Liquidity and Foreign Asset Management Challenges for Latin American Countries

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The Global Financial Crisis put to the fore the challenges of managing liquidity and foreign assets at times of heightened volatility. Earlier concerns of some observers regarding the costs of precautionary hoarding notwithstanding, the Global Financial Crisis (GFC) validated the buffer value of international reserves and active management of buffer funds. These issues are especially pertinent for commodity exporters, where the high volatility of their commodity terms of trade translates into large shocks impacting the real exchange rate, and the GDP. The history of Latin American countries provides ample examples where adverse terms of trade shocks terminated spells of 'good time,' leading to capital flight and financial crises.

Intriguingly, 'this time has been different' for countries that followed the dictum of "save for a rainy day" during the 2000s, opting for counter-cyclical macro policies, Chile being the prime example of it (Céspedes and Velasco, 2012; 2014). Frankel (2013) found that since 2000, fiscal policy in Chile has been governed by a structural budget rule that has succeeded in implementing countercyclical fiscal policy.[1]

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1. A crucial ingredient accounting for Chile's success is the official estimates of trend output and the 10-year price of copper—which is key to the decomposition of the budget in Chile into structural versus cyclical components—that are made by independent expert panels and thus insulated from the political process.

Commodity Prices and Macroeconomic Policy, edited by Rodrigo Caputo and Roberto Chang. Santiago, Chile.

Furthermore, Frankel, Vegh and Vuletin (2011) found that, over the last decade, about a third of the developing world has been becoming countercyclical.

In commodity exporting countries, pro-active liquidity, exchange rate and foreign assets management have supported such fiscal policy. Using the pre-GFC data, Aizenman and Riera-Crichton (2008) found that international reserves cushion the impact of terms-of-trade shocks on the real effective exchange rate (REER), and that this effect is especially significant for countries exporting natural resources. Financial depth reduces the buffer role of international reserves in developing countries. In a more detailed analysis, Aizenman, Edwards and Riera-Crichton (2012) found that active reserve management not only lowers the short-run impact of commodity terms of trade (CTOT) shocks significantly, but also affects the long-run adjustment of REER, effectively lowering its volatility. Relatively small increases in the average holdings of reserves by Latin American economies, to levels still well below other emerging regions current averages, provided a policy tool as effective as a fixed exchange rate regime in insulating the economy from CTOT shocks. Reserve management could be an effective alternative to fiscal or currency policies for relatively trade closed countries and economies with relatively poor institutions or high government debt. Céspedes and Velasco (2012), using commodity price boom and bust episodes, provided empirical evidence that commodity price shocks have a significant impact on output and investment dynamics. Economies with more flexible exchange rate regimes exhibit less pronounced responses of output during these episodes. They also found that the impact of those shocks on investment tends to be larger for economies with less developed financial markets. Moreover, international reserve accumulation, more stable political systems, and less open capital accounts tend to reduce the real exchange rate appreciation (depreciation) in episodes of commodity price booms (busts), respectively.

The purpose of this paper is to revisit these issues, extending earlier analysis by looking at the degree to which the more recent data (up to 2013), and the new institutional developments validate the earlier results that relied on pre-GFC data. Specifically, we analyze the degree to which the growing importance of sovereign wealth funds (SWFs), and the diffusion of inflation targeting and augmented Taylor rules have impacted the post crisis adjustment of LATAM to the challenges associated with terms of trade and

financial shocks.[2] The paper focuses on the reduced form, positive analysis of observed correlations between key variables, and patterns of observed and conditional volatility. There is no attempt to provide normative analysis; although, the results are consistent with the possibility that volatility triggered by exogenous shocks may be of concern for policy makers. In the discussion section we review some of papers dealing with the normative aspects of these issues; although a fuller treatment of these issues would require a detailed public finance analysis of the conditions and policy tools which may increase welfare by mitigating any adverse effects of heightened terms of trade volatility.[3]

Extending the dataset to 2013, we are able to replicate our previous results: stock of reserves and active management reduce the effects of transitory Commodity Terms of Trade (CTOT) shocks to real exchange rate in LATAM economies. This "buffer effect"[4] seems to work more against risk of real appreciation than against risks of depreciations. Fixed exchange regimes act as a substitute policy to reserve accumulation, and this buffering policy seems to work under relatively high levels of external debt, and in economies that are less open to trade. We confirm the income effects of CTOT–positive correlation of CTOT shocks and the real GDP growth. The positive association between the two seems to be stronger with negative shocks for low debt and more open economies. Accumulation (*de-accumulation*) of reserves helps in buffering the transmission of positive (negative) CTOT shocks to output, respectively.

SWFs add new dimensions to foreign asset managements. In contrast to reserves, SWFs seem important to buffer the real effective exchange rate [REER] from CTOT shocks with fixed exchange rate regimes and in relatively closed economies. SWFs also reinforce the effects of CTOT shocks on real output during negative shocks with

2. See Aizenman and Glick (2014) for an overview of the diffusion of SWFs and possible division of labor between SWFs and central banks. See Mishkin and Schmidt-Hebbel (2007); Aizenman, Hutchison and Noy (2011) and Céspedes, Chang, and Velasco (2014) for analysis on Inflation Targeting in practice.

3. Theory would often imply that the real exchange rate should adjust to reflect real external shocks, including commodity terms of trade shocks. Hence, policies that impede such adjustment, including liquidity management, may have ambiguous or even welfare reducing effects. Thereby, the case for proactive liquidity management may hinge on the structure of the economy, and the quality of institutions.

4. Throughout the paper we refer to "buffering" as the effective reduction of the transmission effects of exogenous real shocks (i.e., CTOT shocks) to key domestic macroeconomic variables such as real output or real exchange rates. This "cushioning" is captured by an opposite-signed non-linear term in our regression specification.

fixed exchange rate regimes, and buffer the effect for relatively high external debt levels. Our buffer story seems to show its strongest version during the 1980s, 1990s and the end of the Great Moderation (2003-2007). Yet, during the great recession (2008-2009) we observe a disconnect between CTOT and REER, and the role of reserves. The REER-CTOT relationship seems to resume during the post-Great Recession period (2010-2013), and reserve buffering returns, but not at the levels observed previous to the crisis. The same story applies for active use of reserves, except that our buffer story returns in a stronger fashion during the post-recession period.

There seems to be a "substitution" between reserves and where SWFs take over the buffering of the REER and the real GDP during the Great Recession and the post-Great Recession period. Inflation targeting policy seems to matter, potentially diverting resources to the preservation of domestic price stability: IT countries seems to give up the use of reserves to buffer against CTOT shocks, relegating this role to the SWFs. In LATAM countries that seem to follow an augmented Taylor rule, their monetary authorities seem to place a large weight on output gaps, while inflation seems to gain importance for IT countries. The nature of the regime matters: non-IT countries seem to switch from a REER stabilization target to an inflation target when committing to a formal IT rule.

The rest of the paper is organized as follows: In section 1, we define the data used in the paper as well as present a set of summary statistics describing the evolution of external liquidity and CTOT shocks over the last three decades. Section 2 presents our econometric strategy to uncover the way CTOT shocks affect macroeconomic performance measures such as the real exchange rates and output growth, both in the short and long runs. We also show the proposed methods to capture the role of international reserves in smoothing temporary TOT shocks under a set of alternative macroeconomic regimes. In section 3, we discuss our econometric results from the analysis of the buffering effect from the *stock of reserves and the stock of sovereign wealth funds*. These results include an investigation of the buffer effect of liquidity management following positive versus negative CTOT shocks under different exchange rate regimes, different stocks of external debt and different degrees of trade openness. Section 4 looks at the changes in the CTOT-REER and CTOT-growth relationship as well as our buffer story over different sample periods. Specifically, we look at the turbulent period from 1980 to 2002, the Great Moderation, the

Great Recession and the period following the global crisis up to the present. Section 5 looks at the relationship between reserves and sovereign wealth funds as competing tools for international liquidity management. Section 6 explores the role of other monetary policies implemented in Latin American economies in the last two decades. This section focuses on the adoption of inflation rules by half the countries in our sample. In section 7, we discuss related literature dealing with positive and normative aspects of buffer and stabilization policies. Section 8 concludes.

1. Macroeconomic Performance, Commodity TOT Shocks and Liquidity Management in Latin America

Looking at the macroeconomic performance of the largest economies (LAC-7) in Latin America over the last two decades, as shown in table 1, we see that "this time was really different." LAC-7 economies did experience a slowdown in growth and increase in volatility during the Great Recession relative to the "good times" of the Great Moderation. Nevertheless, the slowdown did not turn into a crash as in previous occasions and most countries continued to experience real appreciations against the dollar throughout the worst of the crisis. Furthermore, the recovery was "fast and furious" with average rates of annual growth above five percent, rates of real appreciation of almost three and a half percent per year and lower macroeconomic volatility than in the Great Moderation. In this paper we investigate the role of active liquidity management in this success story.

Traditionally, one of the main transmission mechanisms of global real shocks to Latin American economies has been sudden changes in relative international prices. In this paper, we use a "commodity terms of trade" (CTOT) data set to analyze the way in which shocks to commodity prices affect key macroeconomic performance measures such as changes in the real effective exchange rate (REER) or output growth. Our analysis focuses on the twelve largest Latin American economies: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Mexico, Paraguay, Peru, Uruguay and Venezuela. As shown in previous work, this set of emerging countries has the highest volatility in CTOT. Our current work covers the 1980-2014 period but focuses special attention to the period of relatively low

Table 1. Real Output Growth and Real Exchange Rate in LAC-7

	Pre-GM 1990-2003	*Great moderation 2003-2007*	*Great recession 2008-2009*	*Post-GR 2010-2013*
Real output growth				
Annual averages	3.01	5.71	2.04	5.12
St. dev.	2.43	1.87	4.12	0.91
Real appreciation v. the US$				
Annual averages	-1.21	5.61	1.56	3.40
St. dev.	7.61	3.24	7.83	3.21

Source: Annual data were taken from IADB Macro Watch. LAC-7 includes Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela.

volatility before the Great Recession, dubbed the end of the Great Moderation (2002-2007), the Great Recession (2008-2009) and the post-Great Recession period of 2010-2013. Our key measure, the concept of "commodity terms of trade," follows Ricci and others (2008) and differs from the traditional measure in that it only includes the relative prices of a country's commodity exports and imports, weighted by their country specific GDP shares. By excluding industrial goods, and concentrating on commodity prices, we focus on the most volatile component of import and exports prices. Specifically, this commodity terms-of-trade data set was constructed as follows: $CTOT_i = \prod_j (P_j/MUV)^{X_j^i} / \prod_j (P_j/MUV)^{M_j^i}$, where P_j is the price index for six commodity categories (food, fuels, agricultural raw materials, metals, gold, and beverages), and (X_j^i, M_j^i) are the average shares of commodity j in country i's exports and imports over GDP for the 1980-2012 period, respectively. Commodity prices are deflated by the manufacturing unit value (MUV) index. Since they are averaged over time, the movements in $CTOT$ are invariant to changes in export and import volumes in response to price fluctuations and thus isolate the impact of commodity prices on a country's terms of trade.[5] Another

5. By construction, a percentage increase (decrease) in the commodity terms of trade measure is approximately equal to the aggregate net trade gain (loss) relative to GDP from changes in real individual commodity prices (see Spatafora and Tytell (2009)). See the appendix of NBER working paper # 17692 for further details regarding the derivation of CTOT, data definitions and sources.

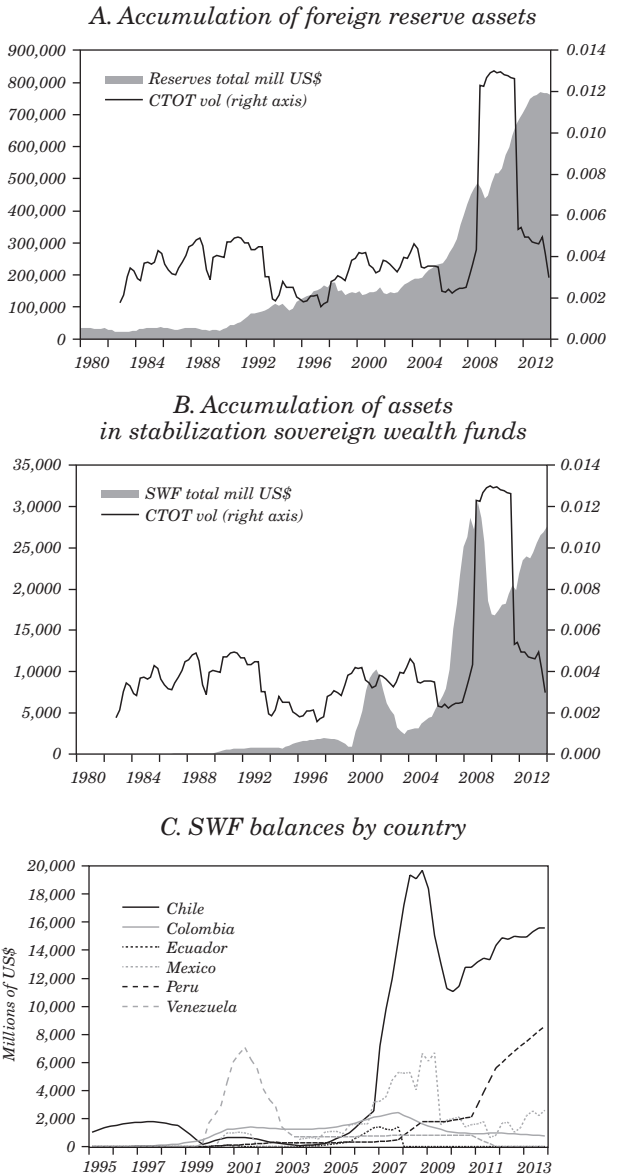
useful property of this CTOT measure arises from the use of export/import over GDP as our weights. This allows us to reinterpret CTOT shocks as income shocks to the home economy and build a direct link to effects on aggregate income and production.

Figure 1 gives us an overview of the evolution of CTOT shocks volatility over time, as well as the accumulation of international liquidity and composition of this liquidity by Latin American economies over the last three decades. While CTOT shock volatility doubled during the Great Recession, volatility was already persistently high in the previous twenty years. In spite of this high volatility, LATAM economies managed to achieve low output and REER volatility during the last decades, including the Great Recession. Part of this success may have been achieved thanks to a set of countercyclical fiscal policies and, more relevant to our work, a set of monetary policies dedicated to carefully manage international liquidity in order to lower price and output volatility. In this light, figure 1A shows how Latin American economies had started to accumulate large amounts of foreign reserves well before the last crisis. This accumulation drove LATAM economies to move from an average stock of reserves of 7.5 percent of GDP before the Great Moderation, to more than 15% after the Great Recession.

Figure 1B showcases the appearance of stabilizing sovereign wealth funds (SWFs) as an alternative source of international liquidity. Most of these SWFs acted as automatic stabilizers following a fiscal rule dedicated to manage the windfalls from abnormal high prices of the commodities typically exported by each country. Table 2, depicts the SWF used in this analysis.

Figure 1C shows the country composition of the aggregate balance of these stabilization funds in the region. While Chile has been the clear leader of the pack, accumulating close to 20 billion dollars in its copper fund before the crisis, other countries like Mexico, Colombia, and later in the sample, Peru, have been increasing their SWFs thanks to windfalls from their energy (oil and gas) funds. Venezuela was able to accumulate a large amount of funds in the early 2000's but then their fund was liquidated and has not been active since. Another relevant policy change adopted by LATAM countries during the nineties was a set of explicit inflation targets. As shown in table 3, up to half of the countries in our sample became inflation-targeters. Potentially, inflation targeting represents an important part of our buffer story since inflation-targeting (IT) countries may deviate resources from REER stabilization to internal price stabilization.

Figure 1. CTOT Shocks Volatility, Accumulation and Composition of International Liquidity by Latin American



Source: See appendix.

Table 2. Commodity Based Stabilization SWF in LATAM

Country	*Fund*	*Coverage*	*Commodity*	*Source*
Chile	Fondo de Estabilización de los Ingresos del Cobre (Copper Fund)	1987-2006	Copper	Tesorería General de la República
Chile	FEES	2007-2013	Copper	Hacienda Pública de Chile
Colombia	Fondo de Ahorro y Estabilización Petrolera	1996-2013	Oil	Ministerio de Hacienda y Crédito Público
Ecuador	FEP	2000-2007	Oil	Ministry of Economy
Ecuador	FEIREP	2002-2004	Oil	Ministry of Economy
Ecuador	CEREPS	2005-2007	Oil	Ministry of Economy
Ecuador	FAC	2005-2007	Oil	Ministry of Economy
Ecuador	FEISEH	2006-2007	Oil	Ministry of Economy
Mexico	Fondo de estabilizacion de ingresos petroleros (FEP)	2000-2013	Oil	Secretaría de Hacienda y Crédito Público
Peru	Fondo de Estabilización Fiscal	2000-2013	Oil and Gas	Ministerio de Economía y Finanzas del Perú
Venezuela	Fondo de Estabilidad Macroeconómica	1999-2013	Oil	Banco Central de Venezuela

Table 3. Inflation Targets in Latin America

Country	*Converging target period*	*Stationarity-Target period*	*2005 inflation target level (%)*
Brazil	1999:1–2004:4	2004-	4.5 (+/–2.5)
Chile	1991:1–2000:4	2001-	2–4
Colombia	1999:1–2004:4	2004-	5 (+/–0.5)
Mexico	1999:1–2002:4	2004-	3 (+/–1)
Peru	1994:1–2001:4	2002-	2.5 (+/–1)
Uruguay	2002:2–2003:4	2004-	N.A.

Source: See appendix.

2. Macroeconomic Adjustment and Commodity Terms of Trade Shocks

Following previous work, in this paper, we use a fixed effects error correction model to capture the effects of CTOT shocks and the dynamic adjustment of REER and output growth. Our basic framework is represented by equation (1):

$$\Delta Ln(X)_{it} = \alpha_i + \beta_1 \Delta Ln(X)_{it-1} + \beta_2 ECTX_{it-1} + [\theta_1 + \theta_2 Y_{it-1}]TCTOT_{it-1} + \beta_3 Y_{it-1} + \varepsilon_{it} \quad (1)$$

where X corresponds to one of our two measures of macroeconomic performance: 1) REER, the real effective (trade weighted) exchange rate.[6] 2) Real GDP. $ECTX$ is the error correction term for (the logarithm of) X. As usual, this term is defined as the log deviations of X from its equilibrium value. In order to compute the equilibrium/long-run REER, we use a co-integrating approach.[7] The long-run value of output growth is obtained applying an HP filter to the original series with a smoothing parameter set at 1600. Similarly,

6. For the rest of the empirical section, REER is defined as foreign currency in terms of the domestic currency, e.g., an increase in REER corresponds to a real appreciation of the domestic currency

7. See the Edwards (1989) and Montiel (1999) derivation long-run REER that is detailed in the appendix.

the term *TCTOT* represents transitory CTOT shocks, and is defined as the log deviations of current CTOT from its long-run value. The latter, again, is obtained applying an HP Filter to the original series with a smoothing parameter set at 1600. Finally, Y represents our liquidity measure. In this paper we will use the stock of international reserves to GDP ratio, the stock of SWF to GDP ratio, and the change of these ratios as our proxies for liquidity management policy.

To investigate the potential differences in our buffer story over different sample periods, different macroeconomic/policy structures or asymmetric underlying shocks, we use another layer of non-linearities for our approach:

$$\begin{aligned}\Delta Ln(X)_{it} = {} & \alpha_i + \beta_1 \Delta Ln(X)_{it-1} + \beta_2 ECTX_{it-1} \\ & + [\theta_1(1-Z) + \theta_2(1-Z)Y_{it-1} + \theta_3 Z + \theta_4 ZY_{it-1}]TCTOT_{it-1} \\ & + \beta_3 Y_{it-1} + \varepsilon_{it}\end{aligned} \tag{2}$$

where Z is defined as a vector of dummy variables that split the regression by sample period or by different economic structures such as degree of trade openness, indebtedness or exchange rate regime.

To provide a more dynamic look at the effects of CTOT shocks to REER and output and the potential for our buffering effect under different macroeconomic conditions, we set up a series of accumulated impulse response functions (IRFs). To build these IRFs, we follow the single-equation approach advocated by Jorda (2005) and Stock and Watson (2007). We use these linear local projections (LP) of real appreciation and output growth on our dynamic error correction model:

$$\begin{aligned}\Delta Ln(X)_{it+h} = {} & \alpha_{i,h} + \beta_{1,h} \Delta Ln(X)_{it-1} + \beta_{2,h} ECTX_{it-1} \\ & + [\theta_{1,h}(1-Z) + \theta_{2,h}(1-Z)Y_{it-1} + \theta_{3,h} Z + \theta_{4,h} ZY_{it-1}] \\ & TCTOT_{it-1} + \beta_{3,h} Y_{it-1} + \varepsilon_{it}\end{aligned} \tag{3}$$

where $\Delta Ln(X)_{it+h} = Ln(X)_{it+h} - Ln(X)_{it-1}$. It is important to note that, in this approach, each step in the accumulated IRF is obtained

from a different individual equation. Thus, we obtain the IRF values directly from the coefficients in each equation "h." Compared to a standard IRF built on a single dynamic panel specification, Jorda's LP methodology gains efficiency using new information for each step of the response function (each step is constructed from the estimates of a unique regression). While our IRF should be very close in the first lags of a traditionally built IRF, as we move further, we would expect the LP to keep providing information on the IRF while the traditional IRF would "die" shortly after it runs out of persistence. Additionally, our methodology does not impose the dynamic restrictions implicitly embedded in traditional simultaneous equation specifications, that is, vector autoregressions (VARs), and can conveniently accommodate non-linearities in the response function. As explained in Jorda (2005), there are multiple advantages in the use of LP. In particular, LPs: (i) can be estimated by single-regression techniques (least-squares dummy variables or LSDVs in our case), (ii) are more robust to potential misspecifications, and (iii) can accommodate highly non-linear, flexible specifications that may be impractical in a multivariate SVAR (structural vector autoregression) context.

3. Has Liquidity and Foreign Asset Management Buffered LATAM Countries from External Real Shocks? Results from a Pooled Regression

We start our results section updating our previous work on the buffer role of foreign reserves with quarterly data until 2013. All regressions include all available data. The pooled regressions include a quarterly sample that ranges in the period from 1980 to 2013. Not all countries have a full sample of data, so our panel regressions are unbalanced. Descriptive statistics of all the variables are summarized in table 4. Additionally, we include a set of stationarity tests for our dependent variables: real output growth and real exchange rate appreciation in table 5. These tests also contain the average optimal lag structure selected through AIC, BIC and HQIC information criterions. All tests show a level of stationarity in our panel that allows proceeding to our main specification without further adjustments. The optimal average lag structure revolts around 1.

Table 4. Descriptive Statistics

All obs.	*No. obs.*	*Mean*	*Std. dev.*	*Min*	*Max*
DREER	1,576	-0.001492	0.088289	-1.936263	0.6924086
ECT REER	1,516	-0.0015106	0.1273096	-0.5987437	1.365942
DRGDP	1,083	0.0088561	0.0203312	-0.1385784	0.1955137
ECT RGDP	1,093	0.0005406	0.0294761	-0.28123	0.1574097
TCTOT	1,632	3.94E-11	0.0144423	-0.1111243	0.1186696
RES OVER GDP	1,632	0.097068	0.0651493	0.0053772	0.4217554
SWF OVER GDP	1,632	0.0028891	0.010467	0	0.1132718
DRES	1,620	0.0007563	0.0116144	-0.086744	0.0801628
DSWF	1,620	0.0000591	0.0017731	-0.0247848	0.0261156
IT DUMMY	1,632	0.2444853	0.4299133	0	1
FLEX REGIME	1,138	0.4841828	0.4999695	0	1
FIXED REGIME	1,138	0.5158172	0.4999695	0	1
HI DEBT	1,632	0.471201	0.4993229	0	1
LOW DEBT	1,632	0.528799	0.4993229	0	1
TRADE OPEN	1,632	0.4920343	0.5000898	0	1
TRADE CLOSE	1,632	0.5079657	0.5000898	0	1

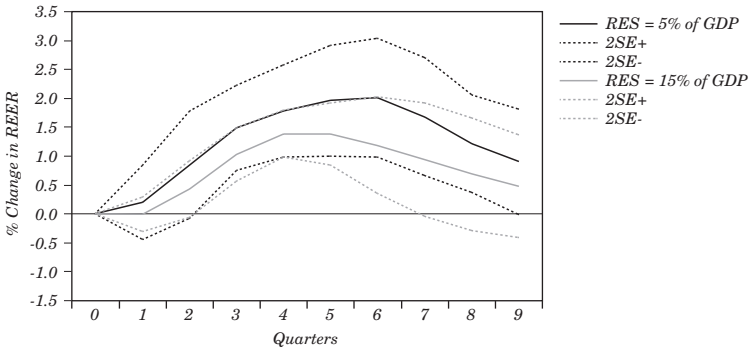
Source: See appendix.

Table 5. Panel Stationarity Test for Dependent Variables and Optimal Lag Structure

Type of test	*Info criterion*	*No. obs.*	*Countries*	*Test statistic*	*P-value*	*Optimal lag structure*
Real output growth						
IPS	AIC	1,164	13	-21.31	0.00	1.54
IPS	BIC	1,178	13	-30.24	0.00	0.46
IPS	HQIC	1,171	13	-27.34	0.00	1.00
Fisher (DF)	-	1,197	13	60.36	0.00	-
Fisher (PP)	-	1,197	13	99.73	0.00	-
Real exchange rate appreciation						
IPS	AIC	1,674	13	-27.91	0.00	1.85
IPS	BIC	1,690	13	-34.39	0.00	0.62
IPS	HQIC	1,684	13	-30.33	0.00	1.08
Fisher (DF)	-	1,711	13	97.61	0.00	-
Fisher (PP)	-	1,711	13	122.98	0.00	-

Source: See appendix.
H0: All panels contain unit roots.
Ha: Some panels are stationary.
Notes: IPS corresponds to Im-Pesaran-Shin (2003), DK to Dickey-Fuller, PP to Phillips-Perron tests. One Lag was used as a default for the Fisher Tests. The test statistics reported correspond to the W-tilda-bar for IPS and the modified version of the inverse chi-squared transformation proposed by Choi (2001) for the Fisher Test.

Figure 2. REER IRF to 1% CTOT Shock under High and Low Stock of Reserves



Source: See appendix.

Tables 6A y 6B corroborate our previous findings in our updated dataset. Table 6A reports the estimation of the basic model using the stock of reserves over GDP as a proxy for "liquidity availability." Meanwhile, table 6B uses the change in reserves as a proxy for "active reserve management." In both tables, the first column confirms a positive correlation between TCOT and REER; column 2 showcases our basic reserve buffer story: a stock of reserve of 15 percent of GDP or a change in reserve holdings of 3 percent of GDP can, on average, decrease the REER effects of CTOT shocks on impact by half. To see the gains of this policy more clearly and in a dynamic environment, we show the dynamic IRF in figure 2. Moving the stock of reserves from 5 percent to 15 percent decreases the REER volatility (measured as the standard deviation of the point estimates on the IRF) by almost 30 percent over the following two years.

Columns 3-6 in tables 5 and 6 use dummy variables to estimate the differences in our buffer story given different policy and macroeconomic structure. Results in both tables are very similar: the buffer effect works against risk of real appreciation more than against risk of depreciation.[8]

8. This asymmetry may reflect a country's concern that losing reserves during a downturn might increase its vulnerability to deleveraging and sudden stops. In addition, deflationary shocks (drops in commodity prices, collapsing export demands, etc.) may mitigate concerns of the inflationary consequences associated with depreciation, increasing the perceived gain of depreciation as a form of demand switching policy, improving the competitiveness of a country.

Table 6A. Buffer Effect on REER
Of stock of reserves

Model	*Basic model*	*Stock of reserves*	*Pos (X) vs Neg (Y) CTOT shock*	*Flex (X) vs Fixed (Y) forex*	*Hi (X) vs Low (Y) debt*	*Open (X) vs Close (Y) trade*
Variables	*DREER*	*DREER*	*DREER*	*DREER*	*DREER*	*DREER*
DREER ($t-1$)	0.0927	0.0930	0.0921	0.3894	0.0931	0.0938
	[0.060]	[0.060]	[0.061]	[0.044]***	[0.060]	[0.059]
ECT REER ($t-1$)	-0.2356	-0.2368	-0.2390	-0.1459	-0.2369	-0.2435
	[0.066]***	[0.067]***	[0.067]***	[0.017]***	[0.067]***	[0.071]***
TCTOT ($t-1$)	0.4756	0.7856				
	[0.141]***	[0.228]***				
TCTOT * RES (t-1)		-2.5802				
		[0.705]***				
TCTOT * X ($t-1$)			1.8765	1.3254	0.8367	0.2177
			[0.459]***	[0.624]*	[0.318]**	[0.164]
TCTOT * Y ($t-1$)			-0.0397	0.2526	0.7031	2.1394
			[0.511]	[0.085]**	[0.222]***	[0.527]***
TCTOT * RES * X ($t-1$)			-9.7578	-6.9353	-2.8613	-0.1352
			[2.804]***	[3.541]*	[0.750]***	[0.917]
TCTOT * RES * Y ($t-1$)			2.2305	0.9470	-1.9789	-8.0886
			[2.695]	[0.605]	[1.714]	[3.032]**
RES ($t-1$)	0.1126	0.1100	0.1730	0.0766	0.1093	0.1122
	[0.043]**	[0.042]**	[0.065]**	[0.022]***	[0.041]**	[0.045]**
No. observations	1,496	1,496	1,496	1,082	1,496	1,496
R^2	0.113	0.114	0.117	0.153	0.114	0.121
Number of countries	12	12	12	12	12	12

Source: See appendix.
Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.
DREER is the real exchange rate appreciation. TCTOT represents transitory commodity terms of trade shocks. RES is the stock of international reserves over GDP. DRES is the change in RES. Quarterly observations from 1980.I to 2013.IV. All observations available were used.

Table 6B. Buffer Effect on REER
Of active change of reserves

Model	*Basic model*	*Change in reserves*	*Pos (X) vs Neg (Y) CTOT shock*	*Flex (X) vs Fixed (Y) forex*	*Hi (X) vs Low (Y) debt*	*Open (X) vs Close (Y) trade*
Variables	*DREER*	*DREER*	*DREER*	*DREER*	*DREER*	*DREER*
DREER ($t-1$)	0.0929 [0.060]	0.0937 [0.060]	0.0933 [0.061]	0.3841 [0.041]***	0.0937 [0.060]	0.0899 [0.055]
ECT REER ($t-1$)	-0.2358 [0.066]***	-0.2362 [0.067]***	-0.2391 [0.067]***	-0.1464 [0.017]***	-0.2371 [0.067]***	-0.2402 [0.072]***
TCTOT ($t-1$)	0.4853 [0.154]***	0.4972 [0.157]***				
TCTOT * DRES ($t-1$)		-6.4029 [1.946]***				
TCTOT * X ($t-1$)			1.0007 [0.342]**	0.5217 [0.200]**	0.5299 [0.246]*	0.2026 [0.078]**
TCTOT * Y ($t-1$)			0.1710 [0.264]	0.3540 [0.053]***	0.5094 [0.084]***	1.1951 [0.600]*
TCTOT * DRES * X ($t-1$)			-21.4704 [10.014]*	-23.7249 [5.466]***	-16.0492 [2.687]***	1.4333 [1.494]
TCTOT * DRES * Y ($t-1$)			-0.0196 [12.498]	10.9922 [5.238]*	15.0122 [3.242]***	-80.6740 [36.803]*
RES ($t-1$)	0.1150 [0.050]**	0.1175 [0.051]**	0.1182 [0.051]**	0.0665 [0.027]**	0.1211 [0.052]**	0.1162 [0.048]**
DRES ($t-1$)	-0.0662 [0.318]	-0.0667 [0.316]	0.0477 [0.361]	0.1187 [0.258]	-0.0468 [0.312]	-0.0526 [0.317]
No. observations	1,496	1,496	1,496	1,082	1,496	1,496
R^2	0.113	0.113	0.116	0.163	0.116	0.125
Number of countries	12	12	12	12	12	12

Source: See appendix.
Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.
DREER is the real exchange rate appreciation. TCTOT represents transitory commodity terms of trade shocks. RES is the stock of international reserves over GDP. DRES is the change in RES. Quarterly observations from 1980.I to 2013.IV . All observations available were used.

Fixed exchange regimes seem to act as a substitute policy to reserve accumulation. Reserve management appears to be a more effective policy under relatively high levels of external debt and the buffer policy works in relatively trade-closed economies.

Given the potentially direct relationship between CTOT shocks and income shocks, countries may choose to stabilize output rather than REER. In tables 7A and 7B, we explore the role of reserve accumulation and active reserve management as output stabilizing polices. The first column in both tables confirms the direct income effect of CTOT shocks with a strong positive correlation between both measures. Interestingly, columns 3, 5 and 6 show this income effect being stronger under negative shocks, low debt and relatively open economies. While column three does not provide clear evidence of our buffer effect for either stock of reserves or change in reserves, column 4 in table 7B shows that accumulation and de-accumulation of reserves buffers the transmission of positive and negative CTOT shocks to output. Results from the IRF in this last specification paint a slightly different picture. Figure 3A shows a clear role of active reserve management on stabilizing output volatility under positive shocks. Increasing the rate at which the country accumulates reserves from 1 percent to 3 percent of GDP helps decrease the volatility of real output growth after positive CTOT shocks by 26 percent over the following two years.[9] On the opposite end, figure 3B shows that while de-accumulation of reserves seems to help decrease the effect of negative CTOT shocks into output growth on impact, this policy seems to have an insignificant role buffering the CTOT shock in the following periods.

As mentioned above, an important extension to our previous work with reserves consists in looking at the effects of managing foreign assets in the form of SWF balances. The SWFs included in this study follow a set of fiscal rules that allow countries to manage windfalls from increases in the international prices of the exporting commodities. Tables 8A and 8B report the estimated coefficients for our basic model using the balance of SWFs as our proxy for access to international liquidity. While the most significant effects are obtained in the study of different periods (see table 9 and text below), there are some interesting results captured by tables 8A and 8B. First, in contrast to what we observed with reserves, SWFs seem to act as an important buffer to REERs under fixed exchange rate regimes and relatively close

9. Here we define volatility as the standard deviation of the point estimates for the first 10 periods of each impulse response function.

Table 7A. Buffer Effect on Output Growth
Of stock of reserves

Model	*Basic model*	*Stock of reserves*	*Pos (X) vs Neg (Y) CTOT shock*	*Flex (X) vs Fixed (Y) forex*	*Hi (X) vs Low (Y) debt*	*Open (X) vs Close (Y) trade*
Variables	*DRGDP*	*DRGDP*	*DRGDP*	*DRGDP*	*DRGDP*	*DRGDP*
DRGDP ($t-1$)	0.1672 [0.053]***	0.1664 [0.053]***	0.1637 [0.054]**	0.1692 [0.056]**	0.1700 [0.052]***	0.1670 [0.054]**
ECT RGDP ($t-1$)	-0.2690 [0.044]***	-0.2686 [0.045]***	-0.2653 [0.044]***	-0.3265 [0.023]***	-0.2753 [0.045]***	-0.2698 [0.043]***
TCTOT ($t-1$)	0.2138 [0.061]***	0.2639 [0.075]***				
TCTOT * RES ($t-1$)		-0.4139 [0.376]				
TCTOT * X ($t-1$)			0.1800 [0.075]**	0.2467 [0.313]	0.1076 [0.127]	0.3108 [0.037]***
TCTOT * Y ($t-1$)			0.3596 [0.092]***	0.3126 [0.038]***	0.2782 [0.078]***	0.0235 [0.235]
TCTOT * RES * X ($t-1$)			-0.3937 [0.537]	-0.0284 [2.127]	-0.1399 [0.399]	-0.6093 [0.254]**
TCTOT * RES * Y ($t-1$)			-0.5547 [0.474]	-0.5785 [0.301]*	0.2957 [0.809]	0.1523 [2.075]
RES ($t-1$)	0.0190 [0.009]*	0.0182 [0.009]*	0.0176 [0.011]	0.0112 [0.011]	0.0182 [0.009]*	0.0197 [0.010]*
No. observations	1,073	1,073	1,073	842	1,073	1,073
R^2	0.155	0.155	0.156	0.191	0.160	0.157
Number of countries	12	12	12	12	12	12

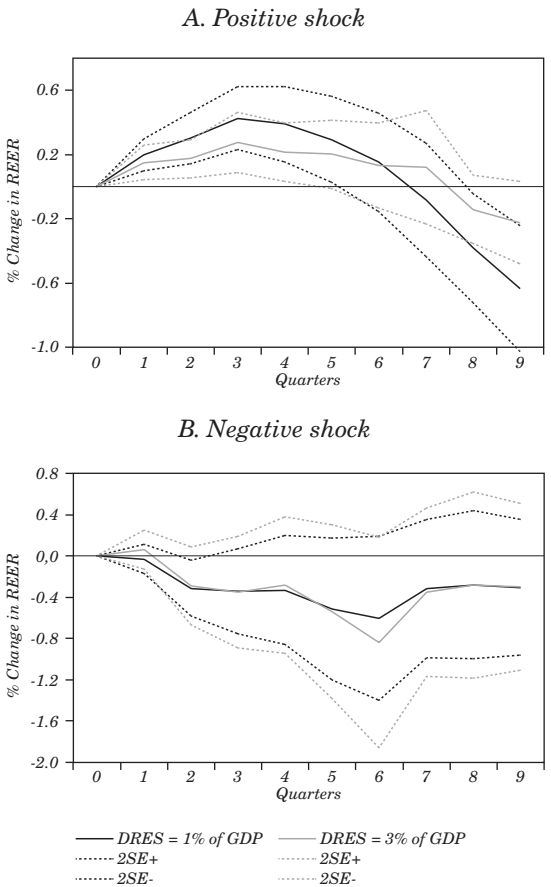
Source: See appendix.
Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1. DRGDP represents real output growth. TCTOT represents transitory commodity terms of trade shocks. RES is the stock of international reserves over GDP. DRES is the change in RES. Quarterly observations from 1980.I to 2013.IV. Observations under hyperinflation episodes (>100% inflation) are not included.

Table 7B. Buffer Effect on Output Growth
Of active change of reserves

Model	*Basic model*	*Change in reserves*	*Pos (X) vs Neg (Y) CTOT shock*	*Flex (X) vs Fixed (Y) forex*	*Hi (X) vs Low (Y) debt*	*Open (X) vs Close (Y) trade*
Variables	*DRGDP*	*DRGDP*	*DRGDP*	*DRGDP*	*DRGDP*	*DRGDP*
DRGDP ($t-1$)	0.1670 [0.053]***	0.1676 [0.053]***	0.1704 [0.052]***	0.1696 [0.056]**	0.1729 [0.052]***	0.1691 [0.054]***
ECT RGDP ($t-1$)	-0.2685 [0.045]***	-0.2689 [0.045]***	-0.2701 [0.045]***	-0.3266 [0.023]***	-0.2762 [0.046]***	-0.2693 [0.044]***
TCTOT ($t-1$)	0.2070 [0.066]***	0.2072 [0.067]**				
TCTOT * DRES ($t-1$)		0.5048 [1.864]				
TCTOT * X ($t-1$)			0.1842 [0.058]***	0.2400 [0.068]***	0.0745 [0.086]	0.2272 [0.056]***
TCTOT * Y ($t-1$)			0.3133 [0.090]***	0.2383 [0.065]***	0.3080 [0.032]***	0.0448 [0.207]
TCTOT * DRES * X ($t-1$)			-10.3490 [2.267]***	-0.4778 [6.058]	-3.1602 [1.807]	0.9845 [1.680]
TCTOT * DRES * Y ($t-1$)			7.5174 [1.358]***	0.3416 [2.023]	3.7605 [1.136]***	-9.8432 [20.360]
RES ($t-1$)	0.0171 [0.008]*	0.0169 [0.007]**	0.0185 [0.007]**	0.0122 [0.011]	0.0177 [0.008]**	0.0179 [0.009]*
DRES ($t-1$)	0.0480 [0.050]	0.0489 [0.049]	0.1380 [0.042]***	0.0332 [0.065]	0.0581 [0.045]	0.0463 [0.049]
No. observations	1,073	1,073	1,073	842	1,073	1,073
R^2	0.155	0.156	0.163	0.190	0.163	0.158
Number of countries	12	12	12	12	12	12

Source: See appendix.
Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1. DRGDP represents real output growth. TCTOT represents transitory commodity terms of trade shocks. RES is the stock of international reserves over GDP. DRES is the change in RES. Quarterly observations from 1980.I to 2013.IV. All observations available were used.

Figure 3. Output IRF to 1% CTOT



Source: See appendix.

economies. Additionally, SWFs buffer the effect on output growth for relatively high debt observations. Interestingly, holding large SWF balances seems to increase, instead of decrease, the effects of CTOT shocks on real output during negative shocks and under fixed exchange regimes. As explained in the next section of the paper, this effect may reflect the period of SWF accumulation just before the Great Recession. Once we divide the sample in different periods of interest, we observe that SWFs start buffering the CTOT effects on output during and after the Great Recession, replacing reserves in this role.

Table 8A. Buffer Effect of the Stock of SWF Assets
On REER

Model	*Basic model*	*Stock of SWF*	*Pos (X) vs Neg (Y) CTOT shock*	*Flex (X) vs Fixed (Y) forex*	*Hi (X) vs Low (Y) debt*	*Open (X) vs Close (Y) trade*
Variables	*DREER*	*DREER*	*DREER*	*DREER*	*DREER*	*DREER*
DREER ($t-1$)	0.0935	0.0937	0.0934	0.3960	0.0935	0.0942
	[0.062]	[0.062]	[0.063]	[0.044]***	[0.062]	[0.061]
ECT REER ($t-1$)	-0.2319	-0.2323	-0.2339	-0.1484	-0.2321	-0.2401
	[0.061]***	[0.062]***	[0.061]***	[0.019]***	[0.062]***	[0.066]***
TCTOT ($t-1$)	0.4807	0.4648				
	[0.141]***	[0.190]**				
TCTOT * SWF ($t-1$)		2.6679				
		[11.859]				
TCTOT * X ($t-1$)			0.6626	0.4643	0.4698	0.1395
			[0.288]**	[0.092]***	[0.234]*	[0.142]
TCTOT * Y ($t-1$)			0.2446	0.2355	0.4819	1.4552
			[0.245]	[0.113]*	[0.175]**	[0.389]***
TCTOT * SWF * X ($t-1$)			14.6074	-10.8218	-30.5439	9.2066
			[14.893]	[2.464]***	[38.633]	[13.061]
TCTOT * SWF * Y ($t-1$)			-5.3774	19.6930	2.6773	-285.7981
			[6.258]	[3.229]***	[11.614]	[62.898]***
SWF ($t-1$)	0.2549	0.2674	0.0827	0.0737	0.2685	0.2868
	[0.094]**	[0.101]**	[0.149]	[0.086]	[0.103]**	[0.112]**
No. observations	1,496	1,496	1,496	1,082	1,496	1,496
R^2	0.109	0.109	0.110	0.152	0.109	0.117
Number of countries	12	12	12	12	12	12

Source: See appendix.
Robust standard errors in brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
DREER is the real exchange rate appreciation. TCTOT represents transitory commodity terms of trade shocks. SWF is the balance of sovereign wealth funds over GDP. DSWF is the change in SWF. Quarterly observations from 1980.I to 2013.IV. All observations available were used.

Table 8B. Buffer Effect of the Stock of SWF Assets
On output growth

Model	*Basic model*	*Stock of SWF*	*Pos (X) vs Neg (Y) CTOT shock*	*Flex (X) vs Fixed (Y) forex*	*Hi (X) vs Low (Y) debt*	*Open (X) vs Close (Y) trade*
Variables	*DRGDP*	*DRGDP*	*DRGDP*	*DRGDP*	*DRGDP*	*DRGDP*
DRGDP ($t-1$)	0.1656 [0.054]**	0.1653 [0.054]**	0.1635 [0.054]**	0.1634 [0.057]**	0.1662 [0.053]***	0.1665 [0.055]**
ECT RGDP ($t-1$)	-0.2668 [0.044]***	-0.2689 [0.044]***	-0.2665 [0.043]***	-0.3265 [0.023]***	-0.2727 [0.044]***	-0.2703 [0.042]***
TCTOT ($t-1$)	0.2163 [0.062]***	0.1864 [0.058]***				
TCTOT * SWF ($t-1$)		3.1976 [2.053]				
TCTOT * X ($t-1$)			0.1309 [0.057]**	0.2161 [0.115]*	0.1131 [0.085]	0.2041 [0.047]***
TCTOT * Y ($t-1$)			0.2413 [0.071]***	0.1905 [0.053]***	0.2756 [0.031]***	0.0131 [0.200]
TCTOT * SWF * X ($t-1$)			2.5032 [3.260]	0.3075 [2.125]	-20.9137 [8.658]**	2.8718 [2.095]
TCTOT * SWF * Y ($t-1$)			3.7074 [2.009]*	8.9772 [1.657]***	1.9230 [2.072]	36.8200 [40.583]
RES ($t-1$)	-0.1157 [0.077]	-0.0981 [0.074]	-0.0827 [0.083]	-0.1462 [0.116]	-0.0887 [0.076]	-0.0983 [0.072]
No. observations	1,073	1,073	1,073	842	1,073	1,073
R^2	0.155	0.157	0.158	0.201	0.161	0.158
Number of countries	12	12	12	12	12	12

Source: See appendix.
Robust standard errors in brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
DRGDP represents real output growth. TCTOT represents transitory commodity terms of trade shocks. SWF is the balance of sovereign wealth funds over GDP. DSWF is the change in SWF. Quarterly observations from 1980.I to 2013.IV. Observations under hyperinflation episodes (>100% inflation) are not included.

Table 9. Buffer Effects of International Liquidity Management by Periods of Interest

Variables	*X=RES Y = DREER*	*X=DRES Y = DREER*	*X=SWF Y= DREER*	*X=RES Y = DRGDP*	*X=DRES Y= DRGDP*	*X=SWF Y =DRGDP*
Y ($t-1$)	0.0958	0.0961	0.0952	0.1550	0.1554	0.1460
	[0.057]	[0.057]	[0.058]	[0.049]***	[0.047]***	[0.050]**
ECT Y ($t-1$)	-0.2469	-0.2445	-0.2414	-0.2831	-0.2837	-0.2802
	[0.077]***	[0.075]***	[0.070]***	[0.038]***	[0.038]***	[0.038]***
CTOT ($t-1$)	1.8291	0.6369	0.5151	0.2249	0.2696	0.2048
	[0.563]***	[0.243]**	[0.287]	[0.148]	[0.074]***	[0.061]***
CTOT * GM ($t-1$)	-0.4119	-0.4091	-0.6468	-0.1828	-0.1245	0.0060
	[1.003]	[0.311]	[0.514]	[0.355]	[0.061]*	[0.101]
CTOT * GR ($t-1$)	-1.9051	-0.3664	-0.2102	0.0900	-0.0678	-0.0132
	[0.664]**	[0.260]	[0.261]	[0.206]	[0.059]	[0.054]
CTOT * AGR ($t-1$)	-1.2083	-0.2749	-0.0492	0.0669	-0.0374	0.0437
	[0.783]	[0.520]	[0.644]	[0.166]	[0.085]	[0.088]
CTOT * X ($t-1$)	-10.8622	-15.1314	20.4624	0.4305	1.3378	7.5401
	[4.276]**	[3.308]***	[7.151]**	[0.983]	[3.538]	[1.099]***
CTOT * X * GM ($t-1$)	1.1372	-5.6076	11.2714	0.5731	3.3774	-10.7666
	[7.114]	[17.919]	[15.753]	[2.664]	[9.293]	[7.366]
CTOT * X * GR ($t-1$)	13.1715	31.6379	-28.6769	-1.1617	-0.2277	-6.6374
	[4.352]**	[6.339]***	[4.763]***	[1.207]	[2.834]	[1.586]***

Table 9. (continued)

Variables	*X=RES Y = DREER*	*X=DRES Y = DREER*	*X=SWF Y= DREER*	*X=RES Y = DRGDP*	*X=DRES Y= DRGDP*	*X=SWF Y =DRGDP*
CTOT * X * AGR ($t-1$)	8.5414 [4.292]*	-15.4449 [72.282]	-31.6551 [9.424]***	-1.0388 [1.068]	-19.3620 [14.101]	-9.6771 [3.120]**
RES ($t-1$)	0.0999 [0.057]	0.0937 [0.056]		0.0113 [0.011]	0.0090 [0.011]	
DRES ($t-1$)		-0.0302 [0.318]			0.0691 [0.066]	
SWF ($t-1$)			0.0137 [0.094]			-0.1472 [0.113]
No. observations	1,496	1,496	1,496	982	982	982
R^2	0.122	0.120	0.117	0.188	0.189	0.196
Number of countries	12	12	12	12	12	12

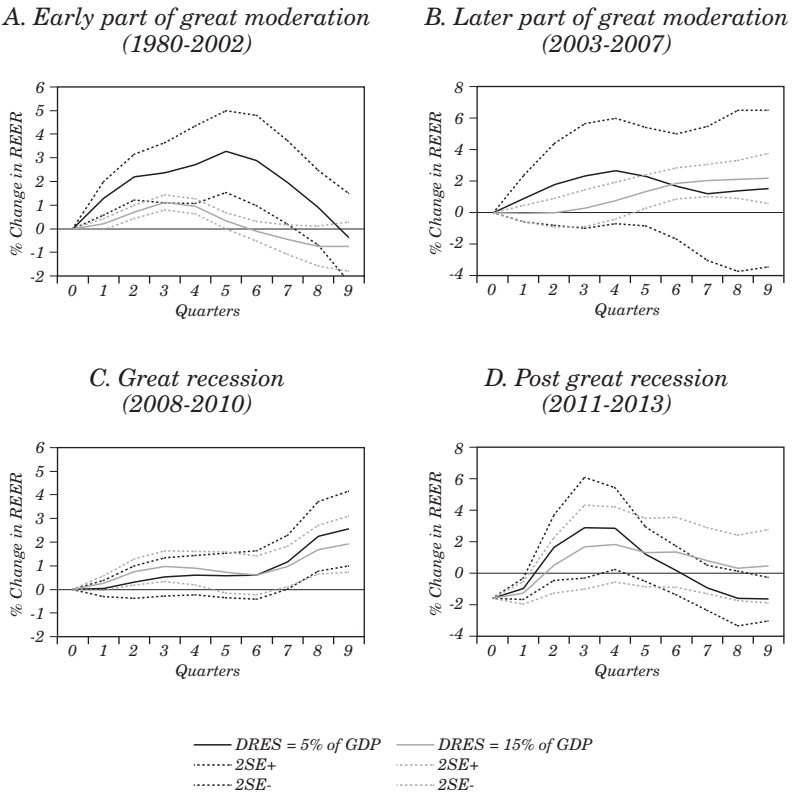
Source: See appendix.
The first three columns are for DREER and the last three for DRGDP
Robust standard errors in brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
DRGDP represents real output growth. TCTOT represents transitory commodity terms of trade shocks. SWF is the balance of sovereign wealth funds over GDP. Quarterly observations from 1980.I to 2013.IV. GM = Great Moderation, GR = Great Recession, AGR = After Great Recession.

4. What were the Effects of the Great Recession on our Buffer Story?

One of the more important questions in this project is to examine the effects of the Great Recession. In this section, we apply our basic model of liquidity buffer to four distinct periods in time, each with a special economic significance for LATAM region. Our first sample period covers data ranging from the beginning of 1980s to the end of 2002. These are turbulent times in Latin America. Just to cover a few of the major economic crises, we have the debt crisis in 1982 that led to the lost decade, the Tequila crises in 1994-1995 and the Argentinian crises in 2001-2002. Many Latin American economies were plagued by hyperinflation during this period and carried high output and real exchange rate volatility. From table 9, we see how the buffer effect, measured from either the stock of reserves or its active management, is strongest during this period. To explore this point, we compare the IRFs from holding 5% or 15% of GDP in reserves in figure 4A. From this figure we observe a very large decrease in REER volatility; specifically, volatility in the IRF drops by almost 45%. We could argue that in the absence of credible inflation rules or other countercyclical fiscal policies, liquidity management (through international reserves) was one of the strongest tools for emerging LATAM economies to lower inherited macroeconomic volatility. These two decades are the poster child for our international liquidity buffer story.

The second period of interest runs from 2003 to 2007. Due to the relatively low macroeconomic volatility in many emerging regions, this period is commonly dubbed as the end of the Great Moderation (GM). During this time, the relationship between CTOT shocks and real appreciation remains positive but we lose some significance in our regressions. As shown by the IRFs in figure 4B, the buffer effect of reserves remained strong, delaying any reaction of REER to changes in CTOT by more than a year. The Great Recession (GR) brings a change in the previously found empirical regularities. In short, the link between CTOT and REER seems to decrease substantially, and any role for reserves to buffer the shocks disappears. Figure 4C clearly represents this change. Finally, we observe the relationship between CTOT and REER and our buffer story reappear during the years following the GR (2010 to 2013). Nevertheless, neither the link between CTOT and REER, nor the buffer effect of reserves returned to the levels observed before the crises.

Figure 4. REER IRF to 1% CTOT under High and Low Stock of Reserves by Periods

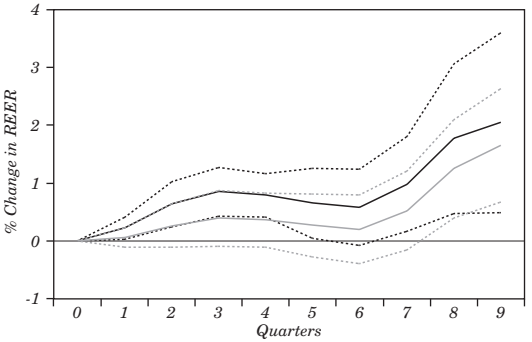


Source: See appendix.

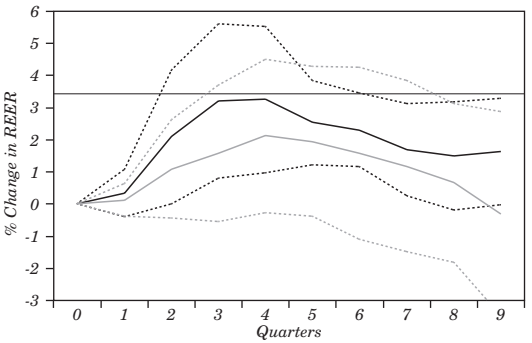
Interestingly, while the stock of reserves fails to smooth the transmission of CTOT shocks to REER during the Great Recession, we observe SWFs stepping up as a potential substitute to traditional reserve assets. Figures 5A and 5B show how moving the stock of SWF assets from 1 to 3 percent of GDP decreased volatility in the GR and the post-GR period by 16 and 32 percent respectively. Column 6 of table 9 shows that SWFs were also effective smoothing the transmission of CTOT shocks to real output growth during the GR and the post-GR periods.

Figure 5. REER IRF to 1% CTOT under High and Low Stock of SWF by Periods

A. Great recession (2008-2010)



B. Post great recession (2008-2010)



Source: See appendix.

5. International Reserves versus Sovereign Wealth Funds: Substitutes or Complements?

Results in the previous section show that during the Great Recession (2007-2009) and the following years, SWFs seemed to inherit the role of buffering LATAM economies against real external shocks previously assigned to international reserves. In this section, we want to look closely at the relationship between the two different tools of liquidity management over last two decades. In order to understand the short-run relationship between movements in the stock of reserves and movements in the balance of SWFs, we build a set of simultaneous equations such as:

$$\Delta RES_t = \sum_{k=1}^{N} \beta_{1k} \Delta SWF_{t-k} + \sum_{k=1}^{N} \theta_{1k} \Delta RES_{t-k} + \varepsilon_t \tag{4}$$

$$\Delta SWF_t = \sum_{k=1}^{N} \beta_{2k} \Delta RES_{t-k} + \sum_{k=1}^{N} \theta_{2k} \Delta SWF_{t-k} + \mu_t \tag{5}$$

where *RES* and *SWF* represent the stock of reserves and the total balance of *SWF* as a ratios of GDP respectively.

In our estimation strategy, we want to account for the potential correlation of the errors terms in these regressions, thus, we collapse equations (4) and (5) into a typical vector autoregression (VAR) specification:

$$\begin{bmatrix} \Delta RES_t \\ \Delta SWF_t \\ \Delta RES_{t-1} \\ \Delta SWF_{t-1} \\ \vdots \end{bmatrix} = \begin{bmatrix} \theta_{11} & \beta_{11} & \dots & \theta_{1n} & \beta_{1n} \\ \theta_{11} & \beta_{11} & \dots & \theta_{1n} & \beta_{1n} \\ 1 & 0 & \cdots & 0 & 0 \\ \vdots & \vdots & & \vdots & \vdots \end{bmatrix} \begin{bmatrix} \Delta RES_{t-1} \\ \Delta SWF_{t-1} \\ \Delta RES_{t-2} \\ \Delta SWF_{t-2} \\ \vdots \end{bmatrix} + \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ \vdots & \vdots \end{bmatrix} \begin{bmatrix} \varepsilon_t \\ \mu_t \end{bmatrix}$$

Or in matrix form,

$$X_t = A(L)X_{t-1} + \in$$

The results of estimating A(L) for a sample of years starting from 2003 (where most SWFs start to arise) and restricting the sample to countries that had stabilizing SWFs (Chile, Colombia, Ecuador, Mexico and Venezuela) are shown in table 10. Since the different information criteria used on both endogenous variables determined a wide array of different optimal lags (from 2 to 8), we show the regressions with three different numbers of lags (2,3 and 4) for robustness. Interestingly, we observe that an increase on assets in SWFs seems to be followed by a significant decrease of international reserves after one quarter in all specifications. These negative correlations range from a 0.6 to 0.9 percent GDP decrease in reserves in the face of a 1 percent GDP increase in SWF balances. To confirm joint significance of the lags we provide the p-values of a simple VAR Granger causality test conducted for both equations in the system. We observe that, while borderline significant at 10 percent, changes in SWFs tend to Granger-cause changes in RES while the opposite can be easily rejected. This evidence seems to reaffirm our substitution story. The emergence of SWFs during the 2000s seemed to provide a valid substitute tool for active liquidity management policies in LATAM countries. While further analysis of these interesting policy interactions seems warranted, we leave a more in-depth analysis for future work.

Table 10. Pool Vector Autoregression Model for the Change of Reserves and Change of SWF

Variables	*1 DRES*	*2 DRES*	*3 DRES*	*1 DSWF*	*2 DSWF*	*3 DSWF*
DRES (t)	0.2325 [0.083]***	0.1880 [0.083]**	0.1482 [0.082]*	0.0182 [0.020]	0.0161 [0.017]	0.0126 [0.018]
DRES ($t-1$)	0.1125 [0.091]	0.0964 [0.088]	0.0784 [0.088]	0.0029 [0.022]	0.0029 [0.019]	0.0071 [0.019]
DRES ($t-2$)		0.2333 [0.093]**	0.2070 [0.093]**		-0.0121 [0.020]	-0.0189 [0.020]
DRES ($t-3$)			0.2370 [0.093]**			0.0100 [0.020]
P-value Granger cause				0.624	0.772	0.778
DSWF ($t-1$)	-0.6036 [0.367]	-0.9471 [0.438]**	-0.9817 [0.473]**	0.1862 [0.088]**	-0.1485 [0.093]	-0.2223 [0.102]**
DSWF ($t-2$)	0.6708 [0.362]*	0.3595 [0.409]	0.1730 [0.421]	0.3719 [0.087]***	0.1009 [0.087]	0.0498 [0.090]
DSWF ($t-3$)		0.7845 [0.523]	0.6970 [0.518]		0.6735 [0.111]***	0.6359 [0.111]***
DSWF ($t-4$)			0.4608 [0.532]			0.2014 [0.114]*
P-value Granger cause	0.13	0.092*	0.175			
Constant	Yes	Yes	Yes	Yes	Yes	Yes
No. observations	113	113	113	113	113	113
R^2	0.109	0.162	0.208	0.278	0.471	0.485

Source: See appendix.
Robust standard errors in brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
RES STOCK is the total international reserves over GDP. DRES represents 1 period change in RES STOCK. SWF STOCK is the balance of sovereign wealth funds over GDP. DSWF represents 1 period change in SWF STOCK. Sample corresponds to quarterly observations from 2003.I to 2013.IV.

6. Liquidity management and Inflation Targeting

During the last decade and a half, half of our country sample moved to an inflation-targeting regime. This key change in monetary policy regime could, potentially, help explain the resilient macroeconomic performance of Latin American countries during the last decade. Prior to the Great Recession, evidence suggested improved performance for inflation target (IT) adopters, especially among emerging economies (Lin and Ye, 2009; Mishkin and Schimdt-Hebbel, 2007). An important feature among a number of emerging IT economies has been their "flexible" approach to inflation targets. Emerging IT economies are confronted by an additional set of problems to those managed by their advanced economy counterparts. Given their small size and their exposure to external shocks, the exchange rate and the management of capital flows become important targets for these economies (Chinn, 2014). Thus, the emerging economies "flexible" approach to IT is not limited to the use of alternative conventional and unconventional monetary tools, but also to the use of "mixed strategies" where additional targets are imposed by the monetary authority.[10] Aizenman and others (2011) observe that IT emerging markets (especially those exporting basic commodities such as our sample of Latin American economies) appear to use both inflation and real exchange rates as important determinants of policy interest rates. Importantly, for our study, they also observe that the response to real exchange rates is more constrained under IT rather than non-IT regimes. This constrained behavior could translate into less willingness of emerging economies to use liquidity management strategies to smooth real external shocks after the adoption of an IT rule. In this section, we investigate how target rules affected the ability or willingness of LATAM economies to use international liquidity to reduce the macroeconomic volatility inherited from external shocks.

In order to understand the policy goals of LATAM economies we start by setting up an augmented Taylor rule where we 'account' the domestic policy interest rate by a measure of the output gap, CPI inflation and real appreciation. In an alternative specification

10. See Céspedes and others (2014) for a review of the behavior of Latin American targeters under different macroeconomic scenarios. The authors observed a range of behaviors that went from hard targets during normal times to the use of a number of unconventional monetary tools during the Great Recession.

we use a non-linear dummy approach to separate the sample between IT and non-IT countries. Table 11 reports the estimated coefficients. Interpreting these coefficients as the weights across macroeconomic policy goals, we observe that output gaps seem to be the most important component for setting up the policy rate. While inflation gains importance for IT countries, the weight in the Taylor rule seems relatively small. Importantly, for our study, non-IT countries seem to switch from a REER target to an inflation target when committing to an IT rule.[11] This means, potentially, that liquidity management is no longer used towards the stabilization of REER under an IT rule. To investigate this possibility, we adjust our basic specification to account for IT countries and show the results in table 12. Figure 6 builds the IRF for non-IT vs IT countries. As expected, liquidity management seems to be efficient only across non-IT countries, reducing CTOT volatility by 35 percent over two years in the IRF. The relationship between CTOT and REER becomes more chaotic and the buffer story disappears among IT countries. Based on columns 2 and 4 from table 12, SWFs seem to provide IT countries with an alternative form of liquidity management against foreign shocks when traditional reserves are committed to other macroeconomic goals. This is true for both REER and output growth stabilization.

11. This results is consistent with other recent studies using a wider sample of emerging economies, see Chinn (2014).

Table 11. Augmented Taylor Rule

Methodology variables	*LSDV policy rate*	*LSDV policy rate*	*LSDV policy rate*	*HT policy rate*
Policy rate ($t-1$)	0.8406 [0.038]***	0.8529 [0.030]***	0.8572 [0.028]***	0.8042 [0.021]***
Policy rate * IT ($t-1$)			-0.1917 [0.049]***	-0.1682 [0.043]***
ECT RGDP ($t-1$)	38.3912 [6.181]***	35.1963 [5.982]***	32.6971 [8.087]***	28.3668 [7.916]***
ECT RGDP * IT ($t-1$)			-6.0744 [12.187]	-1.8203 [15.827]
INF ($t-1$)	4.4019 [3.042]	2.7090 [3.099]	0.5896 [3.245]	-2.0895 [2.854]
INF * IT ($t-1$)			10.9982 [4.928]**	2.4312 [9.057]
DREER ($t-1$)		12.2343 [6.515]*	19.6533 [9.748]*	17.8656 [4.901]***
DREER * IT ($t-1$)			-21.0437 [10.494]*	-18.6527 [7.736]**
No. observations	1,023	1,023	1,023	1,023
R^2	0.773	0.775	0.782	
Number of countries	13	13	13	13

Source: See appendix.
Robust standard errors in brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
EC GDP represents real output gap. IT is a dummy with value 1 if the country is targeting inflation, 0 otherwise.
DREER represents real exchange rate appreciation. Quarterly observations from 1980.I to 2013.IV. Observations under hyperinflation episodes (>40% inflation) and with Policy rates above 100 percent are not included.
HT - the Hausman-Taylor regression with all dependent variables considered as potentially endogenous.

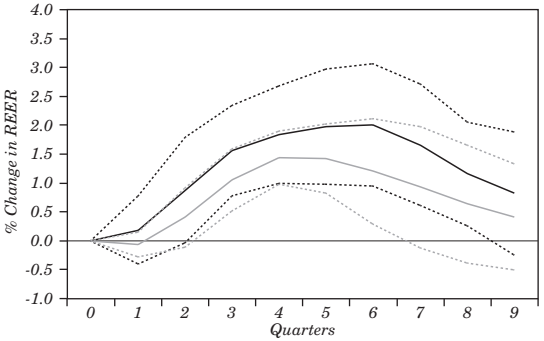
Table 12. The Buffering of International Liquidity Management and Inflation Targeting

Variables	*(1)* *Y= DREER*	*(2)* *Y= DREER*	*(3)* *Y =DRGDP*	*(4)* *Y= DRGDP*
Y ($t-1$)	0.0928	0.0930	0.1632	0.1626
	[0.060]	[0.062]	[0.052]***	[0.053]**
ECT Y ($t-1$)	-0.2370	-0.2323	-0.2672	-0.2681
	[0.068]***	[0.062]***	[0.045]***	[0.044]***
CTOT ($t-1$)	0.8206	0.4369	0.2807	0.1663
	[0.234]***	[0.204]*	[0.069]***	[0.063]**
CTOT * IT ($t-1$)	-1.3213	-0.0374	-0.4233	0.0616
	[0.615]*	[0.336]	[0.171]**	[0.126]
CTOT * RES ($t-1$)	-2.7496		-0.5985	
	[0.642]***		[0.213]**	
CTOT * RES * IT ($t-1$)	7.6299		3.1150	
	[3.202]**		[0.875]***	
CTOT * SWF ($t-1$)		20.9043		8.7804
		[5.864]***		[1.437]***
CTOT * SWF * IT ($t-1$)		-27.1766		-9.0664
		[6.572]***		[2.115]***
IT DUMMY	-0.0046	0.0010	0.0019	0.0032
	[0.009]	[0.007]	[0.001]	[0.002]*
RES ($t-1$)	0.1189		0.0141	
	[0.046]**		[0.009]	
SWF ($t-1$)		0.2097		-0.1283
		[0.112]*		[0.087]
No. observations	1,496	1,496	1,113	1,113
R^2	0.115	0.110	0.184	0.188
Number of countries	12	12	12	12

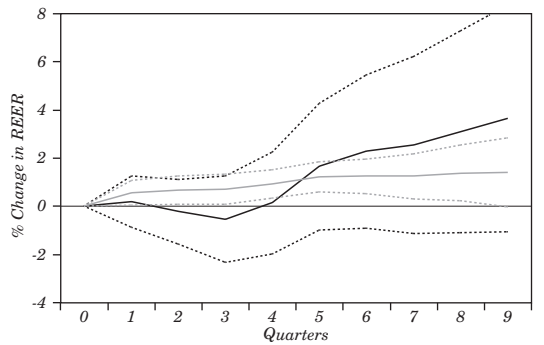
Source: See appendix.
Robust standard errors in brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
DRGDP represents real output growth. TCTOT represents transitory commodity terms of trade shocks. IT is a dummy with value 1 if the country is targeting inflation, 0 otherwise. RES are the stock of international reserves over GDP. DRES is the change in RES. SWF is the balance of sovereign wealth funds over GDP. Quarterly observations from 1980.I to 2013.IV. For output regressions observations under hyperinflation episodes (>100% inflation) are not included.

Figure 6. REER IRF to 1% CTOT under Inflation Rules

A. Non-IT countries



B. IT countries



Source: See appendix.

7. Discussion

In this paper, we provided evidence consistent with buffer rules using international liquidity to diminish the effects of external shocks. Among these buffer rules we find that SWFs follow fiscal rules that allow countries to manage windfalls and mishaps associated with terms of trade volatility. Similarly, central banks implement buffer rules using 'leaning against the wind' management of international reserves. While we do not evaluate the optimality of these arrangements, this section links our findings with the existing literature. In general, the case for proactive liquidity management may hinge on the structure of the economy, and the quality of its institutions. Chances are that liquidity management, or even welfare reducing, would be redundant with perfect capital markets in the absence of adjustment costs and political and economic frictions. The literature suggests various circumstances and different channels under which buffer policies and liquidity management in the presence of terms of trade shocks may be beneficial for countries with functioning institutions. Velasco (2007) outlines the case of a fiscal rule aiming at curbing the overspending tendencies in a decentralized fiscal system subject to fiscal competition among ministers or provinces. Such a rule aims at reducing the pro-cyclicality bias and excessive fiscal spending in the presence of political competition (see also Velasco, 2000; Frankel, 2011 and Céspedes and Velasco, 2014). In a different context, Devereux and Engel (2007) develop a view of exchange rate policy as a trade-off between the desire to smooth fluctuations in real exchange rates so as to reduce distortions in consumption allocations, and the need to allow flexibility in the nominal exchange rate so as to facilitate terms of trade adjustment. They show that optimal nominal exchange rate volatility will reflect these competing objectives, and find that the optimal exchange rate volatility should be significantly less than would be inferred based solely on terms of trade considerations.[12] Aghion and others (2009) provides a monetary growth model in which real exchange

12. Another perspective on these issues is offered in the presence of sunk fixed costs and uncertainty regarding the permanency of real shocks with entry and exit of heterogonous firms and product variety. In these circumstances, liquidity management aiming at price stability, linked to the perceived permanency of real shocks, may be welfare enhancing (see Bilbiie, Ghironi, and Melitz, 2007).

rate uncertainty exacerbates the negative investment effects of domestic credit market constraints. Testing the relevance of these channels for explaining the possible gains of optimal buffer policy is left for future research.

8. Conclusion

Our paper documents and validates the growing importance of liquidity management for commodity exporting countries. Liquidity management is used to mitigate the transmission from terms of trade shocks to the real exchange rate and output growth, thereby stabilizing the domestic economy. We find evidence that SWFs may provide another margin of stabilization, and this role may be of greater relevance for IT countries, and in periods of heightened volatility. This division of labor is consistent with the Tinbergen rule in policy design: to reach n targets, one uses n independent instruments. International reserves are useful in dealing with balance sheet exposure, aiming at short and intermediate run stabilization objectives. Yet, hoarding international reserves is not a panacea, as the opportunity cost of reserves imposes a fiscal cost, and hoarding reserves may require sterilization to mitigate their inflationary consequences. Thereby, inflation targeting regimes may relegate the goal of real exchange rate stabilization to its sovereign wealth fund. Such a fund may have greater risk tolerance, and its accumulation directly impacts the fiscal stance and the real exchange rate.[13] Remarkably, the buffering role of reserves and SWFs does not need East Asian levels of hoarding–they are operative in LATAM at relatively modest levels of reserves/GDP and SWF/GDP.

13. This assignment is consistent with the view that IR has a comparative advantage dealing with balance sheet exposure, SWFs with longer term saving and fiscal stabilization.

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APPENDIX

Data Definition and Sources

CTOT: Commodity terms-of-trade data set was constructed following Ricci et al. (2008):

$$CTOT_i = \prod_j (P_j/MUV)^{X_j^i} / \prod_j (P_j/MUV)^{M_j^i},$$

where P_j is the price index for six commodity categories (food, fuels, agricultural raw materials, metals, gold, and beverages), and (X_{ij} , M_{ij}) are the average shares of commodity *j* in country *i*'s exports and imports over GDP for the period 1980-2012, respectively. Commodity prices are deflated by the manufacturing unit value index (*MUV*). Sources: UN ComTrade, IMF, World Bank.

TCTOT: Transitory CTOT shocks are defined as the log deviations of actual CTOT from long-run values calculated through a HP filter.

REER: Real effective exchange rate is defined a trade based weighted average of nominal bilateral exchange rates deflated by the relative consumer price indices. An increase in REER represents a real appreciation of the domestic currency. **DREER** represents the log change in REER. Sources: DataStream, IMF.

RES: The stock of foreign reserve assets is measured in millions of U.S. dollars and deflated by the five year moving average of the interpolated annual nominal Gross Domestic Product. **DRES** represents the change in the reserves to GDP ratio. Global Financial Data, IMF.

ECT REER: Error correction REER is the log difference between current REER and long-term REER. In order to compute the equilibrium/ long-run REER, we use a co-integrating approach. The methodology calls for a series of co-integrating regressors. Following Edwards (1989), Montiel (1999) and others, we estimate the following equation:

$$Ln(REER)_t = \alpha + \mathrm{B}\begin{bmatrix} Ln(CTOT)_t \\ GOV_t \\ TradeOpen_t \\ USINF_t \\ TimeTrend_t \\ IntSpread_t \end{bmatrix} + \varepsilon_t \qquad \text{(A1)}$$

The term *CTOT* is commodity terms of trade, *GOV* represents the share of government expenditures over GDP, TradeOpen is a measure of Trade Openness (exports plus imports over GDP), *USINF* is a measure of inflation in the U.S. based on the U.S. CPI and represents world inflation and IntSpread is the domestic market reference interest rate spread from the 3-month U.S. T-Bill. Once we obtain the coefficients from equation (A1), we use the HP filter to find the long-run values of the fundamentals, we then use these values, jointly with the estimated coefficients, to generate what we refer to as the Long-run REER (LRREER). Sources: World Bank, Penn Tables.

RGDP: Real GDP is taken at a true quarterly frequency from different sources. Table A1 shows the source and data availability. **DRGDP** represents the log change in RGDP.

Table A1. Real GDP Data Sources in Latin America

Country	*Source*	*Data*
Argentina	Inter American Development Bank	1990.I
Bolivia	Inter American Development Bank	1990.I
Brazil	Inter American Development Bank	1990.I
Chile	Global Financial Data	1991.I
Colombia	Global Financial Data	1994.I
Costa Rica	FRED	1991.I
Ecuador	Global Financial Data	1992.I
Mexico	FRED	1981.I
Paraguay	Inter American Development Bank	1994.I
Peru	Global Financial Data	1980.I
Uruguay	Inter American Development Bank	1997.I
Venezuela	Inter American Development Bank	1993.I

FIXED vs FLEX FOREX DUMMIES: Using the de facto exchange rate regime classification of Ilzetzki, Reinhart, and Rogoff (2008), we define, a nominal fixed exchange regime as one where the country either has no legal tender, a hard peg, a crawling peg, and de facto or pre-announced bands or crawling bands with margins of no larger than +/- 2%. All other arrangements are classified as nominal flexible regimes (we exclude episodes of "Free Falling" from the sample of the regression). Sources: Reinhart, C. M., & Rogoff, K. S. 2002. "The Modern History of Exchange Rate Arrangements: a Reinterpretation." (No. w8963). National Bureau of Economic Research.

TRADE OPEN vs CLOSED DUMMIES: Based on the literature we consider a country to be "Open" if our ratio (EX+IM)/GDP is larger than 40% and close if its lower than 40%.

HIGH vs LOW DEBT DUMMIES: We consider High Government Debt any amount over 45 percent of GDP.

IT: Inflation targeting is a dummy with value 1 if the country is officially targeting inflation and zero otherwise. The table 3 shows the IT country/periods. Target bands and transition periods.

SWF: Balance of Sovereign Wealth Fund balances obtained from commodity revenues and dedicated to macroeconomic stabilization. SWF is measured in millions of U.S. dollars and is deflated by the five-year moving average of the interpolated annual nominal GDP. **DSWF** represents the change in SWF balance over GDP ratio. See table 2 for the summary of the funds.

Central Bank Policy Rate: Reference interest rate used by the central bank to conduct monetary policy. Table A2 are the reference rates used and data availability.

Table A2. Data Availability for the Monetary Policy Rate in Latin America

Country	*Policy rate*	*Data availability*
Argentina	Argentina 15-day Loans to Financial Institutions	1980-2013
Bolivia	Bolivia Central Bank Discount Rate	1980-2014
Brazil	Brazil Deposit Rate Over SELIC	1980-2015
Chile	Chile Monetary Policy Rate	1990-2016
Colombia	Colombia Bank of the Republic Discount Rate	1980-2017
Costa Rica	Costa Rica Central Bank Deposit Rate	1991-2018
Ecuador	Ecuador Central Bank Discount Rate	1980-2019
Mexico	Mexico 28 Day Interbank Rate (TIIE)	1980-2020
Paraguay	Paraguay Interbank Rate	1990-2022
Peru	Central Bank of Peru Discount Rate	1980-2023
Uruguay	Uruguay Central Bank Discount Rate	1981-2024
Venezuela	Venezuela Central Bank Discount Rate	1980-2025

Sources: Global Financial Data, DataStream.

Glossary of Terms for Tables in the Appendix

REER:	Real Effective Exchange Rate. An increase implies real appreciation.
DREER	One period log change in REER.
RES:	Stock of Reserves over GDP.
DRES:	One period change in the reserves over GDP.
TCTOT:	Transitory CTOT shocks are defined as the log difference between CTOT and a long-run measure of CTOT obtained from applying the HP filter to the original series.
RGDP:	Real Gross Domestic Product in national currency and seasonally adjusted.
DRGDP:	One period log change of RGDP.
X and Y:	We use "X" and "Y" to proxy for the different variables used in different specifications across the same table. See the top row of each column to see what these variables are in each specification.
ECT:	The Error Correction Term is the distance of the variable to the long-run value. See appendix for the description of the REER long-run value. For output growth, we take log deviations from the smoothed series obtained from applying the HP filter to the original series.
SWF:	Balance of the Macro-Stability Sovereign Wealth Fund as a ratio of GDP.
DSWF:	One period change in the balance of SWF over GDP.
GM:	Great Moderation Dummy: 1 if between 2003.I-2007.IV, 0 otherwise.
GR:	Great Recession Dummy: 1 if between 2008.I-2009.IV, 0 otherwise.
AGR:	After Great Recession Dummy: 1 if between 2010.I-2013.IV, 0 otherwise.
INF:	Inflation measured as the log difference of the consumption price index.
IT:	Inflation Target Dummy: 1 if the country has an Inflation Target, 0 otherwise.