it was weak; ii) there is no general coincidence among countries in the periods of large interventions. While Brazil and Peru undertook their largest sales in the F/X market during the Lehman episode, the central banks of Colombia and Chile rarely intervened. On the other hand, Figure 6 suggests that while the currencies of Peru, Chile and Colombia fluctuated frequently from mildly strong to mildly weak, in Brazil RER volatility was much greater; with less frequent but much larger fluctuations.

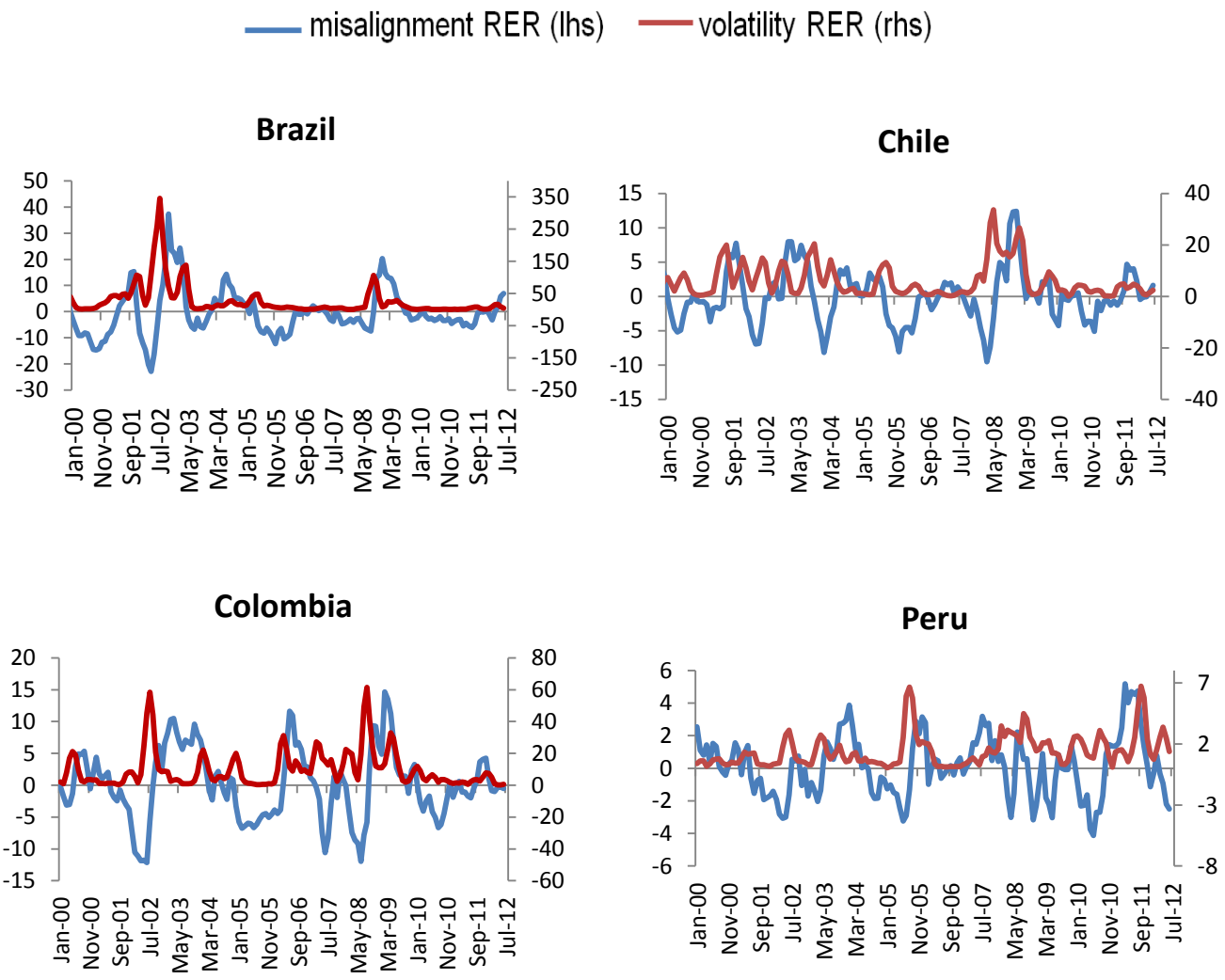
Figure 5. Central Bank Net Foreign Purchases and the RER Gap



Source: Author´s calculations. The series fwere originally taken from Central Bank data. In Brazil data provided by BTG Pactual.

Notes: The left axis is for deviations in the Real Exchange rate from the HP ($reer_d hp$). The right axis is for Foreing Curreny Purchases and is measured by $ US millions .

Figure 6: RER GAP and volatility



Source: Author´s calculations based on Central Bank data.
Note: The left axis is RER misalignment, measured as the percentage deviations of the RER from its HP trend. The right axis is RER volatility, measured as the 6-month rolling variance of the monthly RER.

In what follows we explore the possible determinants of *FCL*, a variable that can be positive (net reserve purchases by the central bank) or negative (net sales). In particular, we want to provide evidence as to whether F/X interventions are motivated by issues of *exchange rate volatility* or *accumulation of reserves* (as is usually argued by central bankers) or if concerns with regard to

exchange rate levels and/or inflation are relevant. In particular, we estimate the following "reaction function" for interventions in the foreign currency market:

$$FCI_t = \theta + \gamma_1(RER_d hp) + \gamma_2(D_1 * RER_d hp)_t + \gamma_3(RER_d hp * RER\sigma^2) + \gamma_4(RER_d hp * NIR) + \gamma_5(E_t\pi_{t+1} - \pi_t^T) + \varepsilon_t \quad (3)$$

The dependent variable, FCI, is monthly net foreign currency purchases. We consider several explanatory variables: (i) $RER_d hp$ as a proxy for real exchange rate misalignment that will allow us to determine whether interventions depend on the *level* of the exchange rate; (ii) We also allow for asymmetric response, depending on whether the currency is relatively strong or weak. For this purpose, we interact $RERhp$ with a dummy variable D_1 (equal to 1 when $RER_d hp$ is below trend –i.e. relatively strong— and equal to 0 when it is above trend –i.e. relatively weak; (iii) We also want to assess the possible importance of exchange rate volatility as a determinant of central bank intervention in the F/X market. With that purpose in mind, we include the interaction between $RER_d hp$ and $RER\sigma^2$ to test if Central Banks intervened more forcefully when volatility has been higher; (iv) We also include the interaction between NIR (the level of net international reserves) and $RER_d hp$ to uncover the relationship between foreign currency net purchases and the level of Net International Reserves; (v) Finally, we include the inflation gap (as in the monetary reaction function) to determine whether F/X intervention is directly related to an inflation objective. For example, in the face of rising inflation, the central bank might intervene to prevent a depreciation that would feed into inflation via pass-through.

Of course, there is a potential endogeneity problem to the extent that the level of the exchange rate as well as the inflation gap could potentially depend on F/X intervention itself. We therefore undertake 2SLS estimations using as instruments the FED interest rate, EMBI and the VIX index of volatility in the U.S. stock market as reflecting external conditions that have an impact on the exchange rate and domestic inflation[22]. The validity of the instruments is supported by the results reported in Table 14.

[22] For the NIR and $RER\sigma^2$ we used their lags as instruments

Table 14: First Stage (2SLS)[23]

Column	(1.1)	(1.2)	(1.3)	(1.4)
	Real Exchange Rate Misalignment			
Country	Brazil	Chile	Colombia	Peru
VIX		0.18** (0.01)	0.22** (0.01)	
EMBI	0.008*** (0.00)			
i FED				0.16*** (0.00)
R^2	0.32	0.22	0.28	0.33
Observations	153	153	153	153

Source: Author´s calculations.

Note: p-values are in the parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

The second-stage results, reported in Table 15, can be summarized as follows: i) in Brazil, Chile and Peru deviations from trend in the RER are significant determinants of interventions in the F/X market; ii) the coefficients for $D_1 * RER_d hp$ support the idea that in Chile, Colombia and Peru intervention is asymmetric, with greater intervention (purchases) when the currency is strong than (sales) when it is weak; iii) in Brazil, while there is symmetric intervention, intervention is negatively related to volatility; iv) only in the case of Chile are interventions are related to the inflation gap, but the sign of the relationship is not the expected one; v) only in Chile does intervention intensify in periods of higher volatility. Contrary to statements from all central banks, Table 6 suggests that intervention in the F/X market in the other three countries does not seem to be related to RER volatility. Finally, the interaction of *RERdhp* does not lend much support to the idea that intervention is done to build up a stock of reserves. If there were an

[23] In particular, we first run a regression of the level of RER misalignment as a function of the instruments in order to validate the latter. The second stage is performed using as explanatory variables the estimated values obtained in the first stage.

implicit target level for reserves, then we would expect intervention to decline as the level of reserves increases. However, this is only marginally so in Brazil, and not the case in the other three countries.

Table 15: Determinants of Intervention in the F/X market (2SLS)

	Description	**(1.1)**	**(1.2)**	**(1.3)**	**(1.4)**
		Brazil	Chile	Colombia	Peru
Intercept		808.5* (0.05)	1297 *** (0.00)	140.5*** (0.00)	39152** (0.01)
$RERdhp$	RER deviatons from trend	-457*** (0.00)	-241.2*** (0.00)	-67.9 (0.15)	-48158** (0.02)
$D1 * RERdhp$	Negative RER deviations from trend (currency too strong)	-79.5 (0.19)	-824.4*** (0.00)	-61.9** (0.04)	-51513** (0.02)
$RERdhp * RER\sigma^2$	RER deviations from trend interacted with volatility	1.43** (0.02)	-6.56** (0.00)	0.40 (0.62)	-0.22 (0.16)
$RERdhp * NIRlevel$	RER deviations from trend interacted with NIR level	-0.001* (0.09)	0.003 (0.20)	0.001 (0.49)	-0.01 (0.35)
Inflation gap	Inflation Gap	243.9 (0.37)	248*** (0.00)	3944 (0.49)	-104.1 (0.41)

Source: Author´s calculations.

Note: p-values are in the parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

3. Summary and Conclusions

Of late concerns have emerged in the sense that, in addition to striving to achieve macroeconomic stability, special regard should be given to financial stability. Indeed, many observers believe that the recent global financial crisis was partially determined by the complacency that came about after years of low and stable inflation. With CPI inflation very much under control, monetary policy was loosened. In the context of severe weaknesses in financial supervision and regulation, a loose monetary policy stance set the stage for severe dis-alignments in key asset prices including, prominently, real estate and the stock market. Policy prescriptions following the financial crisis include the use of macro-prudential measurers and maybe even the incorporation of variables other than the output and inflation gaps in the monetary reaction function of central banks.

In this paper we analyze the implementation of inflation targeting in Brazil, Chile, Colombia and Peru during 2000-2012. An interesting feature of these countries is that they all had in place a rather sophisticated toolkit of macro-prudential instruments before the collapse of Lehman brothers. We start by performing OLS estimations of conventional Taylor rules and show that in all four countries the central bank increases its repo rate of interest in response to increases in the output gap and, except in the case of Peru, also to deviations of inflation expectations from established targets. Second, using a Markov-Switching methodology that allows the data to "speak for itself" in terms of identifying possible structural breaks, we find that in Chile, Colombia and Peru the policy rule was quite stable; departures were infrequent, most often in response to large external shocks such as the 2002-3 period of heightened risk aversion toward emerging markets and the 2008-9 global turmoil unleashed by the collapse of Lehman Bros. In the case of Brazil, the policy rule was even more stable, as it was impossible to detect a meaningful departure from the rule. Third, we expanded the conventional Taylor Rule to include variables related to exchange rate misalignments and to developments in domestic credit markets. Interestingly, there is only limited evidence that the countries in our study have actually used some form of expanded or integrated inflation targeting framework along these lines. In particular, in the MS estimations there is evidence that the repo rate responded only marginally

to real exchange misalignment in the case of Colombia and to credit gap in the case of Chile. One possible reason for this result is that we lack sufficient post-Lehman observations to see the emergence of a stable financial stability objective in the reaction function.

However, the IT framework practiced in these countries may have expanded in other ways, namely through the use of additional instruments, in particular foreign exchange intervention. We analyze whether central bank intervention in foreign exchange markets, present throughout our study period, contained a systematic response to objectives other than pure inflation stabilization. We find strong evidence that, contrary to official central bank statements, intervention seems to be explained to a great extent by concerns with regard to exchange rate misalignments—levels-- rather than to concerns with exchange rate volatility. We also find evidence that, with the exception of Brazil, countries intervene more aggressively in the F/X market when they perceive the currency to be strong than when the currency is perceived to be weak. That is, the fear of appreciation is greater than that of depreciation. Moreover, intervention in the F/X market in general does not seem to be related to RER volatility nor to the level of NIR. In all, we provide evidence that central banks appear to have pursued two distinct objectives with two different instruments: an inflation objective using a mostly standard Taylor rule and an exchange rate objective through interventions in the F/X market. At least to date, there does not seem to have been an inconsistency in the pursuance of these two objectives. Thus, although F/X interventions are consistent with "fear of floating", as emphasized by Reinhart (2013), this has not, at least to date, implied a relaxation of the commitment to low and stable inflation. That is, authorities have not said "goodbye" to either fear of floating or inflation targeting, so far.

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Appendix A. Variables description for Brazil

- Short-term rate (SELIC- last day of the month): From Banco Central do Brasil.
- x_t (Output Gap): It is the percentage deviation of real output from trend. Real output –Y- is the monthly GDP (accumulated in the last 12 months) at constant prices (2008) obtained from the Banco Central do Brasil and seasonally adjusted by us[24]. The trend -Y^*- comes from a conventional HP estimation.
- $E_t\pi_{t+1}$: Expectations are taken from a monthly survey developed and published by Latin Focus Consesus Forecast[25].
- π_t^T: The inflation target is announced by the Banco Central do Brasil and can be found in the "Histórico de Metas para a Inflação no Brazil"
- π_t *:* Inflation corresponds to the annual variation from the CPI. Original series were taken from the Central Bank.
- $RER_d hp$ ($RER - RER\ hp\ /\ RER\ hp$)*:* Our estimations of the of percentage deviations real exchange rate (HP) trend. RER taken from Banco Central do Brasil. It uses CPI as deflator and comprises the 10 main trading partners.
- $RER\ \sigma^2$: 6-month rolling variance of the real exchange rate; our own calculations.
- $C\ 1$ ($\Delta\ RC - \Delta\ x_t$): Credit Growth with respect to the same month of the previous year, deflated by changes in the CPI and defined as the gross loan series. Source: Banco Central do Brasil. Output gap x_t growth with respect to the same month of the previous year.
- $C\ 2$ (RC/GDP): Credit defined as the gross loan series. Source: Banco Central do Brasil. The real output is the Output gap x_t.
- C 3 (*Non-Performing Loans/ RC):* Non Performing Loans over the gross loan series taken from the Banco Central do Brasil.
- FCI_t ($Foreing\ Currency\ Intervention$): Series "Intervenções do Banco Central". This information includes regular spot intervention and all other varieties except derivatives. It includes forward sales/purchases; means repos; lending of foreign currency by the CB to domestic (financial) counterparties; and lending of foreign currency by the CB earmarked for lending as export financing. This data was provided by BTG Pactual.
- $EMBI\ and\ NIR$: This is information is available in the Banco Central do Brasil. EMBI was calculated by J.P.Morgan Chase.

[24] To seasonally adjust the series we used the Tramo-seats methodology which incorporates ARIMA model-based signal extraction techniques.

[25] This is the longest inflation expectations survey available. Unfortunately, it only includes expectations for end December of the current and of the following year. We have decided to establish the month of April as the cutting point: expectations for January-March of year t are those of December year t, whereas expectations for April-December of year t are those of December year t+1.

Appendix B. Variables for Chile

- i_t (Short-term REPO rate): first of the month, from the Banco Central.
- $i_{j,t-1}$: Lag for one period of the j-th short-term REPO rate.
- x_t (Output Gap): Measured as percentage deviations of real output from trend. Real output –Y- is the monthly IMACEC (indicador mensual de actividad económica) -constant prices (1990)- taken from Banco Central de Chile and seasonally adjusted by us. After we obtain the monthly GDP series, the trend -Y^*- comes from a conventional HP estimation.
- $E_t\pi_{t+1}$: Inflation expectations come from a monthly survey developed and published by Latin Focus Consesus Forecast[26].
- π_t^T: The inflation target is announced by the Banco Central of Chile and can be found in its Inflation Reports.
- π_t *:* Inflation corresponds to the annual variation from the CPI. Original series were taken from the Central Bank.
- $RER_d hp$ ($RER - RER\ hp\ /\ RER\ hp$) : Our own calculations of percentage deviations of the real exchange rate from its (HP) trend. The real exchange rate is taken from the Central Bank data (21 main trading partners, deflated by the CPI).
- $RER\ \sigma^2$: 6-month rolling variance of the real exchange rate; our own calculations.
- $C\ 1$ ($\Delta\ RC - \Delta\ x_t$): Credit Growth with respect to the same month of the previous year, deflated by changes in the CPI and defined by the gross loan series. Source: Superintendencia de Bancos e Instituciones Financieras. Output gap x_t growth with respect to the same month of the previous year.
- $C\ 2\ (RC/GDP)$: Credit defined by the gross loan series. Source: Superintendencia de Bancos e Instituciones Financieras. The real output is the GDP monthly calculation based on the methodology proposed by Litterman (1983). [27]
- $C\ 3$ (*Non Performing Loans/ RC):* Non Performing Loans over the gross loan series taken from the Superintendencia de Bancos e Instituciones Financieras.
- FCI_t ($Foreing\ Currency\ Intervention$): Series "Activos de reservas internacionales" component "Operaciones de cambio con banco". Source: Banco Central de Chile.
- VIX: Obtained from Bancolombia; original series comes from Bloomberg.
- $Terms\ of\ Trade$: Quarterly IMF data converted to monthly based on Litterman (1983).

[26] This is the longest inflation expectations survey available. Unfortunately, it only includes expectations for end December of the current and of the following year. We have decided to establish the month of April as the cutting point: expectations for January-March of year t are those of December year t, whereas expectations for April-December of year t are those of December year t+1.

[27] In this methodology we transform the annual series of the GDP obtained in the Banco Central de Chile to a monthly series.

Appendix C. Variables for Colombia

- i_t (Short-term REPO rate): first of the month, from Banco de la República,
- $i_{j,t-1}$: Lag for one period of the j-th short-term REPO rate.
- x_t (Output Gap): measured as the percentage deviation of real output from trend. Real output - Y- is the monthly IPIR (Indice de Producción Industrial) taken from Banco de la Republica -constant prices (1990)- and was seasonally adjusted by us. After we obtain the monthly GDP series, the trend -Y^*- comes from a conventional HP estimation.[28]
- $E_t\pi_{t+1}$: Inflation expectations come from a monthly survey developed and published by Latin Focus Consesus Forecast[29].
- π_t^T: The inflation target is announced by the BdR and can be found in its reports to the Congress.
- π_t *:* Inflation corresponds to the annual variation from the CPI. Original series were taken from the Central Bank.
- $RER_d hp$ ($RER - RER\ hp\ /\ RER\ hp$): Percentage deviations in the real exchange rate from its (HP) trend, based on our own calculations. The real exchange rate is taken from BdR. This index uses CPI as a deflator and is in reference to the weighted average of the 20 main trading partners.
- $RER\ \sigma^2$: 6-month rolling variance of the real exchange rate; our own calculations.
- $C\ 1$ ($\Delta\ RC - \Delta\ x_t$): Credit Growth with respect to the same month of the previous year, deflated by changes in the CPI and defined as the gross loan. Source: Superintendencia Financiera de Colombia. Output gap x_t growth with respect to the same month of the previous year.
- $C\ 2$ (RC/GDP): Credit defined as the gross loans. Source: Superintendencia Financiera de Colombia. The real output is the GDP monthly calculation based on the methodology proposed by Litterman (1983). [30]
- $C\ 3$ (*Non Performing Loans/ RC):* Non Performing Loans over the gross loan series. Source: Superintendencia Financiera de Colombia
- FCI_t ($Foreing\ Currency\ Intervention$): Series "Operaciones de Compra - Venta de Divisas del Banco de la República" (without Government sales). Source: BdR.
- $Terms\ of\ Trade\ and\ NIR$: Source: Banco de la Republica.
- VIX: VIX obtained from Bancolombia; original series from Bloomberg.

[28] Our output gap measure does not correspond to the theoretical found in New Keynesian models of the Woodford-Gali type, which is equal to the difference between output and its flexible price counterpart. According to Cobo (2005), the difference among these approaches for Colombia is marginal in terms of forecasting performance.

[29] This is the longest inflation expectations survey available. Unfortunately, it only includes expectations for end December of the current and of the following year. We have decided to establish the month of April as the cutting point: expectations for January-March of year t are those of December year t, whereas expectations for April-December of year t are those of December year t+1.

[30] In this methodology we transform the annual series of the GDP obtained in the Banco de la Republica (the primary source is the DANE) to a monthly series.

Appendix D. Variables description for Peru

- i_t (Interbank Rate): Series taken from the Banco Central de la Reserva de Peru.
- $i_{j,t-1}$: Lag for one period of the j-th short-term REPO rate.
- x_t (Output Gap): It is measured as the deviations of real output from trend. Real output –Y- is the monthly GDP at constant prices (2008) from the Banco Central de la Reserva. It was seasonally by us. The trend -Y^*- comes from a conventional HP estimation.
- $E_t\pi_{t+1}$: Inflation expectations come from a monthly survey developed and published by Latin Focus Consesus Forecast[31].
- π_t^T: The inflation target announced by the Banco Central de la Reserva del Perú and can be found in its inflation reports.
- π_t *:* Inflation corresponds to the annual variation from the CPI. Original series were taken from the Central Bank.
- $RER_d hp$ ($RER - RER\ hp\ /\ RER\ hp$): Our own estimations of the percentage deviations in the real exchange rate from its (HP) trend. The real exchange rate is taken from Banco Central de la Reserva de Perú. It uses CPI as the deflator and is a weighted average of the 20 main trading partners.
- $RER\ \sigma^2$: 6-month rolling variance of the real exchange rate; our own calculations.
- $C\ 1$ ($\Delta\ dRC - \Delta\ x_t$): Credit Growth with respect to the same month of the previous year, deflated by changes in the CPI and defined as the gross loan. Source: Banco Central de la Reserva del Perú. Output gap x_t growth with respect to the same month of the previous year.
- $C\ 2$ (dRC/GDP): Credit defined as the gross loans. Source: Superintendencia Financiera de Colombia. The real output is the Output gap x_t.
- $C\ 3$ (*Non Performing Loans/* dRC *):* Non Performing Loans over the gross loan series. Source: Superintendencia Financiera de Colombia
- FCI_t ($Foreing\ Currency\ Intervention$): Series "Compras (ventas) netas mensuales de dólares en el mercado por parte del Banco Central de Reserva del Perú".
- $FED\ Interest\ Rate$: Source: Federal Reserve System
- NIR: Source: Banco Central de Reserva del Perú

[31] This is the longest inflation expectations survey available. Unfortunately, it only includes expectations for end December of the current and of the following year. We have decided to establish the month of April as the cutting point: expectations for January-March of year t are those of December year t, whereas expectations for April-December of year t are those of December year t+1.

Appendix E. Policy actions in addition to conventional IT policy in Brazil[32]

F/X market intervention policies[33]		
Date adopted	**Motivation**	**Description**
Second Half 2**001**	The political and economy instability of the world generated strong pressure for the depreciation of the Real in 2001.	The Banco Central's net international reserves at the end of 2000 were US $ 33 billion, the Banco's dollar sales in the second half of 2001 were between one fifth to one sixth of its reserves.
Second half of 2002	Electoral Uncertainty (Lula rose in the polls). The Brazil EMBI Spread changed from 700 basis points on March to 2422 basis points at the end of July.	Foreign exchange intervention had three dimensions. First, the Banco Central agreed to provide up to US $ 2 billion dollars in export credit lines, of which US$ 1.4 billion were drawn in 2002. Second, the Banco engaged in US$ 1.8 billion in foreign exchange repos. Finally, there were spot sales of US $ 5.9 billion. All in all, the Banco Central sold US $ 9.1 billion in 2002, more than one quarter of its reserves at the end of 2001, as a result of its intervention policy
Between 2004 and 2008	Control the appreciation of the exchange rate	The Central bank stated a policy of Reserve accumulation. The level of reserves changed from US $ 62.7 billion level in June 2006 to US $ 205 billion by September 2008.
Between September 2008 and February 2009	Lehman Crisis	The BCB sold US$ 26 billion, or about 13 percent of its net foreign reserves. Almost US$ 50 billion of Foreign exchange swaps contracts were offered by the CB (almost one-fourth of its reservs). Nevertheless, the demand reached only 12 billion. The repo rate was maintained at 13.75 until the end of January 2009
Between 2009 and 2013	Appreciation	Net foreign reserves, which stood around US $ 200 billion at mid-2009, climbed to about US $ 370 billion by the end of 2012
Reserve Requirements		
Date adopted	**Motivation**	**Description**
September 2001	Reduce liquidity	Reintroduced compulsory reserve on time deposit and raised the rate from 0 to ten percent.
October 2008	Leman Period	Montoro and Moreno (2010) calculate that the effective reserve requirement fell by 10 percent points. This reduction was joined with incentives (lower requirement ratios) for large banks to finance smaller institutions.

[32] This information is taken from the Inflation Reports of the Banco Central do Brasil, Chang (2007), Céspedes *et al* (2012) , Pereira (2012), Montoro *et al* (2011).

December 2010	Control appreciation and smooth rapid credit growth.	Required ratios jumped from 8 percent to 12 percent for cash deposits and 15 to 20 percent for time deposits
January 2011	Anticipate potential sources of risk to the Brazilian economy and its financial system	Imposed a 60% unremunerated reserve requirement on bank's short positions in the foreign exchange sport market exceeding $US 3 billion (in July, the limit was tightened to US$1billion). As it is reported in the MPC minutes the CB i)increased bank reserve requirements ii)increased capital requirements for specific segments of the credit market iii)included new reserve requirements on bank's short sport foreign exchange positions.
Capital Controls		
June 2007	Reduce the foreign exchange exposure of financial institutions	In the Circulares 3351, 3352, and 3353 the CB altered the limit of exposure in gold and in assets and liabilities denominated in exchange variance and altered factor "F" applicable to transactions with gold and with assets and liabilities denominated in exchange variance
March 2008	Reverse monetary policy	Imposed 1.5% tax on foreign purchases of fixed income securities. Particularly, to Emerging companies investment Funds (FIEE) and private equity funds (FIP)
October 2008	Lehman Period	Eliminated all tax on credit and exchange transaction
October 2009	Reverse monetary policy	Increased to 2% taxes on credit and exchange transaction. Particularly, the tax on fixed income, variable income (stocks), IPO, FIEE and FIP.
October 2010	Currency appreciation	The tax on fixed income, FIEE and FIP were increased from 2% to 6%. The taxes on financial transaction to derivate margin deposits were also increased from 0.38 to 6%.
December 2010	Incorporate liquidity	The tax on variable income, IPO, FIEE, FIP, FDI to variable income where adjusted to 2%
December 2011 – January 2012	Stimulate the domestic economy.	Taxes on fixed income, variable income, IPO, FIEE, FIP, FDI to variable income, BDR/secondary market were all eliminated (0%).

Appendix F. Policy actions in addition to conventional IT policy in Chile[34]

Date adopted	Motivation	Description
August of 2001	The significant increase in the risk perception of Argentinean economy and a persistent decline in the copper price caused a rapid depreciation of the peso.	In this case the CB announced that would sell up to US $ 2 000 millions dollars in the spot market for the rest of the year. Additionally, as another way to reduce exchange rate volatility, the CB also announced that would sell up other US $ 2000 millions in peso bonds indexed to the dollar. However, due to the good respond of the market, the final amount of dollars actually purchased (US $ 803 million) was less than half the maximum originally announced and sell up to US $ 3000 millions in peso bonds indexed to the dollar.
October 2002	The exchange rate depreciated 7% in one only month and the EMBI Spread reached historical levels, due to the Brazilian elections instability	The Central Bank announced its willingness to intervene in the market by selling up to US $ 2 000 millions dollars in the spot market between October 2002 and February 2003, as it had done the year before. Nevertheless, unlike the previous experience, the pressures on the peso stabilized and the Banco Central ended up not intervening in the spot market. In this sense, the effective intervention was made only by the sell of US $ 1.500 millions in peso bonds indexed to the dollar.
April 2008	During a strongly appreciation of the peso during the second semester of 2007 and the beginning of 2008	The Central Bank announced a program of international reserve accumulation of US$8000 millions.
Between September 2008 and December 2008	Following the collapse of Lehman Brothers	The Central Bank announced the end of the programmatic international reserve accumulation and began a program of repos and swaps to provide domestic and foreign liquidity. The international liquidity provision program consisted initially in 28-day dollar swap auctions for a period of 4 week. These operations were sterilized with repos of the same maturity. On October 2008, the Central Bank extended the program from 1 to 6 months and extended its length to 60 and 90 days. In December 2008, the Central Bank extended the maximum maturity of the swaps to 180 days and extended the program for all 2009 with the objective to provide liquidity for longer terms and guarantee availability in the market. (Céspedes, 2012).
Last quarter 2010	When the nominal exchange rate presented an outstanding appreciation	In this case, the Central Bank announced once again a process of international reserve accumulation referring to the need to reinforce its international reserve position.

[34] This information is taken from the Monetary Policy Reports and the Financial Stability Reports of the Banco Central de Chile, Chang (2007), Céspedes *et al* (2012) and Tapia *et al* (2003).

Appendix G. Policy actions in addition to conventional IT policy in Colombia[35]

F/X market intervention policies		
Date adopted	**Motivation**	**Description**
Between 2002 and 2003	The likely election of President Lula in Brazil and political instability in Venezuela heightened risk aversion	In response to this critical situation, BdR increased its repo rate (by 100 bps in January 2003 and by another 100 bps points in April 2003) and offered auctions to sell US$545 million in the XR market. Furthermore, in February 2003, BdR announced additional auctions to sell up to US$1.000 million
Between 2004 and 2007	Continuous appreciation of the Colombian peso in 2004	The Central Bank announced its willingness to buy up to US$700 million between April and July by means of the put-option mechanism and with monthly amounts announcements. Nevertheless, as this policy response was insufficient to stop inflation, the BdR introduced discretionary interventions and announced its willingness to buy up to US$1 billion during the last quarter of 2004.This trend continued until the first quarter of 2007 (with a brief interruption in the second semester of 2006).
June 2008	Continuous appreciation of the Colombian peso in 2008	In June 2008, the Central Bank announced a daily accumulation of U.S. $ 20 millions through direct purchase auctions for the rest of the year.
September 2008	The collapse of Lehman Brothers	The Central Bank decided to stop the US dollars daily purchase in October 2008 and established that the monetary expansion for the last quarter of the year was going to be achieved via the purchase of treasury bills (TES) in the amount of $500 millions. Additionally, the BdR established that the monetary expansion of 2009 was going to be achieved via the purchase of treasury bills (TES) in the amount of three billion pesos
Between March 2010 and October 2011	In the context of a strong appreciation of the peso	In march 2010, the BdR began programmed purchases of US dollars, buying US$20 million every day until October 2011 (with a brief interruption between July and August 2010).
Between February 2012 and December 2012	Appreciation of the peso caused by the renewed confidence in the economy.	In Febreruary 2012 BdR decided to restart this daily purchases.
Reserve Requirements		
Date adopted	**Motivation**	**Description**

[35] This information is taken from the Monetary Policy Reports and the Financial Stability Reports of Banco de la República, Chang (2007), Céspedes *et al* (2012), Kamil, H. (2008) Vargas *et al* (2010).

Between May 2007 and June 2007	In order to address the issue of a possible unsustainable rate of credit growth (in April 2007 annual credit growth was 32%).	The central bank increased reserve requirements on bank deposits (from 13 to 27% for checking accounts and from 7 to 12.5% for saving accounts). This policy was accompanied by an increase in loan provisioning requirements by the Financial Superintendency. Furthermore, in June of that year BdR established a marginal reserve requirement of 27% on savings deposits.
June 2008	In order to sterilize part of the monetary expansion caused by the program of international reserve purchases (Vargas et al, 2010).	The Central Bank once again changed reserve requirements: this time marginal reserve requirements were eliminated and average levels increased.
February 2009	After the collapse of Lehman Brothers	BdR reduced reserve requirements in February and totally eliminated 4 months later
Capital controls		
Date adopted	**Motivation**	**Description**
2007	Prevent excessive short-term foreign borrowing, reduce the exposure of the economy to speculative capital inflows, and moderate the appreciation of the peso	BdR introduced a 40% non-remunerated reserve requirement on foreign portfolio investment, to be held at BdR for six months. Additionally, the central bank established a limit of five times its capital on the gross exposure of financial intermediaries to foreign exchange derivatives.
September 2008	Following the collapse of Lehman Brothers	The central bank decided to abandon short-term capital controls, keeping only the limits on leverage of financial intermediaries that contained the risk of exposure.

Appendix H. Policy actions in addition to conventional IT policy in Peru[36]

F/X market intervention policies		
Date adopted	**Motivation**	**Description**
September 2002	The Brazilian elections instability	In response to this critical situation, the Central Bank sold US$127 million in the open market. In addition, in November 2002, the Central Bank bought back US$100 million.
Between 2003 and the third quarter of 2005	Control the Sol appreciation and prevent possible increase in the international interest rates	The CB bought up to US$6.5 billion, increasing the stock of net foreign reserves from US $ 9.6 billion to US$13.6 billion.
Between December 2005 and January 2006	The rise of Ollanta Humala in the surveys caused an increase in Peru's risk premium and a five percent depreciation of the sol	In this case, the CB sold up US $ 700 millions
Between January and May 2006	Market volatility fell after the rise and possible victory of Alan Garcia in the elections	The CB purchased US $ 4.2 billion in first half of 2006. The net international reserves changed from US$14.4 billion in June 2005 to US$21.2 billion in May 2006.
Between July 2006 and April 2008	Prevent over heating related to the nominal exchange rate outstanding appreciation	The central bank purchased more than US$23 billion between these periods. The stock of international reserves reached more than US$35 billion.
Between September 2008 and February 2009	Following the collapse of Lehman Brothers	CB sold US$ 6.8 billion. In addition, it issued US$ 3.3 billion in US dollar indexed certificates.
Between March 2009 and August 2012	Allow adequate levels of international liquidity to address potential scenarios of turbulence in international financial markets	Even though it was not a programmatic procedure, the BC purchased an average of US$ 30 billion. In this sense, net foreign reserves are almost US$ 60 billion, in contrast with US$ 30 billion at the beginning of 2009
Reserve Requirements		
Date adopted	**Motivation**	**Description**
September 2000	Reduce the operating level of liquid reserves	The CB lowered marginal reserve requirements on domestic currency deposits in the banking system to 6%
Between February 2008 and September 2008	Support the sterilization mechanisms and control the increasing dynamism of the credit system	Furthermore, those requirements were raised in consecutive steps, so that by September 2008 the marginal reserve requirements had been raised to 25% on domestic currency deposits.
Between September 2008 and February 2009	Following the collapse of Lehman Brothers	Marginal reserve requirements on domestic currency bank deposits were lowered back to 6%. CB reduced legal ratio in February and totally eliminated 4 months later
Between June 2010 and October	Control the accelerating credit growth	Marginal reserve requirements for domestic currency bank deposits jumped from 6% to 25%. Legal minimum reserve

[36] This information is taken from the Inflation Reports of the Banco Central de Reserva Del Peru, Chang (2007), Céspedes *et al* (2012) and Leon *et al* (2010).

2010		ratio was increased from 6% to 9%
Capital controls		
Date adopted	**Motivation**	**Description**
September 2004 and September 2007	Promote financial intermediation, in a context of political uncertainty.	Established reserve requirements of 30% to foreign currency deposits.
May 2008	In order to discourage the entry of foreign capital in the short term.	Reserve requirements on deposits held by foreign residents were set at 120% in May 2008. To compensate for these moves, reserve requirements on long-term (two years or longer) foreign obligations of the banks were eliminated altogether
September 2008	Following the collapse of Lehman Brothers	The reserve requirements of 120% on short-term bank held by foreign residents were lowered to 35%.
Between June 2010 and October 2010	Control the accelerating growth in credit	The reserve requirements on short-term bank held by foreign residents were increased from 30% to 55%. It has maintained constant until the actual report.

Appendix I. Robustness Test for OLS IT, using quarterly data

Short Run				
	Brazil	**Chile**	**Colombia**	**Peru**
	IT	**IT**	**IT**	**IT**
i_{t-1}	0.38***	0.73***	0.61***	0.84***
	(0.00)	(0.00)	(0.00)	(0.00)
x_t	-0.11	0.15**	0.002	0.29***
	(0.56)	(0.03)	(0.95)	(0.00)
π^1	0.71***	0.99***	0.43**	-0.08
	(0.00)	(0.00)	(0.02)	(0.69)
R^2	0.44	0.83	0.49	0.94
Observations	51	51	51	36
D-W test	3.68*	2.38	5.79**	2.44
(χ2)	(0.05)	(0.12)	(0.01)	(0.11)

Source: Author´s calculations

Note: *p*-values are in the parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

In Brazil (IT and ITT), Colombia (IT and ITT) and Chile (ITT) there was originally serial correlation.

Long Run				
	Brazil	**Chile**	**Colombia**	**Peru**
	IT	**IT**	**IT**	**IT**
x_t	-0.17	0.56***	0.005	1.81***
π^1	1.14***	3.67***	1.1**	-0.50

Source: Author´s calculations

Note: *p*-values are in the parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Appendix J. Robustness Test for IIT using different definitions for "credit"

	Brazil			Chile			Colombia			Peru		
	IIT 1	**IIT 2**	**IIT 3**	**IIT 1**	**IIT 2**	**IIT 3**	**IIT 1**	**IIT 2**	**IIT 3**	**IIT**	**IIT**	**IIT**
Regime	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
intercept	0.15*** (0.05)	3.98*** (0.00)	2.15*** (0.00)	0.15*** (0.00)	0.16*** (0.00)	0.28*** (0.00)	0.22*** (0.00)	0.73*** (0.00)	0.16*** (0.00)	0.17*** (0.00)	0.04 (0.59)	0.21*** (0.00)
$\sum_{0}^{4} i_{t-1}$	0.92*** (0.00)	0.93*** (0.00)	0.93*** (0.00)	0.97*** (0.00)	0.98*** (0.00)	0.97*** (0.00)	0.98*** (0.00)	0.98*** (0.00)	0.98*** (0.00)	0.97*** (0.00)	0.98*** (0.00)	0.98*** (0.00)
x_t	0.03*** (0.16)	0.09*** (0.00)	0.03*** (0.00)	0.02** (0.06)	0.02*** (0.00)	0.03*** (0.00)	0.02*** (0.00)	0.03*** (0.00)	0.03*** (0.00)	0.02* (0.06)	0.03*** (0.00)	0.04*** (0.00)
π^{l}	0.01 (0.62)	0.25*** (0.00)	0.19*** (0.00)	0.07** (0.04)	0.07** (0.04)	0.10*** (0.04)	0.02* (0.07)	0.13*** (0.00)	0.10*** (0.00)	0.05** (0.04)	-0.009 (0.79)	-0.02 (0.39)
C 1	0.0002 (0.40)			0.002 (0.37)			-0.002*** (0.00)			0.002 (0.13)		
C 2		-0.05*** (0.00)			0.001 (0.96)			-0.001*** (0.00)			0.002 (0.12)	
C 3			-0.31*** (0.00)			-0.06 (0.96)			0.002*** (0.00)			-0.01*** (0.02)
σ^{S_t}	0.23*** (0.00)	0.15*** (0.00)	0.19*** (0.00)	0.02*** (0.00)	0.01*** (0.00)	0.02*** (0.00)	0.08*** (0.00)	0.03*** (0.00)	0.08*** (0.00)	0.009 (0.00)	0.01*** (0.00)	0.01 (0.00)
$p=p^{11}$	1.00 (0.83)	1.00 (0.83)	1.00 (0.83)	0.96*** (0.00)	0.96*** (0.00)	0.96*** (0.00)	1.00*** (0.00)	1.00*** (0.00)	1.00*** (0.00)	0.98*** (0.00)	0.97*** (0.00)	0.93*** (0.00)

Note: *p*-values are in the parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Specifications in Brazil (IIT 2 and 3) and in Colombia (IIT 1,2 and 3) present Markov Switching estimations problems.

Appendix K. Robustness Test for IIT MS, including EMBI and VIX (Short Run)

	Brazil		Chile		Colombia		Peru	
Intercept	1.06***	-1.92	0.4	0.09	0.39***	-0.34	0.19***	-0.6
	(0.00)	(0.99)	(1.00)	(1.00)	(0.00)	(0.82)	(0.00)	(1.00)
$\sum_{0}^{4} i_{t-1}$	0.93***	-1.11	0.96***	1.5	0.96***	0.95**	0.98***	0.31
	(0.00)	(1.00)	(0.00)	(1.00)	(0.00)	(0.03)	(0.00)	(1.00)
x_t	0.06*	-0.05	0.03	-0.06	0.02***	-0.01	0.03**	0.002
	(0.05)	(0.98)	(1.00)	(1.00)	(0.00)	(0.96)	(0.01)	(0.99)
π^1	0.08*	0.03	0.33***	-3.9	0.25***	-0.32	0.01	-0.04
	(0.06)	(0.99)	(0.00)	(1.00)	(0.00)	(0.55)	(0.73)	(0.86)
$RER_d hp$	0.008	-0.007	0.003	-0.01	0.006	-0.01	0.006	0.01
	(0.18)	(0.99)	(0.43)	(1.00)	(0.10)	(0.90)	(0.24)	(0.98)
C 1	-0.01	0.02	0.01	0.02	0.03***	-0.03	0.001	-0.01
	(0.62)	(0.99)	(1.00)	(1.00)	(0.00)	(1.00)	(0.93)	(1.00)
EMBI	0.0005***	-0.0001	0.0001	-0.0003	0.0002	-0.0001	0.001	0.0006
	(0.00)	(0.99)	(1.00)	(1.00)	(0.13)	(0.97)	(0.60)	(1.00)
VIX	-0.019***	0.003	-0.008	-0.02	-0.08***	0.008	-0.0001	0.009
	(0.00)	(0.99)	(1.00)	(1.00)	(0.00)	(0.90)	(0.41)	(0.90)
σ	0.18***	0.18	0.01***	1.08	0.02***	0.86	0.01***	0.84
	(0.00)	(0.00)	(0.00)	(1.00)	(0.00)	(1.00)	(0.00)	(1.00)
$p=p^{11}$	1.00		0.98**		0.95***		0.96***	
	(0.78)		(0.02)		(0.00)		(0.00)	
L	74.91		35.5		4.1		51.28	

Note: *p*-values are in the parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Specifications in Brazil (IIT 2 and 3) and in Colombia (IIT 1,2 and 3) present Markov Switching estimations problems.

Appendix L. Robustness Test for Intervention, including 12-month rolling variance of RER

	Description	**(1.1)**	**(1.2)**	**(1.3)**	**(1.4)**
		Brazil	**Chile**	**Colombia**	**Peru**
intercept		456.3 (0.56)	1117** (0.00)	143.3*** (0.00)	40153 (0.00)
$RERdhp$	RER deviatons from trend	-733*** (0.00)	-253.2*** (0.00)	-42.5 (0.34)	-49495** (0.03)
$D1 * RERdhp$	Negative RER deviations from trend (currency too strong)	-117.05 (0.17)	-756.4*** (0.00)	-74.02 ** (0.01)	-52833** (0.02)
$RERdhp * RER\sigma^2$	RER deviations from trend interacted with volatility	1.6*** (0.00)	0.09 (0.73)	-.443 (0.22)	-2.4 (0.44)
$RERdhp * NIRlevel$	RER deviations from trend interacted with NIR level	-0.001 (0.22)	0.001 (0.51)	0.001 (0.45)	-0.008 (0.24)
	Inflation Gap	230.9 (0.29)	205*** (0.00)	4055.5 (0.41)	-92.1 (0.56)