NBER WORKING PAPER SERIES

ADJUSTMENT PATTERNS TO COMMODITY TERMS OF TRADE SHOCKS: THE ROLE OF EXCHANGE RATE AND INTERNATIONAL RESERVES POLICIES

Joshua Aizenman
Sebastian Edwards
Daniel Riera-Crichton

Working Paper 17692
http://www.nber.org/papers/w17692

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
December 2011

This is a revised version of a paper presented at the JIMF 4th conference at UCSC, International Policy Implications and Lessons from the Global Financial Crisis. We thank Michael Melvin and the conference participants for their insightful comments. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

Adjustment patterns to commodity terms of trade shocks: the role of exchange rate and international reserves policies
Joshua Aizenman, Sebastian Edwards, and Daniel Riera-Crichton
NBER Working Paper No. 17692
December 2011
JEL No. F1,F15,F31,F32,F36,O13,O54

ABSTRACT

We analyze the way in which Latin American countries have adjusted to commodity terms of trade (CTOT) shocks in the 1970-2007 period. Specifically, we investigate the degree to which the active management of international reserves and exchange rates impacted the transmission of international price shocks to real exchange rates. We find that active reserve management not only lowers the short-run impact of CTOT shocks significantly, but also affects the long-run adjustment of REER, effectively lowering its volatility. We also show that relatively small increases in the average holdings of reserves by Latin American economies (to levels still well below other emerging regions current averages) would provide 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. Finally, we analyze the effects of active use of reserve accumulation aimed at smoothing REERs. The result support the view that "leaning against the wind" is potent, but more effective when intervening to support weak currencies rather than intervening to slow down the pace of real appreciation. The active reserve management reduces substantially REER volatility.

Joshua Aizenman
Department of Economics; E2
1156 High St.
University of California, Santa Cruz
Santa Cruz, CA 95064
and NBER
jaizen@ucsc.edu

Daniel Riera-Crichton
Department of Economics, Bates College
Andrews Road 2
Office 237 Pettingill Hall
Lewiston, ME 04240
drieracr@bates.edu

Sebastian Edwards
UCLA Anderson Graduate School of Business
110 Westwood Plaza, Suite C508
Box 951481
Los Angeles, CA 90095-1481
and NBER
sebastian.edwards@anderson.ucla.edu

"I always wondered why it’s hard to make money trading commodity terms of trade, one can forecast and trade those. May be this is the answer: central banks lean against this stuff, and there is no an opportunity."

Michael Melvin, Black Rock and JIMF, September 2011

I. - Introduction

The recent (2010-2011) surge in commodity prices has brought to the forefront of policy debates the issue of terms of trade (TOT) volatility in emerging economies. An important aspect of this discussion relates to whether these price increases are permanent or transitory, and how they affect a country’s degree of international competitiveness. In many countries – Brazil being a prime example – terms of trade improvements have been accompanied by a surge in capital inflows. A number of prominent policy makers have argued that the combination of significant increases in export prices and higher capital flows has generated “Dutch Disease” type situations, where acute real exchange rate appreciation has resulted in the crowding out of non-commodities tradable industries. Within this picture, emerging countries’ policy makers have discussed a number of palliatives, including the imposition of controls on capital inflows, tax incentives to ailing tradable industries, and active central bank intervention in foreign exchange markets with the concomitant accumulation of international reserves. Most of these offsetting policies fall within the category of “self insurance.” These policy options, however, are shadowed by large opportunity costs, including forgone uses of international liquidity (e.g. in domestic investment), the loss of the independence of monetary policy (as posited by the famous "trilemma" proposition), and/or inefficiencies associated to the use of capital controls.

As a growing body of literature has shown, TOT volatility in emerging countries is 3 times higher than in industrial countries. This results in real income shocks that are 3.5 times as volatile as those affecting advanced countries (see IDB, 1995, and Hausmann, Panizza, & Rigobon, 2006). Among emerging markets, and over the last thirty years, Latin American economies have shown an over-exposure to shocks in their terms of trade (Edwards 2010).

In this paper, we use a “commodity terms of trade” (CTOT) data set to analyze the way in which shocks to commodity prices affect the real exchange rate (REER), and the way international reserves and the exchange rate regime impact the transmission of CTOT to the REER. Our analysis focuses on the Latin American countries – the region that, as noted, has the highest volatility in CTOT – and covers the period 1970-2009. This concept of "commodity terms of trade" 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 by Ricci et. al (2008), as follows: $CTOT_i = \prod_j (P_j / MUV)^{X_j^i} / \prod_j (P_j / MUV)^{M_j^i}$, where Pj 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 period 1970 through 2006, respectively. Commodity prices are deflated by the manufacturing unit value index (*MUV*). As Spatafora and Tytell (2009) have pointed out one of the desirable properties of CTOT is that, since X_j^i and M_j^i 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.[2]

In this study, we analyze the role played by international reserves on the short and intermediate-run REER dynamics generated by a CTOT shock. We also test the degree to which international reserves and the choice of exchange rate regime mitigates REER volatility associated with given CTOT shocks. Specifically, we investigate the way in which international reserves and the exchange rate regime affect the pattern of REER adjustment to transitory CTOT shocks (defined as the log deviations of current CTOT from its long run value). Our analysis focuses on both "reserve availability" -- measured as stock of international reserves --, and "active reserve management", measured as changes in international reserves. In the last section of the paper we concentrate on the effects of reserve assets managed through sovereign wealth funds (SWF). We do this by focusing on a case study: Chile and its "Copper Fund" established in the mid 1980s.

[2] 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 for further details regarding the derivation of CTOT.

Our results confirm the idea that international reserves play an important role in buffering the adjustment of the REER to CTOT shock. A higher stock of international liquidity increases the persistence effect of CTOT shocks on the REER, delaying the reversion of REER towards equilibrium and accelerating the process once REER starts to revert back. Our findings provide some validation to the idea that there are advantages, in terms of low volatility of REER, of holding sizable stocks of reserves. Moreover, we observe reserve policies of "leaning against the wind" that effectively reduce the transmission of CTOT shocks to the REER. As one may expect, our findings show that while large stock of reserves are most effective against the risk of real appreciation suffered from positive CTOT shocks, sales of reserves are not very effective against the risk of real depreciation from negative CTOT shocks. We also find that reserve accumulation is effective as a buffer against CTOT shocks under flexible regimes. As the country increases the amount of reserves, deviations of REER from equilibrium have a lower effect on the dynamics of REER. This indicates that active reserve and nominal exchange management may be closer to being substitutes rather than complements as policies against excess REER volatility. Finally, we observe an important role in our buffer story for assets managed through SWF.

The rest of the paper is organized as follows: In Section II, we discuss alternative ways in which TOT shocks affect real exchange rates both in the short and long runs. We also deal with the role of international reserves in smoothing temporary TOT shocks, under alternative exchange rate regimes. In Section III, we analyze the evolution of TOT and international reserves in Latin America, from an international comparative perspective. We focus on volatility and show that, indeed, REER have been extremely volatile in that part of the world. Section IV contains our econometric results from the analysis of the buffering effect from the *stock of reserves*. We start by presenting our empirical model and reporting the results of a number of co-integration analyses for the long run REER for our countries. We then analyze the effects of CTOT on the REER, under alternative holdings of reserves, using a pooled data set. We, then, move to individual countries analysis. In Section V, we expand our investigation by studying the effect of CTOT shocks on the REER (again under alternative reserves holdings) in countries with "flexible" and "pegged" exchange rate regimes. Section VI contains a number of extensions and robustness checks. We analyze the role of openness (both trade and financial), government expenditures, and quality of institutions. Section VII contains the econometric results from our analysis of active *reserve management* policies and their buffering effects. In Section VIII we focus on the case of Chile, as a way of providing some light on the role played by SWF in smoothing REER fluctuations. Section IX concludes.

II.- On the transmission of TOT shocks to the REER, and the Buffer role of international reserves .

This section overviews, selectively, works on the transmission of TOT shocks to the REER under alternative exchange rate regimes, and the buffer role of international reserves. The past literature investigated these two issues separately, while our paper deals with these issues jointly, identifying the effects of international reserves and exchange rate management on the impact of TOT shocks on REER dynamics.

II.1 TOT shocks and the REER

A number of studies have shown a potential direct link between terms of trade and output through volume effects in net exports, and supply-side effects of imported intermediate inputs. However, the most studied channel of transmission of terms of trade shocks to the real economy is through the real exchange rate. A common definition of the real rate is the nominal exchange rate adjusted by price levels[3].

$$q_t \equiv s_t - p_t + p_t^* \qquad (1)$$

where *s* is the log exchange rate defined in units of home currency per unit of foreign, and *p* and *p** are log price levels. As customary, an asterisk (*) denotes "foreign" or international prices. To understand more clearly the potential determinants in the movement of the real exchange rate, we can decompose (1) into the price of trade and non-traded goods:

$$p_t \equiv \alpha(p_t^N) + (1-\alpha)(p_t^T) \qquad (2)$$

Substituting (2) into (1) yields:

[3] See Chinn (2006) for a short and clear analysis of real exchange rates.

$$q_t \equiv (s_t - p_t^T + p_t^{T*}) + [-\alpha(p_t^N - p_t^T) + \alpha^*(p_t^{N*} - p_t^{T*})] \qquad (3)$$

This decomposition helps us express the real exchange rate as the sum of two components. First, the relative price of tradables, and second, the cross-country relative price of non-tradables in terms of tradables.

Many studies assume that the purchasing power parity (PPP) condition holds for tradable goods, rendering the first term of (3) as a constant. Under this assumption real exchange rate movements are fully determined by changes in the relative price of the non-traded sector across countries.

In order to simplify the exposition, consider the case of perfect capital mobility and labor immobility. In this case, in a small open economy, where the rental rate of capital is given by the world interest rate, the wage rate is uniquely determined. Factor price equalization across sectors will, then, result from perfect inter-sectoral factor mobility. With factor price equalization all the movements in the relative price of non-tradable across countries comes from sectoral productivity differentials. These differentials across countries have long been identified as a major determinant of real exchange rate movements in the long run (Harrod, 1939; Balassa, 1964; and Sarnuelson, 1964).

Breaking with the assumption of PPP for tradables, another set of papers identifies relative price movements within the tradables sector, specifically, movements in the relative price of exports to imports (TOT), as another major determinant of real exchange rate movements (Dornbusch, 1983; Marion, 1994; Ostry, 1988; Edwards, 1989; and Frenkel and Razin, 1992)[4]. These studies suggest direct links between TOT shocks and the REER. Our study will test these links for the most volatile segments of traded goods: commodities, focusing on the most exposed continent to CTOT shocks: Latin America.[5]

II.2 <u>International reserves as a buffer</u>

To recall, the buffer stock approach to international reserves goes back to the Bretton Woods system. Under the Bretton Woods system adequate reserves were measured by

---

[4] See Gregorio and Wolf (1994) for a paper considering both approaches at the same time.

[5] Commodity currencies were studied by Chen, Rogoff and Rossi (2010), concluding that "commodity currency" exchange rates have robust power in predicting global commodity prices, but that commodity prices are less robust in forecasting exchange rates.

months of imports: the prevailing rule of thumb considered four months of imports to be a reasonable coverage. This perspective fitted well in a world with limited financial integration, in which trade openness reflected a country's vulnerability to external shocks (Fischer 2001). In the absence of reserves, balance of payment deficits would have to be corrected through a reduction in aggregate expenditures (or absorption), imposing macroeconomic adjustment costs, and a change in relative prices or "expenditure switching". Adjustment costs manifested in sharp contractions of investment and consumption, thereby inducing recessionary pressures. As greater trade openness increased the exposure to trade shocks, minimizing adjustment costs required higher reserve holdings.

The earlier literature focused on using international reserves as a buffer stock, as part of the management of an adjustable-peg or managed-floating exchange-rate regime. Heller (1966) was the first to derive the optimal level of reserves using a cost-benefit approach.[6] Frenkel and Jovanovic (1980, 1981) reformulated Heller's approach in an optimal inventory management, where reserves serve as a buffer stock. Edwards (1984) showed, empirically, that countries with adjustable peg exchange rate regimes had a different demand function for reserves than countries committed to a fixed exchange rate system. Extensions of the buffer stock model predicts that average reserves depend negatively on the opportunity cost of reserves, and exchange rate flexibility; they depend positively on GDP, adjustment costs, and reserve volatility. Overall, the literature of the 1980s supported these predictions (see Flood and Marion 2002).

Aizenman and Riera-Crichton (2006, 2008) report evidence that international reserves cushion the impact of TOT shocks on the REER, and that this effect is important for developing but not for industrial countries. This finding is consistent with a broader buffer stock view of international reserves, where proper reserve policy reduces the volatility of the REER, possibly supporting superior economic performance.[7]

[6] The benefit from holding reserves in Heller's model stems from the ability to avoid a reduction in output in case of a deficit in the balance of payments. The opportunity cost of holding reserves is the gap between the return on capital and on reserves.

[7] Aghion et al. (2009) found that REER volatility reduces growth for countries with relatively low levels of financial development; hence, factors mitigating REER volatility may be associated with superior economic performance.

In this paper we look at the dynamics of adjustment of the REER to CTOT shocks, identifying conditions under which the proper reserves and exchange rate policy would buffer the transmission from CTOT to the REER.

III.- Commodity Terms of Trade Shocks, Real Exchange Rates, and International Reserves in Latin America

Figure 1 shows that Latin American economies display a higher volatility in commodity TOT (CTOT) than any other set of emerging markets (CTOT shock volatility is measured as the standard deviation of ΔLog CTOT). During the last 40 years, CTOT shocks have been 50 percent more volatile in Latin America than in Emerging Asia, and almost twice as volatile as in other emerging markets.

Table 1 provides the summary statistics for CTOT shocks (defined as the percent change in CTOT) by period for the following Latin American economies in our sample: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay and Venezuela. The data in this table show that there has been a significant increase in the volatility of CTOT shocks over the last two decades. Moreover, while CTOT shocks were weakly positively skewed during the 1990's, during the 2000's, this positive skewdness increased significantly. Finally, with the collapse of the price of commodities traditionally exported by Latin American countries during the "Great Recession," shocks' skewness quickly turned very large and negative. It is also worth mentioning that distribution of CTOT shocks suffered from "fatter" tails (higher probability of large shocks) during the 90's compared to 2000-2006.

An Important question is what happened to REER volatility during periods of increased CTOT shock volatility? As shown in Figure 2, REER volatility in Latin America has significantly decreased over the last two decades. This figure also shows opposite directions in the evolution of CTOT and REER volatilities, leading us to conjecture that active policies were used successfully to insulate international relative prices (REERs) from the volatility of international commodity prices. Recent studies have shown that reserve accumulation may indeed be used for such purposes.[8] Comparing the evolution of reserve accumulation and REER volatility (Figure 3), we observe that the decrease in the latter was

[8] See Aizenman & Riera-Crichton (2006).

accompanied by a steady increase of the former. While governments may accumulate international liquidity for other reasons,[9] this accumulation may be also helpful in buffering the real exchange from CTOT shocks. Moreover, the different speeds at which these economies accumulated reserves during periods where CTOT shocks were positively skewed versus periods were shocks were negatively skewed, may indicate an active use of reserve accumulation as a policy against CTOT volatility.

IV.- Real Exchange adjustment and commodity terms of trade shocks

` We are interested in understanding: (a) how real exchange rates adjust to CTOT shocks in several Latin American economies; and (b) the way in which this adjustment is affected by international reserves policies. We proceed in steps: first we look at the results obtained using pooled data for the region during 1970-2010. Then, we analyze each country individually using a simultaneous SURE approach.

IV.1 The empirical model

In our analysis, we use, as a base-case model, the following linear dynamic error correction formulation:

$$\Delta Ln(REER)_{it} = \alpha_i + \beta_1 \Delta Ln(REER)_{it-1} + \begin{bmatrix}\beta_2 & ; & \beta_3\end{bmatrix} \begin{bmatrix} ECTREER_{it-1} \\ TCTOT_{it-1} \end{bmatrix} + \beta_4 RES_{it-1} + \varepsilon_{it}$$

where REER corresponds to the effective (trade weighted) real exchange rate[10]. ECTREER is the error correction term for (the logarithm of) the REER. As usual, this term is defined as the log deviations of REER from its equilibrium value. The term TCTOT represents transitory CTOT shocks, and is defined as the log deviations of current CTOT from its long run value. The latter, in turn, is obtained applying an HP Filter to the original series with a smoothing parameter set at 1600. Finally, *RES* is the international reserve/GDP ratio.

From this base-case formulation, we introduce the role of reserves through their interaction with the lagged value of REER. Under this new specification, we implicitly assume the autocorrelation of REER depends on the level of international reserves so that β_1 varies over time as:

[9] See Aizenman and Marion (2003) for a precautionary savings view and Dooley, Landau and Garber (2003) for a Mercantilist view of the reserve accumulation in the last two decades.

[10] 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

$$\beta_1 = \lambda_1 + \lambda_2 RES_{it-1}$$

Where β_1 is the autocorrelation coefficient from our basic dynamic model and RES represents stock of international reserves. Assuming that reserves only affect the persistence of the REER deviations, but not the long run equilibrium REER, we obtain the following specification;

$$\Delta Ln(REER)_{it} = \alpha_i + (\lambda_1 + \lambda_2 RES_{it-1})\Delta Ln(REER)_{it-1} + [\beta_2 \quad ; \quad \beta_3]\begin{bmatrix} ECTREER_{it-1} \\ TCTOT_{it-1} \end{bmatrix} + \beta_4 RES_{it-1} + \varepsilon_{it} \tag{4}$$

As an example of such mechanism, a positive CTOT shock leads to a shift in production towards exportable commodities, an increase in the price of non-tradables, and a real appreciation. If the central bank absorbs part of the proceeds of this positive shock in relative export revenue by increasing the stock of foreign reserves, the subsequent expansion of the domestic currency supply will push towards a nominal depreciation of the domestic currency, thereby (partially) softening the original effects of the CTOT shock in the 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:

$$Ln(REER)_t = \alpha + \mathrm{B}\begin{bmatrix} Ln(CToT)_t \\ Gov_t \\ TradeOpen_t \\ USINF_t \\ TimeTrend_t \\ CapitalOpen_t \\ IntSpread_t \end{bmatrix} + \varepsilon_{ti} \tag{5}$$

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 US based on the US CPI and represents world inflation, Capital Openness represents a proxies for Financial Openness (Total private gross flows over GDP) and IntSpread is the domestic market reference interest rate spread from the 3-month US T-Bill. Once we obtain the coefficients from equation (5), 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).

Table 2 shows the coefficients from the co-integrating regression for each individual country in our sample[11]. The following results are worth mentioning:

- *Commodity Terms of Trade*: An improvement in the terms of trade would reduce the supply of non-traded goods (since resources would be drawn towards the traded sector), increasing their price and pushing for a real appreciation. Since we are dealing with commodity terms of trade, this effect would be less significant if resources are drawn from other trading sectors such as manufactures. Most of the economies in Latin America seem to experience a real appreciation, (although there are some exceptions, such as Argentina, Brazil, and Uruguay, with statistically insignificant effects and Nicaragua with statistically significant coefficient).

-*Time Trend:* Our time trend may capture differences in sectoral productivity growth. According to the Ricardo-Samuelson-Balassa effect, as the country develops and productivity spills over to the non-traded sector, there will be a real appreciation. In our sample, only Bolivia displays a negative and statistically significant coefficient.

-*World Inflation*: In theory, world inflation following expansionary monetary policies, could force a nominal devaluation of the foreign currency (excess supply of foreign currency) and, thus, a nominal/real appreciation of the domestic currency. In effect, only Bolivia and Nicaragua show significant negative signs in their USINF coefficients.

-*Government Expenditure*: The effects of fiscal policy on the REER are difficult to determine a priori, since targeted expenditures into traded or non-traded goods could carry opposite effects in the external relative prices. Given this dichotomy, it is not surprising that we observe mixed signs on the coefficient of government expenditures across Latin American economies. On one hand, Brazil, Costa Rica, Ecuador, Mexico, Nicaragua, Peru and Uruguay suffer real depreciations after increases in government consumption indicating a potential biased towards government expenditure in traded goods in those economies. On the other hand, Argentina Bolivia Chile, Colombia, Paraguay and Venezuela experience real appreciations indicating a bias towards non-Traded goods.

---

[11] Given the nature of the exercise, we use low frequency, yearly data in our co-integration equations in order to smooth out as much from transitory shocks as possible.

-*<u>Trade Openness</u>*: Most of the countries in our sample (with the sole exception of Bolivia), display a robust negative relationship between trade openness and the real exchange rate -- in our sample, higher trade volumes/GDP has been associated with real depreciations.

-*<u>Gross Private Capital Flows</u>*: Although capital openness seemed to be an important determinant of the real exchange rate for several Latin American economies, the signs of the coefficients are mixed, with openness leading to real depreciations in countries like Mexico and real appreciation in countries like Costa Rica or Nicaragua.

-*<u>Interest Rate Spreads</u>*: Similarly to fiscal policy, pinning down in the theory the effects of an increase in the foreign interest rate spread can be difficult. On the one hand, if a positive spread opens due to higher productive perspectives, capital inflows will put a pressure on non-traded prices leading to a real appreciation. If, on the other hand, the positive spread is driven by a higher risk, capital outflows may force a real depreciation. As in the case of trade policy, the coefficients in our sample are at best mixed.

To complement our first model, we also assume the possibility that reserves affect the speed of adjustment in our dynamic model.

$$\beta_2 = \theta_1 + \theta_2 RES_{it-1}$$

In order to account for this effect we introduce a second interaction term between reserves and the error correction term. This interaction term gives us the effect of high reserves on the speed adjustment of the real exchange rate back to its equilibrium level.

$$\Delta Ln(REER)_{it} = \alpha_i + (\lambda_1 + \lambda_2 RES_{it-1})\Delta Ln(REER)_{it-1} + \left[\theta_1 + \theta_2 RES_{it-1} \quad \beta_3\right] \begin{bmatrix} ECTREER_{it-1} \\ TCTOT_{it-1} \end{bmatrix} + \beta_4 RES_{it-1} + \varepsilon_{it} \tag{6}$$

Finally, in our last specification, we also assume that the direct effect of changes in CTOT is affected by changes in the stock of reserves.

$$\beta_3 = \theta_3 + \theta_4 RES_{it-1}$$

Again, to account for this effect we include a third interaction with the transitory CTOT shock to capture the role of reserves as a direct buffer from CTOT shocks.

$$\Delta Ln(REER)_{it} = \alpha_i + (\lambda_1 + \lambda_2 RES_{it-1})\Delta Ln(REER)_{it-1} + \left[\theta_1 + \theta_2 RES_{it-1} \quad \theta_3 + \theta_4 RES_{it-1}\right] \begin{bmatrix} ECTREER_{it-1} \\ TCTOT_{it-1} \end{bmatrix} + \beta_4 RES_{it-1} + \varepsilon_{it} \tag{7}$$

<u>IV.2 Pooled-Data Results</u>

Table 3 displays the results from the fixed effect estimation for all countries in our sample for the period 1970-2009. These results show that, in Latin America, the accumulation of international reserves substantially affected REER dynamics. Accumulating reserves not only helps buffer the direct effect of CTOT transitory shocks on the REER, but also decreases the half-life of the shock, substantially lowering the volatility of the REER after the shock. Figure 4 represents the impulse response functions (IRF) calculated from the coefficient means in the regression following our third specification.

The IRF show that an average Latin American economy with reserves of 3 percent of GDP (approximately one standard deviation below the region average holding of international reserves) will suffer a short run real appreciation of approximately a 16 percent as a result of a 20 percent CTOT transitory shock. In turn, the same economy holding 13% percent reserves over GDP (approximately one standard deviation above the region average) would experience a real appreciation of only 8.6 percent in the next period, reaching a maximum appreciation of 9.3 percent in the second quarter.

Looking at the adjustment patterns, we also observe that in the low reserve case the half-life of the CTOT shock hovers around the second and third quarter, while the half-life for the high reserve case is extended until the fourth and fifth quarter. This “smoothing” of the CTOT shock effectively lowers the volatility of log REER (measured as the relative standard deviation) in the first 5 quarters from 5.6 percent to 3.4 percent. Moreover, while the shock in the high reserve case effectively dies off after approximately 7 quarters, in the low reserve case the effects linger well beyond the 12th quarter.

To further illustrate the volatility reduction role of international reserves, Figure 5 illustrates the marginal effect on REER volatility of an average Latin American economy (Table 9 give us the means of all variables describing our “average” Latin American country) of a 1 percent increase in international reserves after an average CTOT shock. Although the REER dynamic adjustment patterns seem to be significantly affected by reserves in the aggregate sample of Latin American Economies, in the next sections, we will show that this effect is much larger in a number of circumstances, such as countries under flexible regimes, or after positive CTOT shocks.

IV.3 REER adjustment by Period and asymmetric Adjustment

In this Sub Section we compare the effectiveness of the buffer role of reserves by decades. The results presented in Table 4 split the sample in 3 sub-periods for which we have data for all countries: 1980-1990, 1990-2000 and 2000-2007. The coefficients in Table 4 provide a consistent message across all the sub-samples: although the adjustment pattern and shock dynamics changed substantially across the three decades, reserves were very effective protecting REER volatility from CTOT shocks in all periods[12]. Figure 6, shows the IRF from Table 4's coefficient. We observe that the largest shock transmission and the largest buffering effect of international reserves occurred during the decade of the eighties. In that period, a 20 percent transitory CTOT shock would increase the REER in low reserve holders (9 percent of GDP) by 54 percent while high reserve holders (13 percent of GDP) would only experience a real appreciation of 13 percent. An increase of reserves of just 3 percent of GDP would decrease REER volatility from 18 percent to 5 percent. During the nineties, an increase of Reserves from 9 percent to 13 percent of GDP would have completely offset the effect of a 20 percent increase in CTOT on REER, reducing REER volatility from 2.8 percent to negligible 0.3 percent. Interestingly, the same increase in 2000 to 2007 would decrease the real appreciation of the same 20 percent CTOT shock from 12 percent to 8 percent, effectively reducing REER volatility from 4.3 percent to 3.4 percent.

When checking for potential asymmetric effects of positive and negative CTOT shocks to the REER, we uncover some interesting results. Table 5 shows that, contrary to what many analysts believe, the REER in Latin American economies are more exposed to positive CTOT shocks than negative ones. It is also shown that the stocks of international reserves play a larger role insulating REER from CTOT when the economy faces positive shocks. Even if we ignore the fact that the CTOT coefficient and its interaction term are statistically insignificant in our full model regression, Figure 7 shows that a positive 20 percent CTOT shock would appreciate the real exchange rate by 38 percent, while an equally

[12] Although the coefficients point in the same direction for all the sample periods during 2000-2007 the interaction term measuring the buffer effect is statistically insignificant.

sized negative shock would cause a real depreciation of 18 percent for economies with low stocks of reserves (3 percent of GDP). Increasing reserves to 13 percent of GDP would reduce the real appreciation to a 13 percent and the real depreciation to 3.4 percent. In both cases, REER volatility is greatly diminished from 11 to 5 percent in the case of the positive shock and from 8 to 1 percent in the case of the negative CTOT shock.[13]

IV.4.- Individual Country Results: A Seemingly Unrelated Regressions Approach

We now turn to the individual country analysis. In order to do this, we estimated dynamic ECM equation for each of them. To account for the fact that REER are related across countries we estimated the model simultaneously, using a seemingly unrelated regression (SURE) procedure. Table 6 shows the results.

From the coefficients in Table 6, we observe that, in most countries (7 out of 11), there is a direct mitigation effect from holding international reserves. The regression results indicate that reserves have been particularly effective in reducing the effect of CTOT shocks on REER in Argentina, Bolivia, Brazil and Mexico. What makes this result interesting is that countries in this group have different exports and production structures. For example, while Mexico exports oil and light manufactures (almost all of them to the US), Argentina is a quintessential commodity exporter (although it does export some manufactured goods, mostly to its Mercosur partner, Brazil).

The role of reserves mitigating on the speed of adjustment is even more extended across the sample (8 out of 11 countries) with large and significant coefficients identified for Argentina, Ecuador, Mexico, Peru and Venezuela. The interaction between the dynamic components gives us 8 out 11 countries with buffering effects , although these interactive terms are only significant for Argentina and Peru, and Uruguay ,

V.- The Role of the Exchange Rate Regime in REER Adjustment Patterns

A second policy that may affect the pattern of adjustment in real exchange rates is the choice of the *nominal* exchange rate regime. More specifically, it is highly likely that countries that peg their nominal exchange rate to a foreign currency or to a basket of

[13] This result is consistent with the 'fear of appreciation,' where emerging markets may be more concerned with transitory appreciations due to the adverse competitiveness effects of commodity driven terms of trade improvement on non-commodities exports.

currencies will exhibit different REER dynamics than countries allowing for full nominal exchange rate flexibility.

In order to investigate the differences in REER adjustment patterns across *nominal* exchange rate regimes, we use the third specification (full model) from the last section. This time, however, we split the sample into observations under fixed or flexible exchange rates regimes. To determine when a country starts running a fixed exchange rate regime, we use the *de facto* exchange rate regime classification of Ilzetzki, Reinhart, and Rogoff (2008).

For each country, a *nominal fixed exchange regime* is defined 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)[14].

Table 7 displays the results from running our extended model and interacting the main variables with dummies for these two groups of countries. In this table, we observe that the effects of CTOT shocks are much larger in flexible regimes. This is expected, since REER is protected from CTOT shocks under fixed nominal rates and sticky domestic prices.

Looking at the impulse response functions (IRF) obtained from the mean coefficients reported in the third column from Table 7 (and graphically represented in Figure 8), we uncover large differences in the adjustment patterns and in the effects of reserve holdings among economies with fixed exchange rate regimes and those allowing their currency to float. Let us assume a representative Latin American economy with a stock of international reserves equivalent to 3 percent of GDP (low reserve case). For economies with flexible exchange rates a 20% transitory CTOT shock would appreciate the REER by 26 percent in the short run, peaking at 34 percent in the second quarter. In contrast, the same 20% transitory CTOT shock would appreciate the REER by only 6 percent in economies with fixed exchange rate regimes. Interestingly, if the same country held reserves amounting 13 percent of GDP (high reserve case), then, the short run appreciation would have been much closer across regimes with a 8.6 percent in the case of flexible regime and 4 percent in the case of fixed regimes. Thus, as in the previous section, large holdings of international

[14] See Table 10 for a complete list of Country-Period under Fixed and Flex Exchange Rate Regimes.

reserves help reduce the volatility of the REER, from 10 to 3 percent, in the case of flexible regimes, and from 3 to 1.5 percent, in the case of fixed exchange rate regimes.

These results leave us with interesting conjectures: First, countries choosing to peg their currencies are able to effectively insulate their external relative prices against transitory CTOT shocks. Second, countries in Latin America have an alternative way of buffering against CTOT shocks through active international reserve management under exchange rate flexibility. These policies seem to be similarly effective for a level of reserves over GDP (13 percent), a level that is far below the mean level of reserves in other emerging regions, such as Asia (20 percent) or East Europe (17 percent). Finally, most of the effectiveness of active reserve policy comes from absorbing the pressure off the nominal exchange rate (see Figure 8)[15].

VI.- Robustness checks

VI.1 Trade Open vs. Trade Closed Economies:

Access to international markets may help countries moderate the volatility of real exchange rates, although it may also increase the country exposure to large changes in terms of trade. Column 1 of Table 8 give us the adjustment coefficients for Latin American economies with interaction dummies for country/periods relatively open to international trade.[16] From these coefficients, we observe that REER in relatively trade closed countries are subject to larger reactions from CTOT shocks. A plausible explanation being that undeveloped trade sectors may enjoy higher potential productivity, improvement in the terms of trade in the face of these potential returns would lead to a stronger shift of resources towards those sectors amplifying the regular transmission mechanism through larger increases in the price of non-traded goods and, thus, larger real appreciations.

The role of international reserves buffering from CTOT shocks among relatively closed economies is substantial. Given the IRF represented in Figure 9, a 20 percent CTOT shock in representative relatively trade closed Latin American economy with low holdings of

[15] We know that there must be also a price mechanism since there is, albeit small, a buffering effect from an increase in reserves in the fixed exchange rate case.

[16] 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%. See list of "Trade Open" Economies and Periods in Table 11. We run sensitivity analysis around this figure without any major changes in our main results.

international reserves (3 percent of GDP), generates a real appreciation of 89 percent after one quarter. The real appreciation suffered by the same country with large holdings of reserves (13 percent of GDP) would be much smaller, 7.6 percent, peaking at 8.9 percent in the second quarter. As before, holding more reserves also lowers the volatility of REER from 21 percent to 3.2 percent. In the case of relatively trade open economies, not only we observe a much weaker relationship between REER and CTOT shocks, but also reserves seem to play a minor role. The same 20% CTOT shock would generate a 16.5% real appreciation for low reserve holders while holding large amounts of reserves would help buffer the real appreciation but only down to a 10%. Volatility is reduced, from 5 to 3.7 percent. A much smaller effect than the one displayed in relatively trade closed economies.

VI.2 The Degree of Financial Integration

Adjustments of the REER in financially integrated economies may differ significantly from relatively close economies. On the one hand, access to international capital markets is of vital importance for developing economies in order to hedge against large changes in international prices. On the other hand, developing countries exposed to volatile "hot money" flows may be subject to large, uncontrolled financial inflows or outflows after shocks to their terms of trade, inducing higher REER volatility. Interestingly, our empirical results show very little (not significant) differences in the adjustment patterns between capital open and capital closed economies. Column 3 in Table 8 shows that while the coefficients in our regular adjustment components are significant all the interaction terms with the "Capital Openness" dummy are small and insignificant.[17]. Figure 10 shows that, in a financially open country with low stock of reserves (3 percent of GDP), a 20 percent CTOT shocks would cause a 23 percent real appreciation. The same country, with a relatively large stock of reserves (13 percent of GDP), would only suffer a real appreciation of 13 percent. High stock of reserves reduces the REER volatility from 9 to 4.8 percent.

VI.3 Institutional Quality

[17] We define our "Financially Integrated" dummy as 1 for observations with private gross capital flows in excess of 25 percent of GDP and zero otherwise. 25 percent of GDP represents the top 10 percent of private gross flows observations in the region and its about 1 standard deviation above the median. See table 11 for "Capital Open" economies and periods. As with our measure of trade openness we run robustness checks around this definition without major changes in our results.

Institutional quality may have a profound impact on the adjustment patterns of REER. Corruption, risk of repudiation on government contracts or low investment profile could render many government policies completely ineffective to deal with external macroeconomic shocks. The lack of credibility or willingness may cause fiscal policy as well as exchange rate policy or trade policy to fail in their effort to buffer the economy against CTOT shocks. In these circumstances, Reserve management, a fairly visible policy which has been respected by Latin American economies, may provide an efficient alternative to the policies mentioned above. In order to investigate the effects of reserve management across different levels of institutional quality, we build an *Institution Quality Index*. This variable acts as a proxy for conflict-management institutions. The methodology follows from Rodrik (1998) and Knack and Keefer (1995), and the raw data originates from the International Country Risk Guide (ICRG). This index is based on underlying numerical evaluations relating to the rule of law, bureaucratic quality, corruption, expropriation risk, and governmental repudiation of contracts. It ranges from 0 to 7, with higher values indicating superior institutions.

In the second column of table 8, we show the coefficients of our full specification regression including interaction terms with a "Good Institutional Quality" dummy variable that takes the value of 1 if the *Institutional Quality Index* score is above the median (*High quality*) and 0 otherwise[18]. Building the IRF from these coefficients in figure 11, we show that Latin American economies with relatively poor institutions suffer a larger (although not statistically significant) initial reaction to CTOT shocks. The major statistically significant impact made by institutional quality is an increase in the persistence of CTOT shocks that combined with a decrease in the speed of adjustment decreases the overall volatility of REER. Applying the typical 20 percent CTOT shock if the average "Bad Institutional Quality" Latin American economy increases international reserve holdings from 3 percent of GDP to 10 percent, we would observe a decrease in REER volatility from 9.3 to 5.8 percent, on the other hand, those countries with relatively good institutions would experience a decrease in REER volatility from 9.5 to 3 percent. Although we observe that Reserves may play an important role in buffering the CTOT shock in economies with poor institutions,

---

[18] The Median Value of our Institution Quality Index in Latin America comes to be 4.0. See Table 12 for a list of "Good Institutions" economies and periods

reducing the initial reducing significantly REER volatility, its in countries with institutional credibility were, again, we observe the most beneficial effects from reserve policy.

VI.4 Government Debt

As in the case of economies with relatively poor institutions, countries with high government debt could have difficulties applying effectively fiscal policies to contain the effects of CTOT shocks into the economy. Reserve management could provide an effective alternative. Column 4 in Table 8 gives us the REER adjustment coefficients interacted with a High Government Debt Dummy[19]. Looking at the IRF represented in figure 12, generated from the fourth column in Table 8, we observe that countries with high government debt suffer larger REER adjustments to CTOT shocks than countries with low government debt. Reserve Management proves once more to be an effective policy to buffer REER from CTOT shocks; this is especially true for high government debt economies. A representative Latin American economy with high debt and low stock of international reserves would suffer, in average, a 40 percent real appreciation after a 20 percent CTOT transitory shock. The same economy with high holdings of reserves would only suffer a 9 percent real appreciation. High reserve holdings reduce the REER volatility, from 12 to 4 percent. Countries with low government debt experience a much smaller improvement, protecting their REER from CTOT with the boost in reserves.

VII. Active use of reserve accumulation

So far we have studied the ability of countries with large *stocks* of international reserves to maintain REER stability. In this section we analyze the effects an active *use* of reserve accumulation aimed at smoothing REERs. The main difference between the analysis in this section and our previous discussion is that we now focus on the *change* in reserves, as opposed to the *level* of reserves.[20]

A priori, the "reserves buffer" would seem to matter more when intervening to support a weak currency (as in the past) rather than intervening to slow down the pace of appreciation (as recently). In order to test this assumption we look at the effectiveness of

[19] We consider High Government Debt any amount over 45 percent of GDP. See Table 12 for "High Gov Debt" economies and periods. As ever, we run sensitivity analysis using different values for robustness without any major change in the main results.

[20] We thank Mike Melvin for suggesting us to look into this issue.

“active reserve management” from absorbing the pressure off the nominal exchange rate during positive as well as negative shocks to CToT.

We define our measure of reserve accumulation, ΔRES, as the deviation of current IR/GDP from its long term level (defined as the difference between the actual series from the HP filtered one)[21]. In Table 9 we present the new results from the estimation of a dynamic model similar to that in previous sections

$$\Delta Ln(REER)_{it} = \alpha_i + (\lambda_1 + \lambda_2 \Delta RES_{it-1})\Delta Ln(REER)_{it-1} + \left[\theta_1 + \theta_2 \Delta RES_{it-1} \quad \theta_3 + \theta_4 \Delta RES_{it-1}\right] \begin{bmatrix} ECTREER_{it-1} \\ TCTOT_{it-1} \end{bmatrix} + \beta_4 \Delta RES_{it-1} + \varepsilon_{it} \tag{8}$$

As before we upgrade the model to make a distinction between positive and negative CTOT shocks.

As seen in columns 1-3 the coefficients of the interaction term between change in reserves and CTOT, when the underlying CTOT is positive, is negative and significant, telling us that an accumulation of reserves is required to fend off the appreciation pressure on REER (a positive ΔRES combined with a negative coefficient would effectively buffer the initial real appreciation pressure generated form an increase in CTOT). Meanwhile, contrary with our previous model with *stock* of reserves, we observe that the buffering effect is important, even larger (for the full specification model), under negative CTOT shocks. This translates in the need of a sale of reserves to buffer the depreciation pressure in the REER. For the rest of the model we observe that, while reserves seem to play little to no role in the persistence of the shocks, they seem to significantly slow down the speed of adjustment majorly after negative CTOT shocks. These results seem to support our prior where “leaning against the wind” would seem more effective when intervening to support weak currencies rather than intervening to slow down the pace of real appreciation.

Figure 13 shows the impulse response function of our full specification model (column 3 in Table 9). As may be seen, a positive 20 percent shock to an average Latin American economy would raise the REER 17.7 percent if the country decides not to change

[21] Defining reserve accumulation this way instead of a normal quarter on quarter difference solve two potential problems: a) The series are very volatile when compared to REER or CTOT; much of this volatility, we suspect, comes from reasons other than the stabilization policy we want to uncover. b) There is a "long term" adjustment to higher levels of reserves during most of our sample period.

its international reserves. If, however, the country decides to accumulate international reserves the initial increase in REER is buffered to 14.5 percent increase in the case of an accumulation of 0.5 percent of GDP. If reserve accumulation is 1.5 percent of GDP the REER will rise by 9.3 percent.

As noted, this effect is not symmetric with a negative shock to CTOT. In this case the buffer effect of active reserve policy is slightly larger. For a 20 percent negative CTOT shock, if the country sells reserves for a value of 0.5 percent of GDP, it would reduce the REER depreciation from 13.1 to 10 percent. If the country sells reserves up to 1.5 percent of GDP then it would almost entirely eliminate the transmission of the CTOT shock into the REER with a real depreciation of a mere 3.3 percent.

Apart from buffering the initial shock, the active reserve management reduces significantly REER volatility. In our example above, accumulating reserves by 1.5 percent of GDP during a positive CTOT shock will lower REER volatility from 5.7 to 3.1 percent. Again, the effect is larger for a negative CTOT where selling reserves by 1.5 percent of GDP will drop volatility from 6 to 1 percent.

The final two columns show the full model for two individual Latin American economies with large exposure to CTOT shocks; Chile and Argentina. While Argentina displays all the “correct” signs and significant coefficients for our buffer story, Chile’s results are somewhat puzzling. We suspect that these results depend on the way in which international reserves are measured. Indeed, according to traditional conventions international reserves don’t include assets held by (semi) independent sovereign wealth funds. In Chile this is potentially important since in the last decade its “Copper Fund” has grown very significantly[22]. In order to investigate the role played by Sovereign Wealth Funds, in Section VIII below to deal in some detail with Chile’s case study.

VIII. The role of assets managed through Sovereign Wealth Funds: The Chilean Case

We believe that the Chilean economy deserves a detailed treatment in this section due to two characteristics: (a) Chile is a perfect representative of a small, open emerging market heavily reliant on commodity trade and thus subject to economic instability derived from CTOT shocks. And (b), in the last 25 years Chile has successfully experimented with fiscal

[22] We do include the assets managed by the “FEES” fund from 2006

rules and active management of international reserves through Sovereign Wealth Funds. In particular, in 1985, Chile founded the "Fondo de Estabilización de los Ingresos del Cobre (Copper Fund)" which was transformed into the "Fondo de Estabilización Económica y Social" (FEES) in 2006. The specific question that we want to address is: how has the existence – and management -- of this fund affected REER in Chile.

From the time the Copper Fund was created, the Chilean authorities established a direct relationship between the price of copper (its main commodity export) and accumulation of foreign assets. Furthermore in 2001, the government of President Ricardo Lagos introduced a fiscal rule based on a structural surplus of 1 percent of GDP. As Andrés Velasco and Eric Parrado noted[23]:

> *"The evidence suggests that the Chilean economy has become more resilient to external shocks. An interpretation that helps reconcile these facts is that policy actions can play a role as shock absorbers. Improved resilience to external shocks may result from policy actions that more effectively stabilize output, which would be manifested, for example, in a shift in the policy component from procyclical (positive correlation with the output gap) to countercyclical (negative correlation)"*.

In Figure 14 we present the evolution of CTOT in Chile against the accumulation of the assets held by the "Fondo de Estabilización Económica y Social" (FEES) from its founding year in 2006 up to the end of 2010. In spite of the fact that the fiscal stabilization policy of 2001 does, a priori, mark a weak relationship between asset accumulation and CTOT shocks[24], we observe that, given the importance played by the price of copper in determining the underlying structural surplus of the country, fiscal rules forced a reserve accumulation in

[23] See Velasco & Parrado

[24] The methodology devised in 2001 by the Budget Directorate to compute the structural balance consisted in (i) estimating ex-ante the expected structural revenues E(SRt), i.e., the revenues that the government would have achieved if the economy was operating at potential and the copper price was at its long-term level; (ii) subtracting from the expected structural revenues the structural balance (SBt, e.g., a 1 percent of GDP surplus as originally envisaged in 2001); and (iii) calculating the expenditures (Et) as a residual, according to the following formulae:

$$Et = E(SRt) – SBt$$

$$E(SRt) = E(Rt) – E(At) = E(Rt) * (Yp /Y)\varepsilon$$

where E(SRt) will equal the expected government revenues (E(Rt)) minus the expected adjustments for the long-term copper price and the output gap, E(At). Yp is the potential output (that is the maximum output compatible, at any given time, with the absence of unexpected inflation), Y is the actual output and ε is the elasticity of revenues with respect to the output gap (See Teresa Dabán 2011 "Strengthening Chile's Rule-Based Fiscal Framework" IMF WP/11/17 and Marcel, M. Tokman, M, Valdes, R., and Benavides, P., 2001, "Methodology and Estimation for the Chilean Central Government 1987–2001," Direccion de Presupuestos, Ministerio de Hacienda).

the FEES fund after large positive shocks to the country's CTOT during the first 3 years of the fund. Later, during the crises, copper prices collapsed causing a large deterioration of Chile's CTOT. Again the FEES reacted to this large swing in CTOT liberating reserve assets in order to protect the fiscal structural surplus. This sale of reserves helped insulate Chile domestic economy from increased volatility in REER.

Figure 15 give us a clear view of this insulating effect going all the way back to the founding of the original Copper Fund in 1985. As Velasco & Parrado noted, the Chilean economy became better insulated to external shocks after the SWF was put into place. Figure 15 shows a break in the correlation between CTOT volatility and REER volatility starting in 1985 (establishment of the Copper Fund). While CTOT volatility continued to be relatively high after 1985, REER volatility remained subdued for the rest of the sample period[25].

In Table 10 we present the results of applying or basic dynamic model to the Chilean economy, using Time dummies to identify a potential break in the relationship between CTOT shocks and REER after the establishment of the Copper Fund. More specifically, we included an interaction term with a dummy for the year 1985 and beyond and a dummy for the year 2001 and beyond. As expected the interaction terms show a clear break in the transmission mechanism between CToT shocks and REER starting in 1985. This effect is reinforced by the 2001 fiscal rule although the coefficient is not statistically significant. Applying the coefficients in column three we would observe a tight correlation between REER and CTOT shocks before 1985 where a 20 percent positive CTOT shock would cause a 48 percent real appreciation. This correlation dissipates after 1985 where the same 20 percent CTOT shock is only accompanied by a mere 8 percent appreciation. Furthermore, if we look at periods beyond 2001 the correlation breaks completely with an expected real depreciation of 3 percent after the positive 20 percent CTOT shock. These results, combined

[25] Looking at the sample means for the volatilities of the series before and after 1985 we observe the large change in REER volatility relative to the change in CToT volatility:

REER VOL AVERAGE <1985	0.071349
REER VOL AVERAGE >1985	0.025696
CToT VOL AVERAGE <1985	0.007085
CToT VOL AVERAGE >1985	0.006667

with the counter-intuitive coefficients for Chile in Table 9, imply that foreign reserves held as part of Sovereign Wealth Funds could be an important part of policies intended to smooth external shocks in the domestic economy. If this is the case, we will need a clear measure of the size of these funds to capture the true effect of these policies

IX. Concluding Remarks

Our paper identified an important role for international reserves and managed exchange rate flexibility in buffering and stabilizing the real exchange rate in the presence of large commodity terms of trade shocks. This result is consistent with the trends observed in the last two decades, where Emerging Markets converge to the middle ground of the Trilemma, opting for greater financial integration *and* larger exchange rate flexibility, buffered by sizable accumulation of international reserves. In principle, the buffering role of reserves may be also provided by sovereign wealth funds, though due to data limitations, we focused only on international reserves. The end of the illusive "great moderation" and the higher volatility of commodity prices suggest greater willingness of Emerging Markets to use financial buffers. Of course, international reserves and sovereign funds may provide buffer services dealing with other shocks, and we don't attempt to identify in this paper the precise share of reserves that are held to deal with any specific buffering role. By the virtue of liquidity, reserves will keep providing time dependent precautionary and buffer services, reducing the vulnerability of emerging markets at times of turbulence[26].

[26] At the core of our buffer story lays the mechanism through which reserve policy reacts to observed or predicted CTOT shocks. Although a different topic and well beyond the scope of this paper, we remain interested in understanding this "Black Box" and we plan to take steps in that direction in future research.

References

Aghion, Philippe, Philippe Bacchetta, Romain Ranciere, and Kenneth Rogoff. 2009. "Exchange Rate Volatility and Productivity Growth: The Role of Financial Development." *Journal of Monetary Economics* 56, 494–513.

Aizenman, Joshua and Nancy P. Marion, 2003,"The High Demand for International Reserves in the Far East: What's Going On?" *Journal of the Japanese and International Economies*, Vol. 17, No. 3, pp. 370–400.

Aizenman Joshua Daniel Riera-Crichton, 2006, "Real exchange rate and international reserves in the era of growing financial and trade integration," *NBER Working paper 12363*.

Aizenman Joshua and Daniel Riera-Crichton, 2008, "Real exchange rate and international reserves in the era of growing financial and trade integration," *Review of Economics and Statistics*, 90: 4, pp. 812-815.

Balassa, Bela, 1964 "The Purchasing-Power-Parity Doctrine: A Reappraisal." J. Political Economy 72, 6: 584—96, December 1964.

Chen Yi-Chin, Kenneth Rogoff and Barbara Rossi . 2010. "Can Exchange Rates Forecast Commodity Prices?" *Quarterly Journal of Economics*, Vol. 125, No. 3,pp.1145–1194.

Dooley, P. Michael, David Folkerts-Landau, and Peter Garber. 2003. "An Essay on the Revived Bretton Woods System." NBER Working Paper No. 9971. Cambridge, MA: National Bureau of Economic Research.

Dornbusch, Rudiger, 1983 "Real Interest Rates, Home Goods, and Optimal External Borrowing." J. Political Economy 91, 1: 141—153, February 1983.

Caballero R. J., 2003, "On the intertemporal financial architecture: insuring emerging markets", NBER Working paper # 9570

Chin, Menzie D., 2006 "Real Exchange Rates" New Palgrave Dictionary.

Edwards, Sebastian, 1984, "The Demand for International Reserves and Monetary Equilibrium: Some Evidence from LDCs" *Review of Economics and Statistics* 66(3), August, 1984.

Edwards, Sebastian, 1989, *Real Exchange Rates, Devaluation, and Adjustment: Exchange Rate Policy in Developing Countries*,, Cambridge, MA: MIT Press.

Edwards, Sebastian, 1994, "Real and Monetary Determinants of Real Exchange Rate Behavior: Theory and Evidence from Developing Countries," in Estimating Equilibrium Exchange Rates, ed. By J. Williamson, IIE.

Edwards, Sebastian, 2004, "Thirty Years of Current Account Imbalances, Current Account Reversals, and Sudden Stops." *IMF Staff Papers* 51 (special issue): 1–49.

Edwards, Sebastian, 2010, *Left Behind: Latin America and the false Promise of Populism*, University of Chicago Press, 2010.

Fischer, Stanley, 2001, "Opening Remarks." IMF/World Bank International Reserves: Policy Issues Forum. Washington, DC.

Flood, Robert, and Nancy P. Marion. 2002. "Holding International Reserves in an Era of High Capital Mobility." In *Brookings Trade Forum 2001*, edited by S. Collins and D. Rodrik.

Frenkel, Jacob A. and Assaf Razin , 1992, Fiscal Policies and the World Economy, 2nd Edition, Cambridge, MA: MIT Press, 1992.

Frenkel, Jacob A. and B. Jovanovic "On Transactions and Precautionary Demand for Money," *Quarterly Journal of Economics* 94, No. 3, August 1980.

Frenkel, Jacob A. and B. Jovanovic "Optimal International Reserves: A Stochastic Framework," *The Economic Journal* 90, June 1981.

Gregorio, J. and Wolf, H. 1994, "Terms of Trade, Productivity and the Real Exchange Rate," NBER working paper

Harrod, Roy F. 1939. International Economics, Cambridge, U.K.: Cambridge University Press,

Hausmann, R., U. Panizza, and R. Rigobon, 2006, "The Long-Run Volatility Puzzle of the Real Exchange Rate," *Journal of International Money and Finance* 25 (2006), 93–134.

Heller, Robert, 1966, "Optimal International Reserves," *Economic Journal*, 76: 302.

IDB (Inter American Development Bank). 1995. Economic and Social Progress in Latin America, Part 2: Overcoming Volatility.

Rogoff, K, Ilzetzki EO, Reinhart CM. 2004. "Exchange Rate Arrangements into the 21st Century: Will the Anchor Currency Hold?" Quarterly Journal of Economics. 119(1):1-48.

Knack, Stephen and Keefer, Philip, (1997), "Does Social Capital Have an Economic Payoff? A Cross-Country Investigation", *The Quarterly Journal of Economics*, 112, issue 4, p. 1251-8

Marion, Nancy P., 1984, "Nontraded Goods, Oil Price Increases, and the Current Account." Journal of International Economics. 16, 1: 29—44, February 1984.

Montiel (1999), "Determinants of the Long-Run Equilibrium Real Exchange Rate: An Analytical Model" in Exchange Rate Misalignment: Concepts and Measurement for Developing Countries, ed. By L. Hinkle and P. Montiel (New York: Oxford University Press for the World Bank)

Neary, Peter E, 1988, "Determinants of the Equilibrium Real Exchange Rate." American Economic Review 78, 1: 210—215, March.

Ostry, Jonathan, 1988 "The Balance of Tnde, Terms of Trade, and the Real Exchange Rate." IMP Staff Papers 35, 4: 541—573, December 1988.

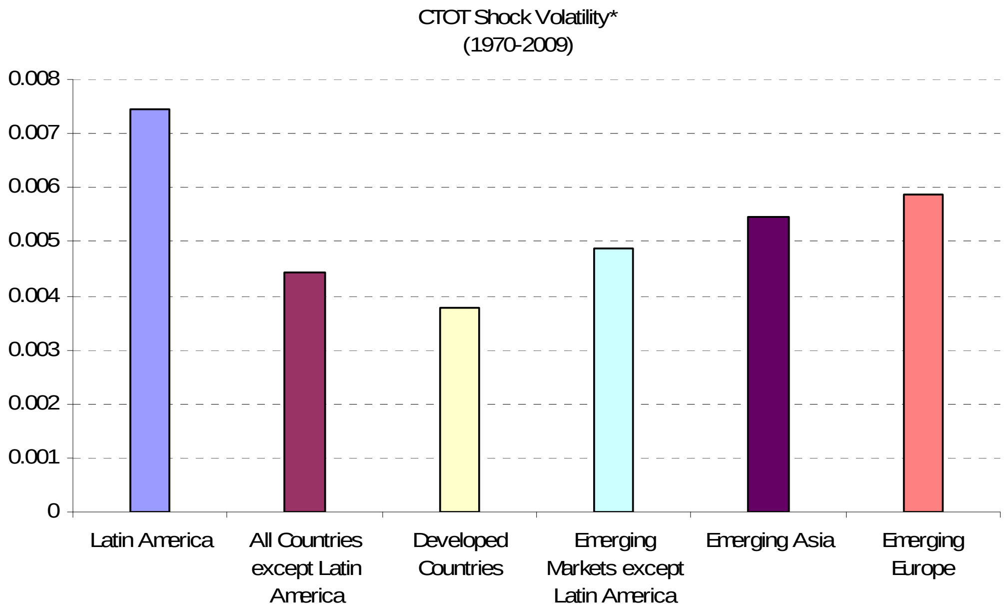
Rodrik, Dani, 1999. " Where Did All the Growth Go? External Shocks, Social Conflict, and Growth Collapses," Journal of Economic Growth, Springer, vol. 4(4), pages 385-412, December

Ricci, L. A., G.M. Milesi-Ferretti, and J. Lee (2008) "Real Exchange Rates and Fundamentals: A Cross-Country Perspective" IMF Working Papers, January 2008 Vol., pp. 1-25.

Samuelson, Paul A., 1964, "Theoretical Notes on 'Trade Problems." Review of Economics and. Statistics 46, 1: 145—154, March 1964.

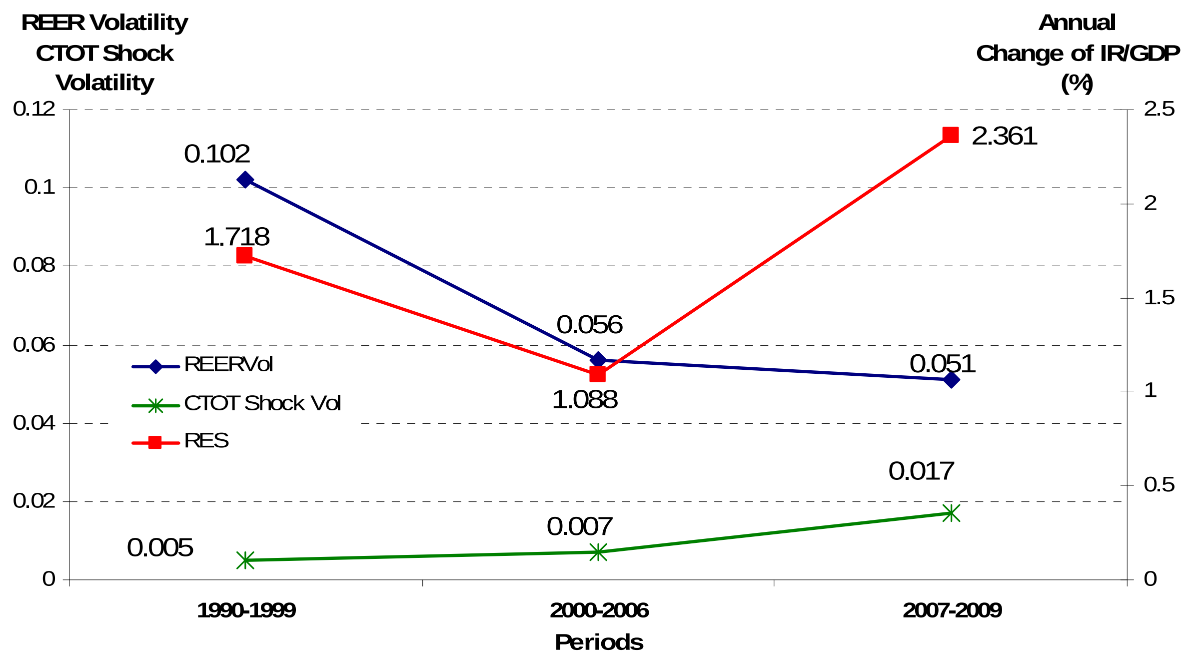
Spatafora, N. and I. Tytell (2009) "Commodity Terms of Trade: The History of Booms and Busts," IMF Working Papers # 09-205.

Figure 1: CTOT Shock Volatility across Emerging Regions



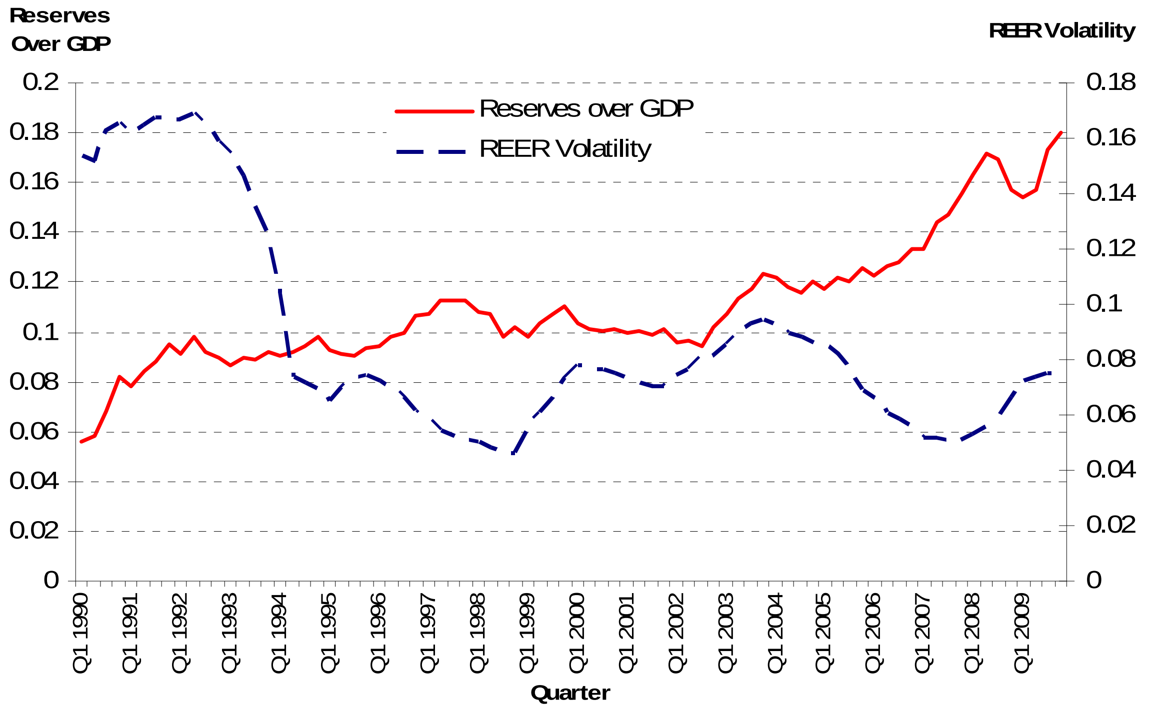
*CTOT Shock Volatility is measured as the standard deviation of ΔLogCTOT

Figure 2: REER volatility, CTOT Shock Volatility and Reserve Accumulation (% Growth of Stock of Reserve over GDP) in Latin America by Periods



CTOT Shock and REER Volatility are measured as the standard deviation of ΔLogCTOT and ΔLogREER respectively. RES corresponds to the average annual change in international reserves over GDP for each sample period.

Figure 3: Evolution of Reserve Stocks vs. REER Volatility in Latin America (1990-2009)



REER volatility is measured as a 5 year rolling standard deviation of REER

Figure 4: IRF to a 20% CTOT shock. Full Sample

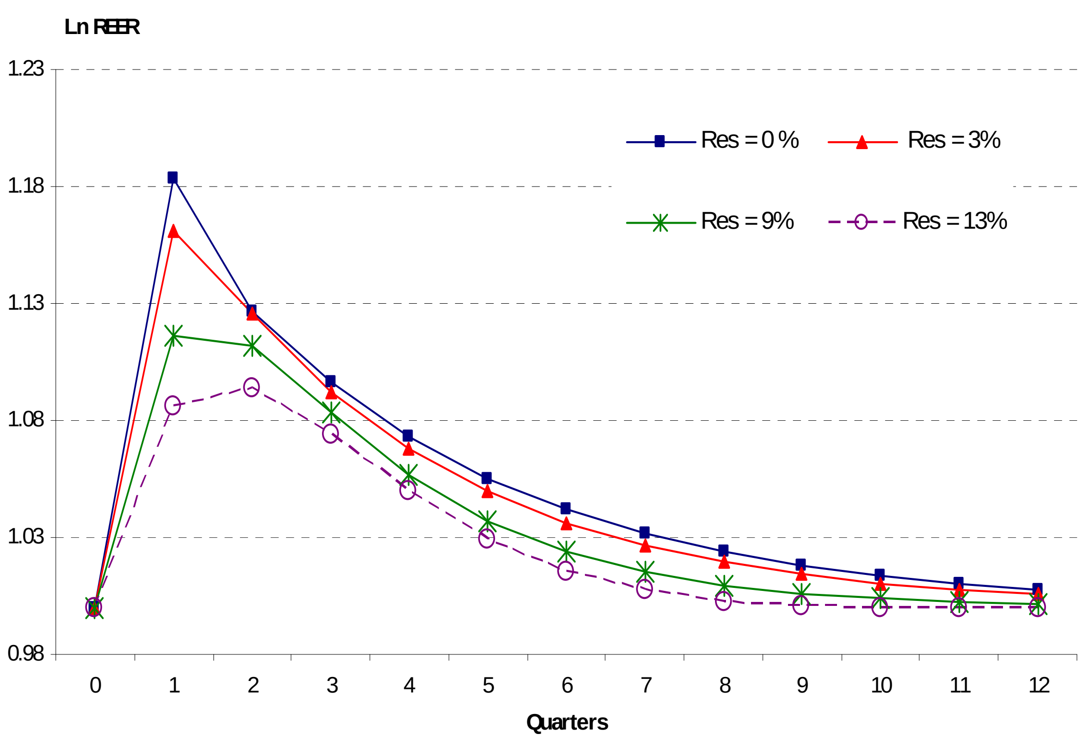
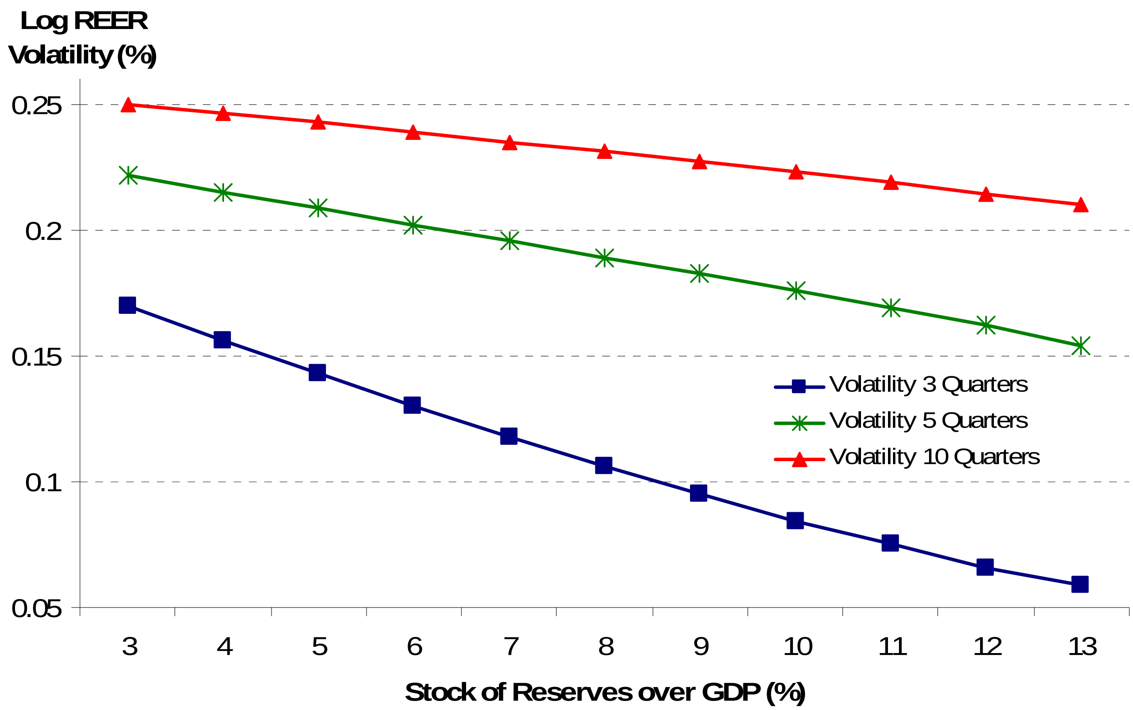


Figure 5: Effect on REER volatility after an average transitory CTOT shock of marginal increases in the Stock of Reserves in the representative Latin American Economy



REER Volatility is calculated as the relative standard deviation (standard deviation divided by the sample average) of the Log REER after a transitory CTOT shock of 3 percent. Volatility is expressed in percentage points.

Figure 6: IRF to a 20% CTOT shock: Split by Decades.

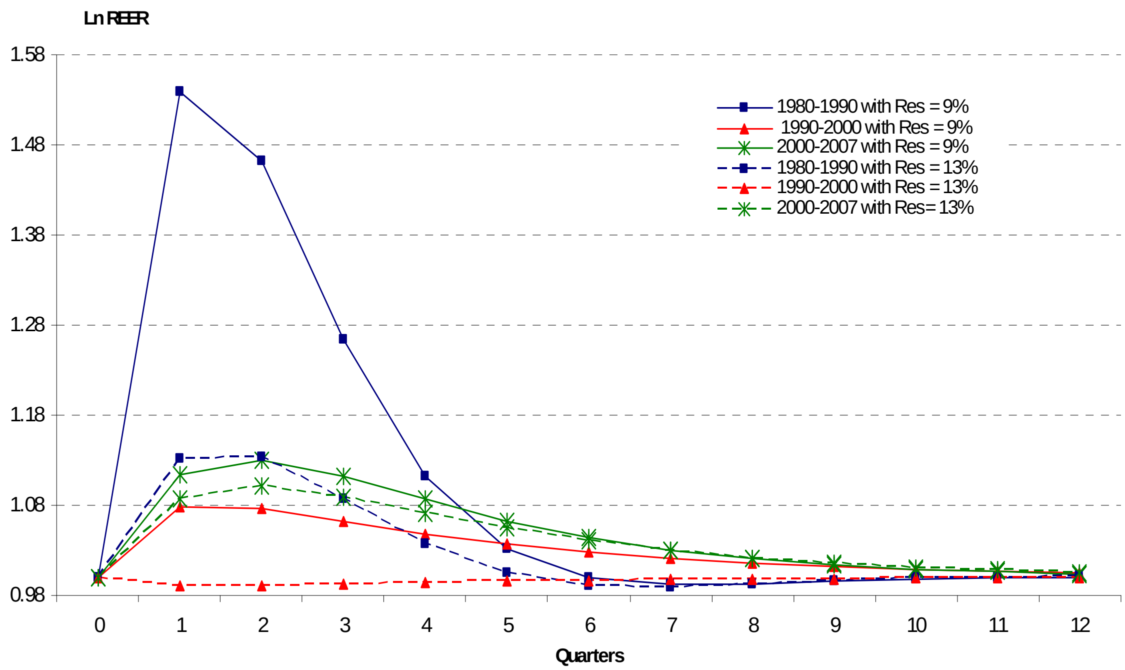


Figure 7: IRF to a 20% CTOT shock: Positive vs. Negative CTOT Shocks

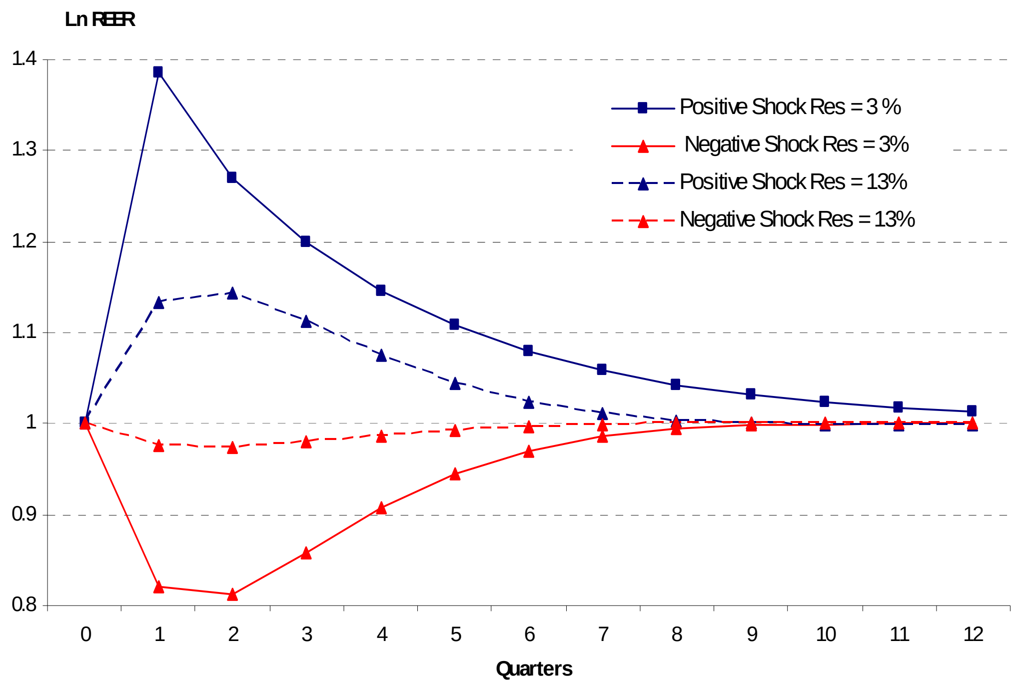


Figure 8: IRF to a 20% CTOT shock: Fixed vs. Flexible Exchange Rate Regimes

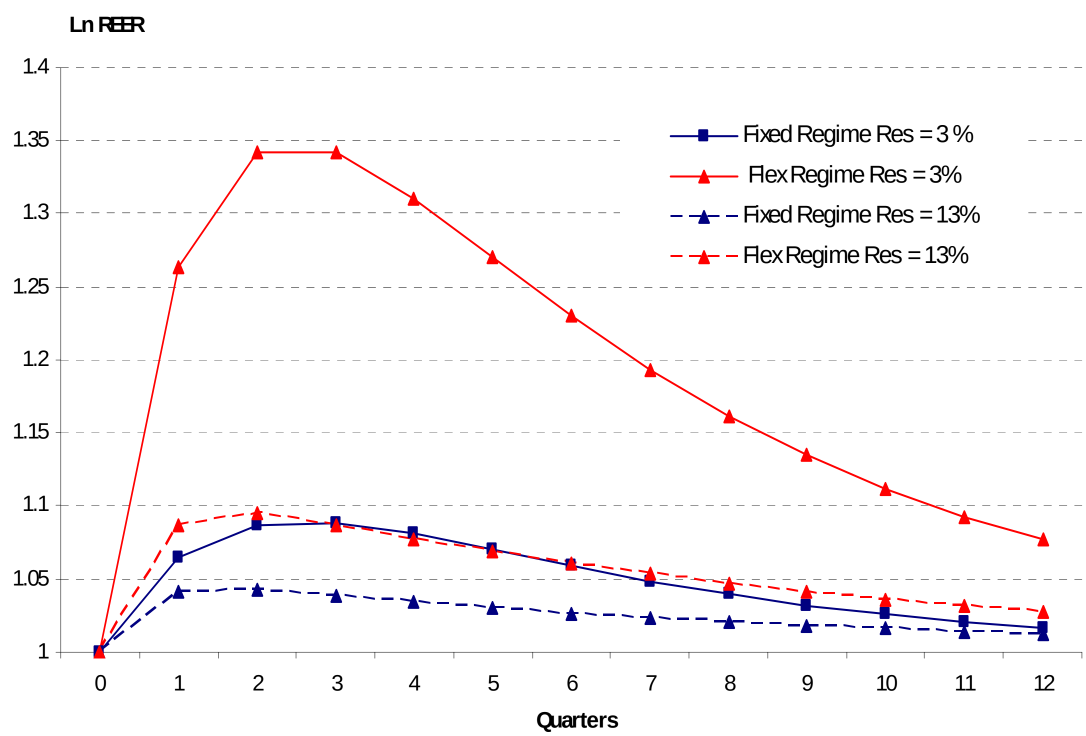


Figure 9: IRF to a 20% CTOT shock: Effects of Trade Opennes

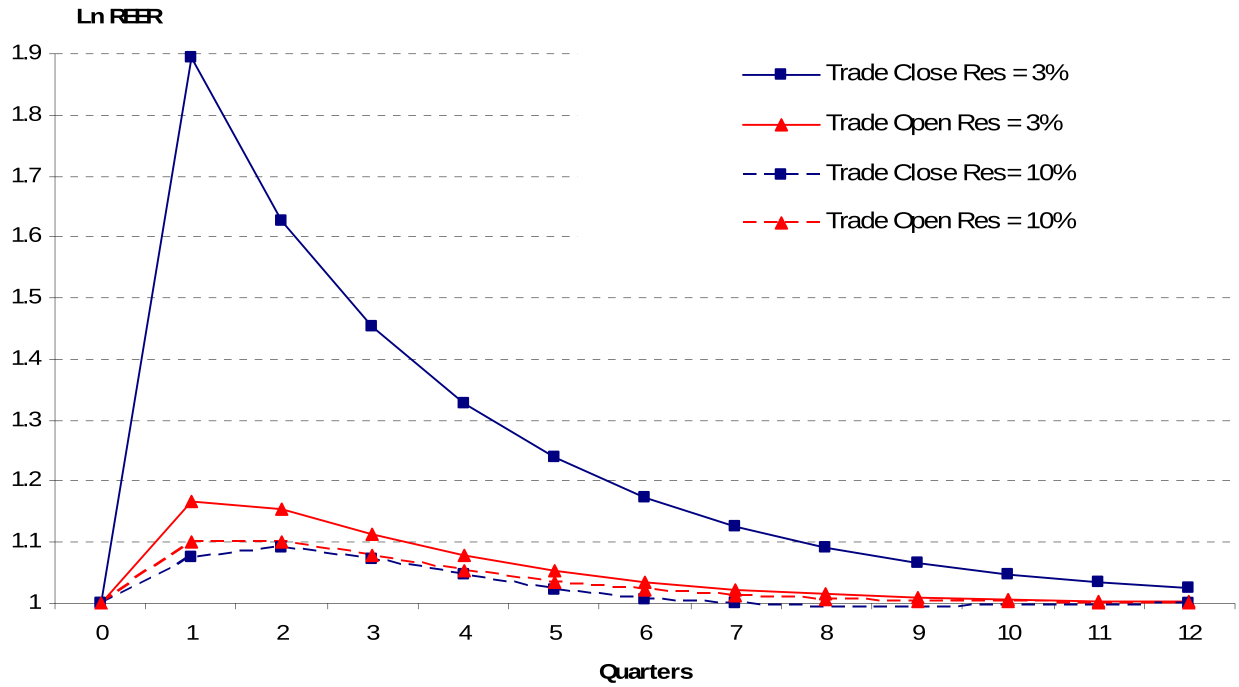


Figure 10: IRF to a 20% CTOT shock: Capital Open vs. Capital Close Economies

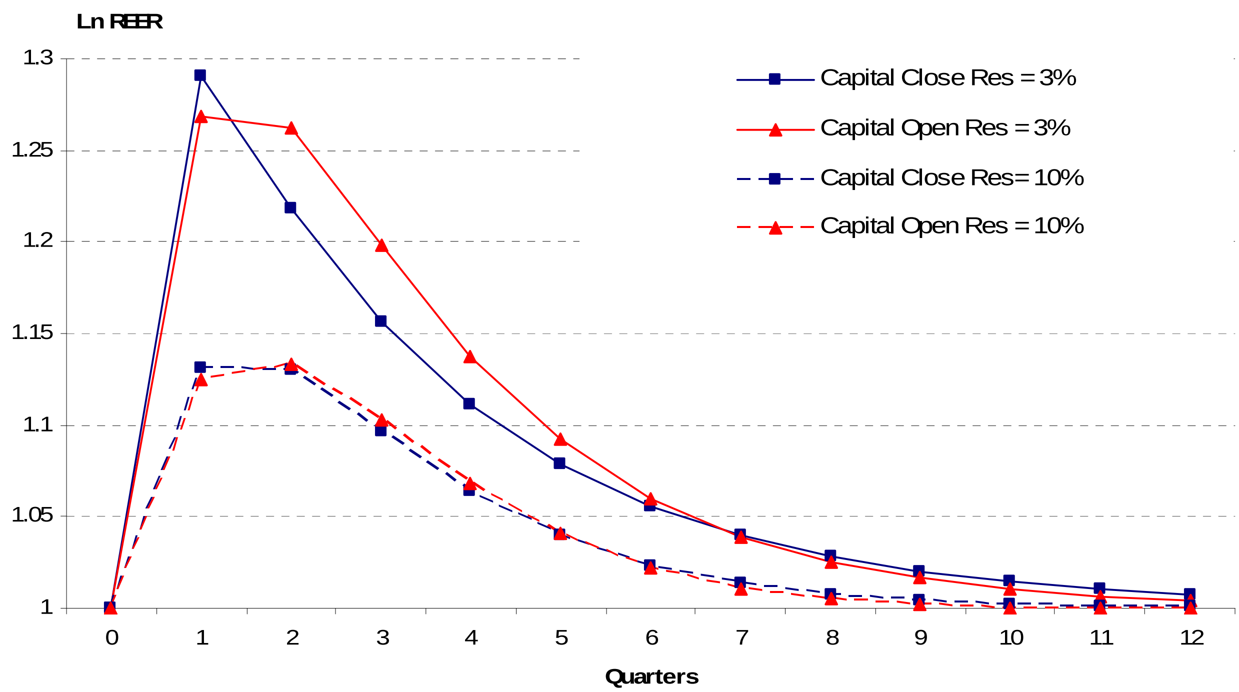


Figure 11: IRF to a 20% CTOT shock: Relatively Good Institutions vs. Poor Institutions.

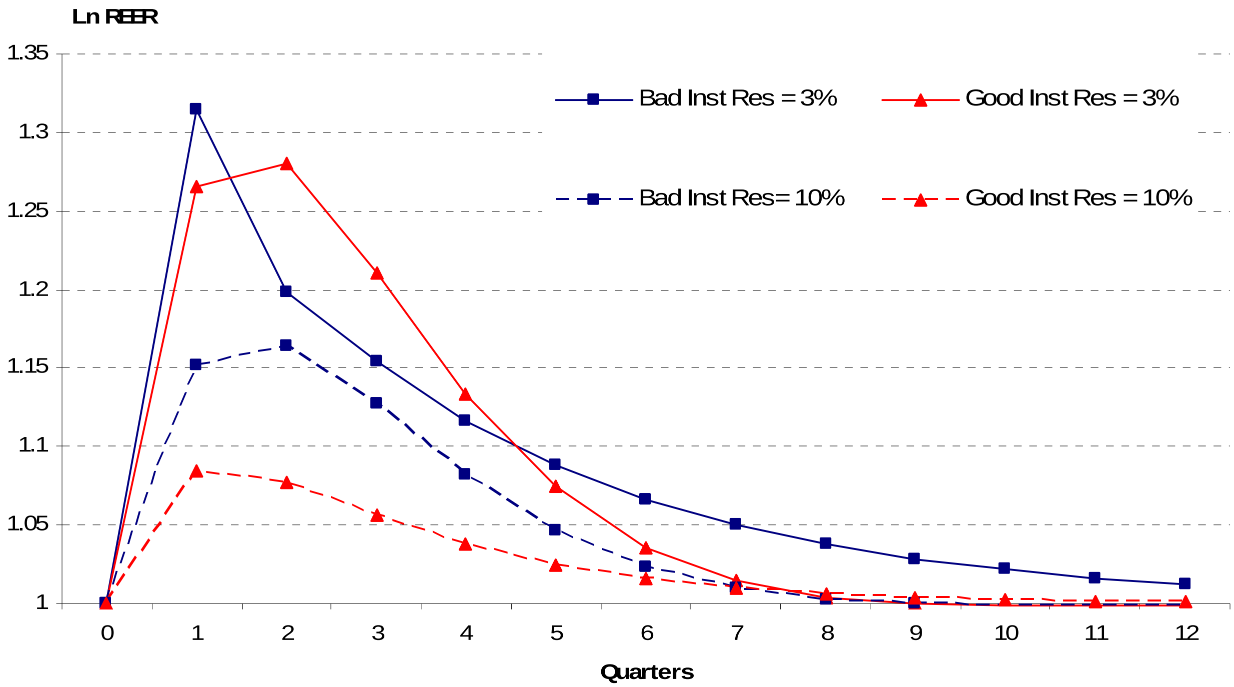


Figure 12: IRF to a 20% CTOT shock: High Government Debt vs. Low Government Debt

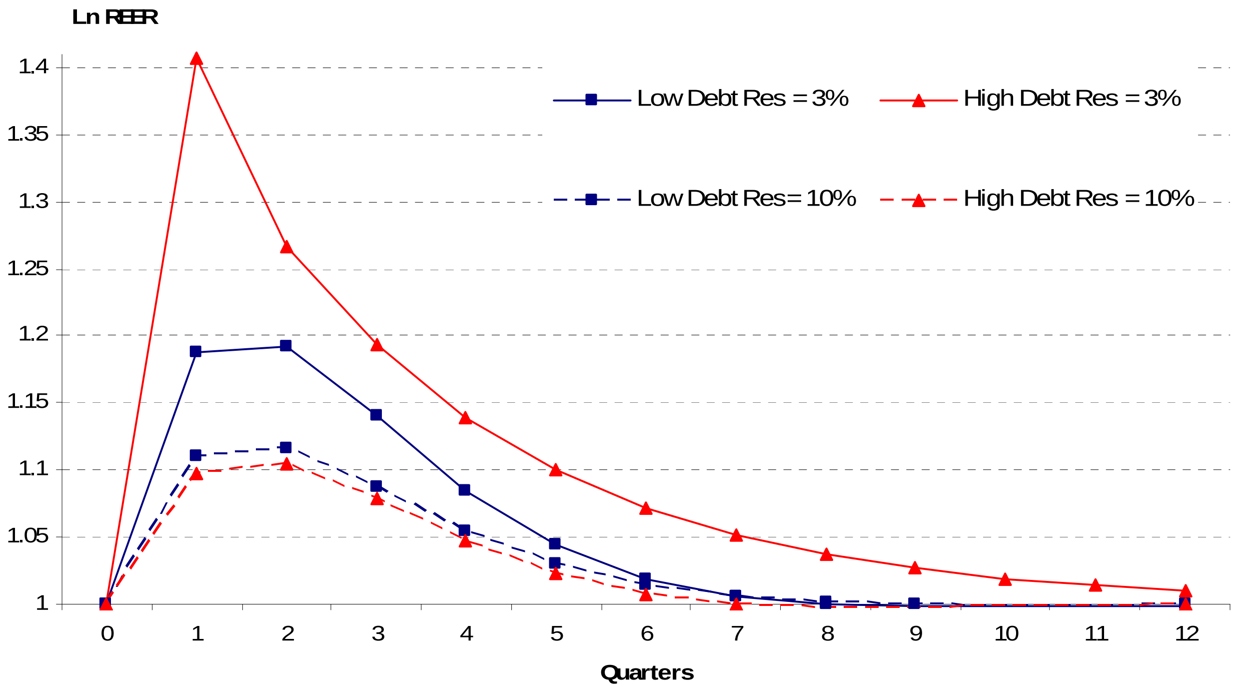


Figure 13: IRF of a 20% CTOT shock with active reserve policy. All LATAM Countries

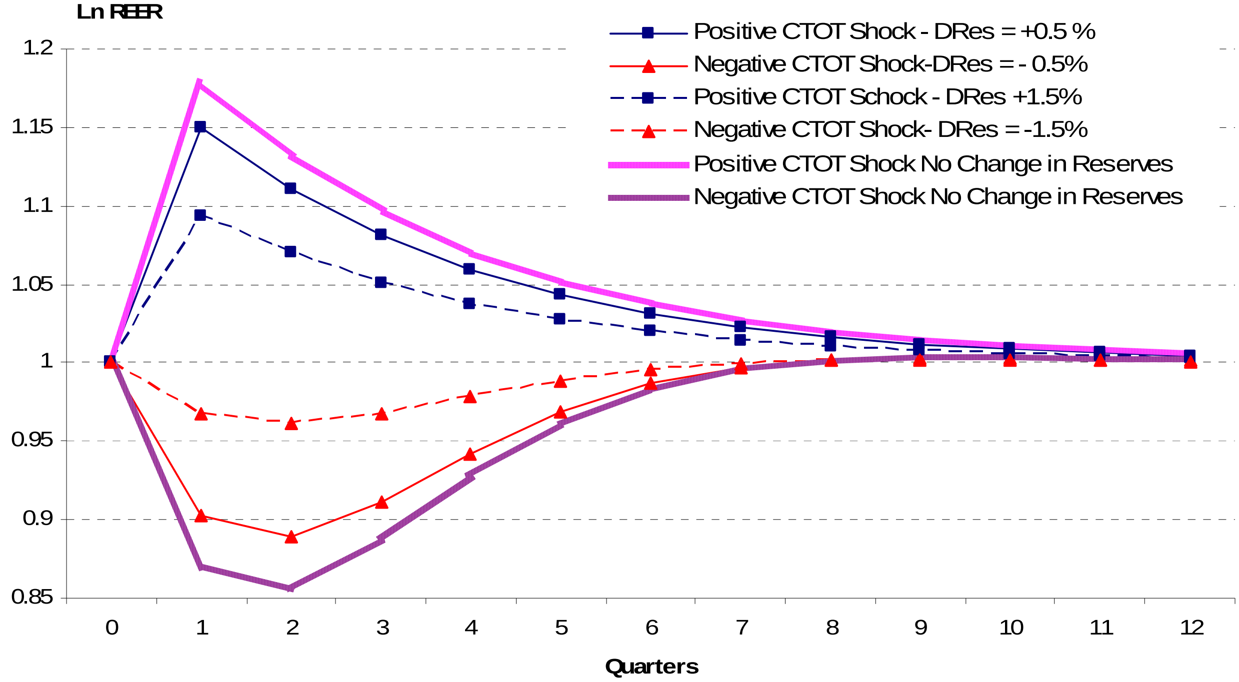
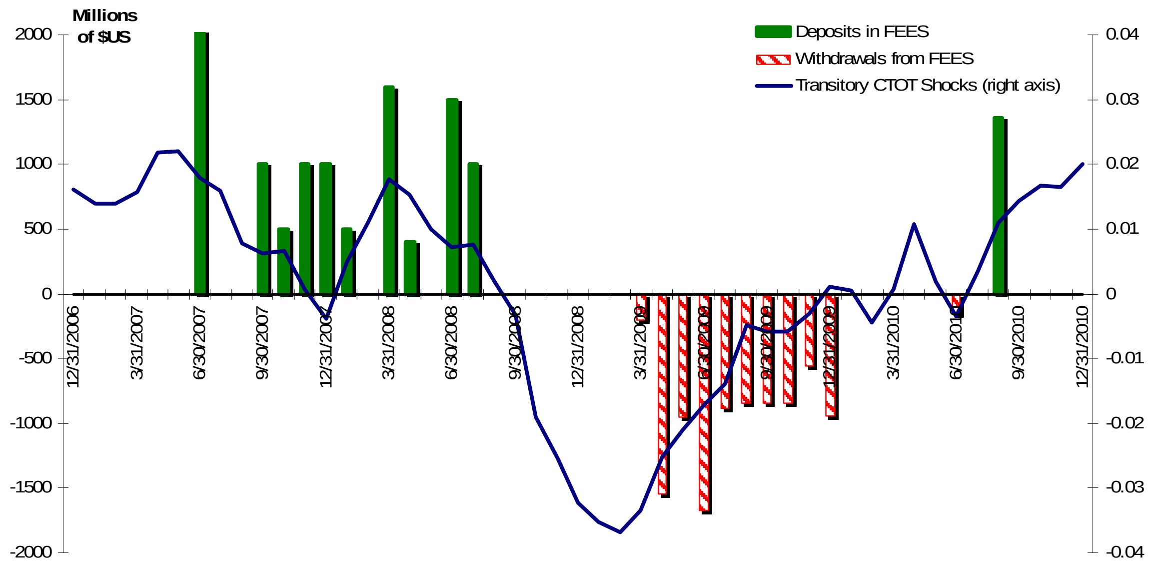
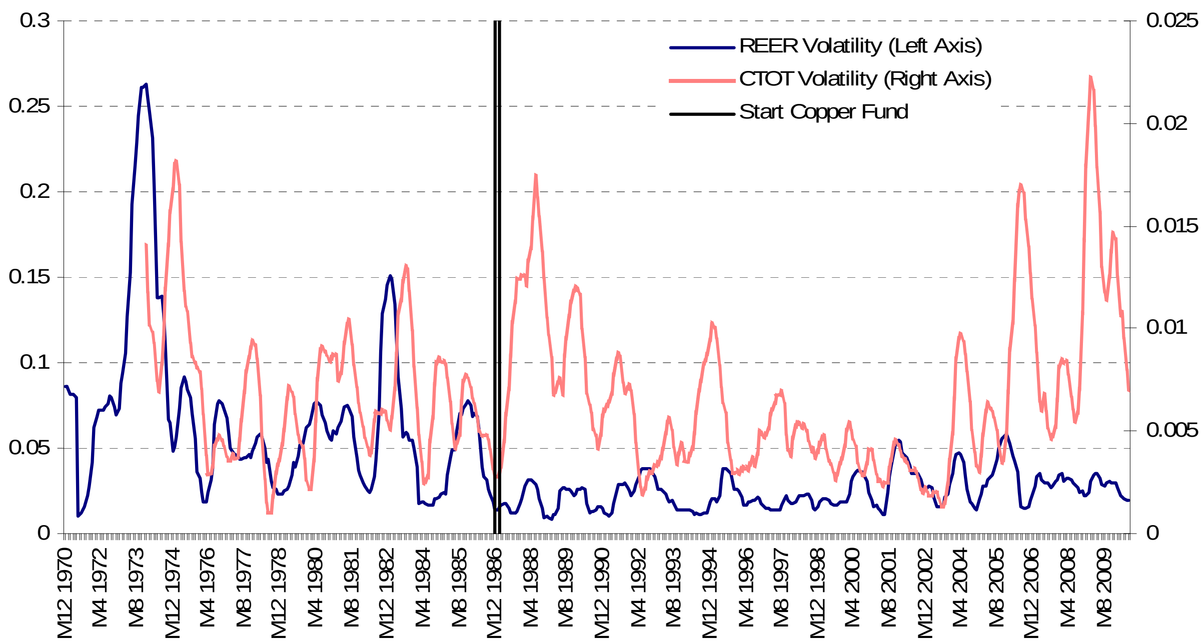


Figure 14: CTOT shocks and the Evolution of the Chilean Sovereign Fund (FEES



Sources: Ministerio de Hacienda de Chile, Executive Monthly Reports on Sovereign Funds.
Transitory CTOT Shocks = log CTOT – HP filtered series, shown in the right axis.

Figure 15: Chile's REER vs. CTOT volatility before and after the establishment of the Copper Fund



Volatility is measured as the rolling 3 year standard deviation of the each monthly series

Table 1: Summary Statistics for Commodity Terms of Trade Shocks in Latin America

Period	All Periods	1990-1999	2000-2006	2007-2009
Observations	2016	520	416	117
Mean	0.0001	-0.0003	0.0011	0.0001
Std. Dev.	0.0075	0.0054	0.0067	0.0167
Variance	0.0001	0.000029	0.000045	0.00028
Skewness	-0.8619	0.0085	0.3706	-3.2158
Kurtosis	49.143	16.4854	10.76	21.4577

Table 2: Individual Co-Integrating Relations

Dep: LnREER	Ln CTOT	Time Trend	INFL	G	Openness	PGFGDP	Spread	Constant	Obs	R^2
Argentina	-0.443	0.016***	0.058***	0.039	-0.022***	0.194	-0.003***	-25.256*	33	0.87
Bolivia	0.292	-0.03***	-0.035***	0.239***	0.009**	0.311	-0.011***	60.494***	30	0.93
Brazil	-2.888	0.018	0.033	-0.068	-0.022***	0.081	0	-17.685	35	0.51
Chile	1.214	0.046***	0.047***	0.094**	-0.019***	0.224	-0.127	-91.795***	33	0.65
Colombia	0.865***	0.004	0.017***	0.011	-0.035***	0.427	0.376	-7.043	40	0.85
Costa Rica	0.7	-0.004	0.029**	-0.077**	-0.006**	0.346**	0.02	11.139	30	0.6
Ecuador	1.783***	-0.018**	-0.004	-0.13*	-0.022***	0.058	0.06	34.594**	30	0.93
Mexico	0.694*	-0.015	-0.022	-0.433***	-0.002	-1.075*	0.26	33.699*	31	0.74
Nicaragua	-14.539**	-0.03	-0.236**	-0.044	-0.03*	0.08*	0	136.423	22	0.82
Paraguay	0.073	0.001	-0.023	0.145**	-0.001	-1.036	-0.772	2.875	22	0.35
Peru	1.382**	0.021***	0.016	-0.009	-0.02***	-0.205	-0.001	-43.264***	33	0.91
Uruguay	-3.791***	-0.004	-0.004	-0.214**	-0.013***	-0.175	0.493	32.427	30	0.78
Venezuela	1.016***	0.008**	0.018	0.084**	-0.027***	-0.069	-0.033	-14.027**	40	0.86

Table 3: Panel Fixed Effects Regression Coefficient to REER Dynamic Adjustment Equations

	Benchmark Model	Model 1	Model 2	Model 3	Chile	Argentina
Dependent Variable:	**Δ log(REER)**	**Δ log(REER)**	**Δ log(REER)**	**Δ log(REER)**	**Δ log(REER)**	**Δ log(REER)**
Δ log(REER) (t-1)	0.092	-0.054	-0.047	-0.053	0.593***	-0.121
	[0.053]	[0.055]	[0.053]	[0.054]	[0.198]	[0.108]
Δ log(REER) * Reserves (t-1)		2.988***	2.863***	2.965***	-2.437*	7.665***
		[0.750]	[0.742]	[0.771]	[1.235]	[2.520]
ECTREER (t-1)	-0.248***	-0.248***	-0.258***	-0.259***	-0.054	-0.616***
	[0.057]	[0.057]	[0.060]	[0.061]	[0.122]	[0.212]
ECTREER * Reserves (t-1)			0.139**	0.140**	-0.268	5.032**
			[0.059]	[0.056]	[0.780]	[2.258]
Transitory CTOT (t-1)	0.507**	0.475**	0.458**	0.917***	1.411	8.318***
	[0.185]	[0.164]	[0.171]	[0.256]	[1.008]	[3.124]
Transitory CTOT * Reserves (t-1)				-3.750***	-5.89	-48.388*
				[1.096]	[5.380]	[25.403]
Reserves Over GDP (t-1)	0.116**	0.082*	0.06	0.063	-0.189	-2.861**
	[0.045]	[0.039]	[0.040]	[0.039]	[0.592]	[1.317]
Observations	1627	1627	1627	1627	128	128
Countries	14	14	14	14		
R-squared	0.13	0.143	0.145	0.147	0.178	0.341

Fixed Effects Model Robust standard errors in brackets. Sample includes observations from 1970 to 2009
Significant at 10%; ** significant at 5%; *** significant at 1%
ECMREER is the error correction term for REER, CTOT corresponds to Transitory CTOT shocks measured as log deviation from long run series, Reserves corresponds to the stock of International Reserves over GDP (While assets from the Chilean FEES are included the assets allocated to the old Copper Fund in Chile are not included in IR)

Table 4: LSDV Coefficients to REER Dynamic Adjustment Equations: Splits by Period

	1	2	3
	1980-1990	**1990-2000**	**2000-2007**
Dependent Variable:	**Δ log(REER)**	**Δ log(REER)**	**Δ log(REER)**
Δ log(REER) (t-1)	-0.061	0.128	0.306**
	[0.063]	[0.082]	[0.131]
Δ log(REER) * Reserves (t-1)	3.394**	0.458	0.128
	[1.171]	[1.112]	[1.410]
ECTREER (t-1)	-0.451***	-0.210***	-0.222***
	[0.130]	[0.053]	[0.041]
ECTREER * Reserves (t-1)	0.697	0.248	0.488**
	[0.550]	[0.218]	[0.198]
Transitory CTOT (t-1)	7.290**	1.376*	0.884***
	[2.922]	[0.758]	[0.283]
Transitory CTOT * Reserves (t-1)	-51.034**	-10.945**	-3.465
	[22.911]	[4.830]	[2.280]
Reserves over GDP (t-1)	0.519	0.072	-0.142
	[0.375]	[0.099]	[0.144]
Observations	415	546	448
Number of country	13	14	14
R-squared	0.225	0.123	0.202

Fixed Effects Model Robust standard errors in brackets. Sample includes observations from 1970 to 2007
Significant at 10%; ** significant at 5%; *** significant at 1%
ECMREER is the error correction term for REER, CTOT corresponds to Transitory CTOT shocks measured as log deviation from long run series, Reserves corresponds to the stock of International Reserves over GDP

Table 5: LSDV Coefficients to REER Dynamic Adjustment Equations: Positive vs. Negative Shocks

	1	2	3
Dependent Variable:	**Δ log(REER)**	**Δ log(REER)**	**Δ log(REER)**
Δ log(REER) (t-1)	0.079		
	[0.048]		
Δ log(REER) + (t-1)		-0.142**	-0.133**
		[0.060]	[0.059]
Δ log(REER) - (t-1)		0.272***	0.280***
		[0.085]	[0.085]
Δ log(REER) * Reserves + (t-1)		3.671***	3.576***
		[1.187]	[1.175]
Δ log(REER) * Reserves - (t-1)		0.884	0.657
		[0.952]	[0.906]
ECTREER (t-1)	-0.254***	-0.257***	
	[0.062]	[0.061]	
ECTREER + (t-1)			-0.283***
			[0.067]
ECTREER - (t-1)			-0.256***
			[0.056]
ECTREER * Reserves + (t-1)			0.295**
			[0.109]
ECTREER * Reserves - (t-1)			0.111
			[0.093]
Transitory CTOT + (t-1)	1.979**	2.031***	2.305***
	[0.697]	[0.638]	[0.746]
Transitory CTOT - (t-1)	1.635*	1.005	1.124
	[0.806]	[0.632]	[0.898]
Transitory CTOT * Reserves + (t-1)	-8.462**	-9.412**	-12.638***
	[3.506]	[3.499]	[4.144]
Transitory CTOT * Reserves - (t-1)	-12.372**	-6.926*	-7.754
	[4.903]	[3.904]	[5.947]
Reserves over GDP + (t-1)	0.113	0.094	0.104
	[0.083]	[0.079]	[0.079]
Reserves over GDP - (t-1)	0.118	0.103	0.091
	[0.077]	[0.069]	[0.069]
Observations	1501	1501	1501
Number of country	14	14	14
R-squared	0.137	0.161	0.167

Fixed Effects Model Robust standard errors in brackets. Sample includes observations from 1970 to 2007 Significant at 10%; ** significant at 5%; *** significant at 1%
ECMREER is the error correction term for REER, CTOT corresponds to Transitory CTOT shocks measured as log deviation from long run series. Reserves correspond to the stock of International Reserves over GDP.
+ signals a dummy that takes the underlying value of the root variable when the country is undergoing a positive CTOT transitory shock and 0 otherwise. – follows the same definition for negative CTOT Transitory shocks and 0 otherwise

Table 6: Seemingly Unrelated Regressions (SUREG): Latin America 1970-2007

VARIABLES	Argentina Δ Ln(REER)	Bolivia Δ Ln(REER)	Brazil Δ Ln(REER)	Chile Δ Ln(REER)	Colombia Δ Ln(REER)	Ecuador Δ Ln(REER)	Mexico Δ Ln(REER)	Peru Δ Ln(REER)	Uruguay Δ Ln(REER)	Venezuela Δ Ln(REER)
Δ Ln(REER) (t-1)	-0.245*	-0.019	0.301*	0.607**	0.296	-0.173	0.239	0.5***	0.466***	-0.167
	(0.133)	(0.474)	(0.171)	(0.247)	(0.305)	(0.256)	(0.145)	(0.186)	(0.118)	(0.378)
Δ Ln(REER) * Reserves (t-1)	12.1***	3.660	-1.107	-2.203	-2.519	8.025	-0.471	-6.8*	-3.842*	3.727
	(3.368)	(12.561)	(3.362)	(1.531)	(3.114)	(5.229)	(3.633)	(3.836)	(2.335)	(3.304)
ECTREER (t-1)	-0.608***	-0.6***	-0.092	-0.066	-0.034	-0.582***	-0.413***	-1.02***	-0.3***	-0.61**
	(0.122)	(0.173)	(0.102)	(0.143)	(0.161)	(0.134)	(0.105)	(0.144)	(0.090)	(0.248)
ECTREER * Reserves (t-1)	5.350**	-0.257	-1.518	-0.368	-0.204	7.689***	4.960**	7.904***	1.731	3.6*
	(2.125)	(3.823)	(1.960)	(1.062)	(1.665)	(2.775)	(2.079)	(2.242)	(1.162)	(2.002)
CTOT (t-1)	13.7***	10.8**	16.4***	-0.431	3.616	-0.129	11.338*	-3.330	0.116	1.543
	(4.561)	(4.457)	(6.093)	(1.318)	(5.107)	(1.269)	(5.994)	(3.701)	(2.476)	(1.167)
CTOT* Reserves (t-1)	-141.2**	-108.3**	-329.2***	4.382	-22.299	19.670	-134.012	50.878	-16.793	-8.883
	(71.508)	(49.415)	(115.480)	(8.202)	(51.258)	(19.597)	(91.999)	(32.382)	(31.839)	(8.833)
Reserves over GDP (t-1)	-3.038**	0.527	1.675	-0.281	0.292	0.709*	-1.998*	5.356***	-1.724	-2.047*
	(1.382)	(1.348)	(1.742)	(0.812)	(0.974)	(0.368)	(1.196)	(1.585)	(1.094)	(1.191)
Constant	0.346***	0.198***	0.063	-0.048	-0.063	-0.060***	0.185***	-0.690***	0.319***	0.351**
	(0.077)	(0.064)	(0.091)	(0.107)	(0.095)	(0.019)	(0.060)	(0.101)	(0.087)	(0.152)
Observations	107	107	107	107	107	107	107	107	107	107
R-squared	0.342	0.279	0.208	0.144	0.178	0.400	0.229	0.337	0.164	0.141

Robust standard errors in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%. To maximize the number of observations we have excluded Panama, Nicaragua, Costa Rica and Paraguay from the regression. ECT refers to the Error Correction Term and represents the log distance between the actual value and its long run estimate. CTOT refers to transitory shocks to CTOT calculated as the log distance between actual CTOT and its long run value. Reserves correspond to the stock of International Reserves over GDP.

Table 7: LSDV Coefficients to REER Dynamic Adjustment Equations: Fixed vs. Flex Exchange Rate Regimes

	1	2	3
Dependent Variable:	**Δ log(REER)**	**Δ log(REER)**	**Δ log(REER)**
Δ log(REER) (t-1)	0.269***		
	[0.048]		
Δ log(REER) * Fixed (t-1)		0.531***	0.526***
		[0.124]	[0.132]
Δ log(REER) * Flex (t-1)		0.453**	0.450**
		[0.187]	[0.184]
Δ log(REER) * Reserves * Fixed (t-1)		-3.007**	-2.967**
		[1.103]	[1.179]
Δ log(REER) * Reserves * Flex (t-1)		-2.001	-1.996
		[1.549]	[1.523]
Error Correction Term REER (t-1)	-0.097***	-0.095***	
	[0.022]	[0.022]	
ECTREER *Fixed (t-1)			-0.090***
			[0.023]
ECTREER *Flex (t-1)			-0.090***
			[0.025]
ECTREER * Reserves * Fixed (t-1)			-0.077
			[0.068]
ECTREER * Reserves * Flex (t-1)			-0.029
			[0.103]
Transitory CTOT * Fixed (t-1)	0.502***	0.389*	0.359
	[0.161]	[0.187]	[0.209]
Transitory CTOT * Flex (t-1)	1.733***	1.585***	1.584***
	[0.534]	[0.485]	[0.473]
Transitory CTOT * Reserves * Fixed (t-1)	-2.602**	-1.53	-1.193
	[1.038]	[1.300]	[1.425]
Transitory CTOT * Reserves * Flex (t-1)	-9.856**	-8.816**	-8.862**
	[3.610]	[3.467]	[3.478]
Reserves over GDP * Fixed (t-1)	0.172***	0.174***	0.199***
	[0.037]	[0.038]	[0.051]
Reserves over GDP * Flex (t-1)	0.047	0.052	0.063
	[0.041]	[0.043]	[0.050]
Observations	1089	1089	1089
Number of country	14	14	14
R-squared	0.124	0.133	0.133

Fixed Effects Model Robust standard errors in brackets. Sample includes observations from 1970 to 2007
Significant at 10%; ** significant at 5%; *** significant at 1%
ECTREER is the error correction term for REER, CTOT corresponds to Transitory CTOT shocks measured as log deviation from long run series. Reserves correspond to the stock of International Reserves over GDP. Fixed is a dummy with value 1 if the country follows a fixed exchange rate regime and 0 otherwise. Flex is a dummy with value 1 if the country follows a flex exchange rate regime and 0 otherwise. Given data availability Exchange rate regime classification we run our regression up to 2007

Table 8: LSDV Coefficients to REER Dynamic Adjustment Equations: The effects of Trade Openness, Capital Openness, High Government Debt and Institutional Quality

Dummy X	**X=Trade Open**	**X=Good Inst**	**X=Cap Open**	**X=High Debt**
Dependent Variable:	**Δ log(REER)**	**Δ log(REER)**	**Δ log(REER)**	**Δ log(REER)**
Δ log(REER) (t-1)	-0.207	-0.276**	-0.064	0.304***
	[0.139]	[0.096]	[0.070]	[0.049]
Δ log(REER) * X (t-1)	0.359*	0.650**	0.238	-0.522***
	[0.187]	[0.255]	[0.248]	[0.060]
Δ log(REER) * Reserves (t-1)	6.361*	6.072***	3.105**	0.11
	[3.047]	[1.679]	[1.225]	[0.509]
Δ log(REER) * Reserves * X (t-1)	-5.35	-8.036***	-1.759	5.643**
	[3.341]	[2.558]	[2.211]	[1.874]
ECTREER (t-1)	-0.293***	-0.285***	-0.287***	-0.287***
	[0.074]	[0.062]	[0.066]	[0.073]
ECTREER * X (t-1)	0.045**	0.021	0.053	-0.021
	[0.018]	[0.020]	[0.050]	[0.022]
ECTREER * Reserves (t-1)	0.352**	0.324*	0.330**	0.203
	[0.157]	[0.155]	[0.113]	[0.143]
ECTREER * Reserves * X (t-1)	-0.283*	-0.289*	-0.453	0.097
	[0.151]	[0.144]	[0.303]	[0.223]
Transitory CTOT (t-1)	6.217**	1.921***	1.794**	1.104**
	[2.788]	[0.531]	[0.620]	[0.435]
Transitory CTOT * X (t-1)	-5.251*	-0.2	-0.145	1.6
	[2.958]	[1.797]	[1.282]	[0.991]
Transitory CTOT * Reserves (t-1)	-58.341*	-11.598**	-11.400**	-5.492
	[28.210]	[3.869]	[4.817]	[3.166]
Transitory CTOT * Reserves * X (t-1)	53.686*	-1.408	1.169	-16.695*
	[29.091]	[12.929]	[9.676]	[8.474]
Reserves over GDP (t-1)	0.225*	0.1	0.186**	0.159*
	[0.114]	[0.077]	[0.063]	[0.081]
Reserves over GDP * X (t-1)	-0.161	0.009	-0.234***	-0.139**
	[0.119]	[0.054]	[0.051]	[0.063]
Observations	1501	1182	1501	1426
Number of country	14	14	14	13
R-squared	0.167	0.189	0.162	0.175

Fixed Effects Model Robust standard errors in brackets. Sample includes observations from 1970 to 2007
Significant at 10%; ** significant at 5%; *** significant at 1%
ECTREER is the error correction term for REER, CTOT corresponds to Transitory CTOT shocks measured as log deviation from long run series. Reserves correspond to the stock of International Reserves over GDP. X represents a different Dummy variable for each regression, its definition can be found at the top of each column. The dummy for Trade Openness takes value of 1 if the trade openness index is above 30 % of GDP and zero otherwise. The dummy for Good Institutions takes value of 1 if Quality of Institutions index is above 4 and zero otherwise. The dummy for Capital Openness takes value of 1 if the total private capital flows measure is above 25 % of GDP and zero otherwise. The dummy for High Government Debt takes value of 1 if total Government Debt is above 45 % of GDP and zero otherwise.

Table 9: Panel and OLS regression Using Changes in Reserves

	Model 1 ΔLn(REER)	Model 2 ΔLn(REER)	Model 3 ΔLn(REER)	Chile ΔLn(REER)	Argentina ΔLn(REER)
ΔLn(REER) (t-1)	0.078*				
	[0.042]				
ΔLn(REER) + (t-1)		0.007	0.01	0.228	-0.011
		[0.025]	[0.025]	[0.152]	[0.126]
ΔLn(REER) - (t-1)		0.392***	0.365***	0.244**	0.238
		[0.084]	[0.080]	[0.114]	[0.210]
ΔLn(REER)*ΔRES+ (t-1)		-0.098	0.301	7.439	17.502*
		[2.443]	[2.516]	[6.839]	[10.224]
ΔLn(REER)*ΔRES- (t-1)		5.555	4.442	-15.580**	-13.159*
		[3.782]	[3.523]	[7.387]	[7.441]
ECTREER (t-1)	-0.254***	-0.259***			
	[0.072]	[0.072]			
ECTREER + (t-1)			-0.269***	-0.089*	-0.313***
			[0.074]	[0.047]	[0.101]
ECTREER - (t-1)			-0.254***	-0.118**	-0.301***
			[0.068]	[0.049]	[0.071]
ECTREER*ΔRES+ (t-1)			0.315	-1.02	5.017*
			[0.344]	[3.090]	[2.721]
ECTREER*ΔRES- (t-1)			0.833**	4.54	12.759***
			[0.346]	[3.503]	[4.301]
CTOT + (t-1)	0.840**	0.914***	0.888**	2.081***	5.871
	[0.279]	[0.271]	[0.345]	[0.714]	[5.552]
CTOT - (t-1)	0.586	0.517	0.653	1.433	6.242**
	[0.607]	[0.442]	[0.386]	[1.242]	[2.933]
CTOT * ΔRES + (t-1)	-24.680***	-25.174***	-28.103**	140.160**	185.481
	[7.578]	[7.773]	[9.417]	[67.888]	[311.519]
CTOT * ΔRES - (t-1)	26.104*	24.466**	32.679**	29.974	-787.164**
	[14.362]	[11.189]	[12.153]	[56.337]	[394.590]
ΔRES + (t-1)	0.660**	0.711**	0.697**	-1.325	-2.941
	[0.230]	[0.244]	[0.233]	[2.244]	[2.220]
ΔRES - (t-1)	0.742**	0.589*	0.478**	3.226	-8.504***
	[0.316]	[0.278]	[0.192]	[2.649]	[3.229]
Observations	1447	1447	1447	119	119
Number of country	13	13	13		
R-squared	0.129	0.151	0.159	0.271	0.392

Fixed Effects Model Robust standard errors in brackets. Sample includes observations from 1970 to 2007
Significant at 10%; ** significant at 5%; *** significant at 1%
ECTREER is the error correction term for REER, CTOT corresponds to Transitory CTOT shocks measured as log deviation from long run series. Reserves correspond to the stock of International Reserves over GDP.
ΔRES + takes the value of the percent deviation of current International Reserves (RES) over GDP from its long run value when the country is undergoing a positive CTOT transitory shock and 0 otherwise. ΔRES – follows the same definition for negative CTOT Transitory shocks and 0 otherwise
International Reserves is defined as the sum of total official reserves assets minus gold reported by the IMF's BOPS. In the case of Chile we add the assets managed by the central bank through the "Fondo de Estabilización Económica y Social (FEES)"

Table 10: Dynamic REER Equation for Chile

	ΔLogREER	ΔLogREER	ΔLogREER
ΔLogREER (t-1)	0.28293***	0.19709**	0.18356**
	[0.08127]	[0.08675]	[0.08677]
ECTREER (t-1)	-0.09498**	-0.07481*	-0.06843
	[0.04640]	[0.04272]	[0.04357]
Transitory CToT (t)	0.55418*	2.34488**	2.40957**
	[0.31303]	[0.95192]	[0.95923]
Transitory CToT *1985 (t-1)		-2.13306**	-1.96037*
		[1.01139]	[1.05119]
Transitory CToT * 2001 (t-1)			-0.63075
			[0.68142]
Observations	128	128	128
R-Squared	0.13935	0.17855	0.18294

Fixed Effects Model Robust standard errors in brackets. Sample includes observations from 1970 to 2007
Significant at 10%; ** significant at 5%; *** significant at 1%
ECTREER is the error correction term for REER, CTOT corresponds to Transitory CTOT shocks measured as log deviation from long run series. Reserves correspond to the stock of International Reserves over GDP.

Table 11: Summary Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
Log Change in REER	1795	0	0.083	-0.909	1.529
Log REER	1808	4.62	0.283	2.967	5.562
REER Error Correction Term	1597	0.183	0.624	-1.07	1.275
Transitory CTOT shock	2080	0	0.011	-0.07	0.104
Reserves over GDP	2017	0.091	0.061	0.002	0.442
Fixed Regime Dummy	1388	0.596	0.491	0	1
Flexible Regime Dummy	1388	0.403	0.491	0	1
High Debt Dummy	1880	0.434	0.496	0	1
Trade Openness Dummy	2080	0.367	0.482	0	1
Capital Openness Dummy	1796	0.157	0.364	0	1
Quality of Institutions Index	1300	3.636	0.834	0.75	6

DATA DEFINITIONS AND SOURCES

Real Effective Exchange Rates (REER): The real effective exchange rate index represents a nominal effective exchange rate index adjusted for relative movements in national price or cost indicators of the home country,

$$REER = \Pi_i^t [(e / e_i)(P / P_i)]^{w_i}$$

Where e: Exchange rate of the subject currency against the US dollar (US dollars per rupee in index form); ei: Exchange rates of currency i against the US dollar (US dollars per currency i in index form); wi: Weights attached to the country/ currency i in the index; P: Consumer Price Index (CPI) of Subject country and Pi is the Consumer price index of country i.

An Increase in REER corresponds to a Real Domestic Appreciation.

Data belongs to the IMF International Financial Statistics and JP Morgan (see the following link as an example of metadata for Argentina: http://product.datastream.com/Navigator/EconomicsMetadata.aspx?mnemonic=AGJPMRBTF&category=12&userlanguage=en)

International Reserves

Definition: Stock of foreign reserve assets minus gold end of period, $US.
Source: IMF, International Financial Statistics

Commodity Terms of Trade measure

Definition: is the ratio of a weighted average price of the main commodity exports to a weighted average price of the main commodity imports. It follows the IMF methodology (see Nikola Spatafora and Irina Tytell. IMF WP/09/205).

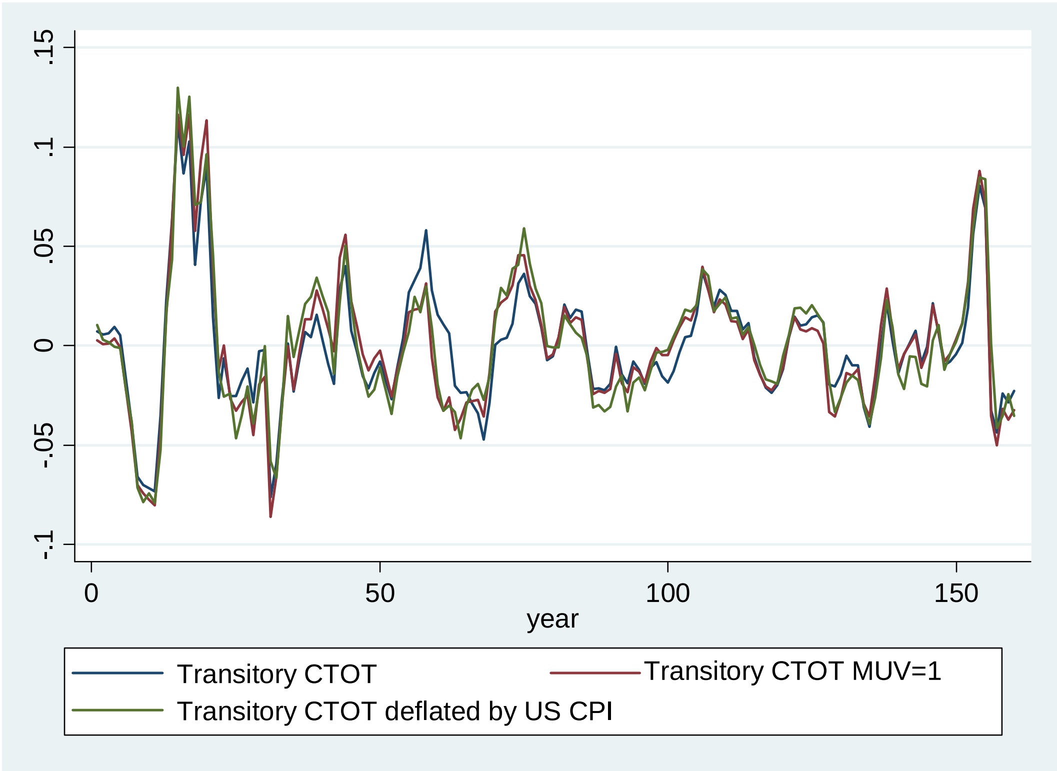
The index is constructed from the prices of six commodity categories (food, fuels, agricultural raw materials, metals, gold, and beverages), measured against the manufacturing unit value index (MUV) from the World Bank. These relative commodity prices of six categories are averaged over the sample period using export and import shares of each commodity category in total GDP as weights. The commodity terms of trade (CToT) index is the ratio of aggregate indexes of commodity exports and imports, as follows: $CTOT_t = \prod_i (P_{it} / MUV_t)^{X^i_{j_t}} / \prod_i (P_{it} / MUV_t)^{M^i_{j_t}}$

where *i* represents the six commodity categories; *X* is the share of exports of commodity *i* in country *j*'s total GDP, and M is the share of imports of commodity *i* in country j's GDP. Giving their nature, weights X and M do not add up to 1. This makes interpretation of the index more difficult but allows us to capture the relative exposure of each economy to relative commodity price changes. Note that $\partial[\ln CTOT_t]/\partial[\ln(P_{it}/MUV_t)] = X^{i}_{j_t}$, hence the appreciation of the price of exported commodity i relative to the manufacturing unit value would 'improve' the CTOT at a rate proportionate to the GDP share of commodity i. It may be viewed as a reduced form measure of the improvement in the external competitiveness of a country in terms of its ability to import manufacturing goods using it's exports of commodity i.

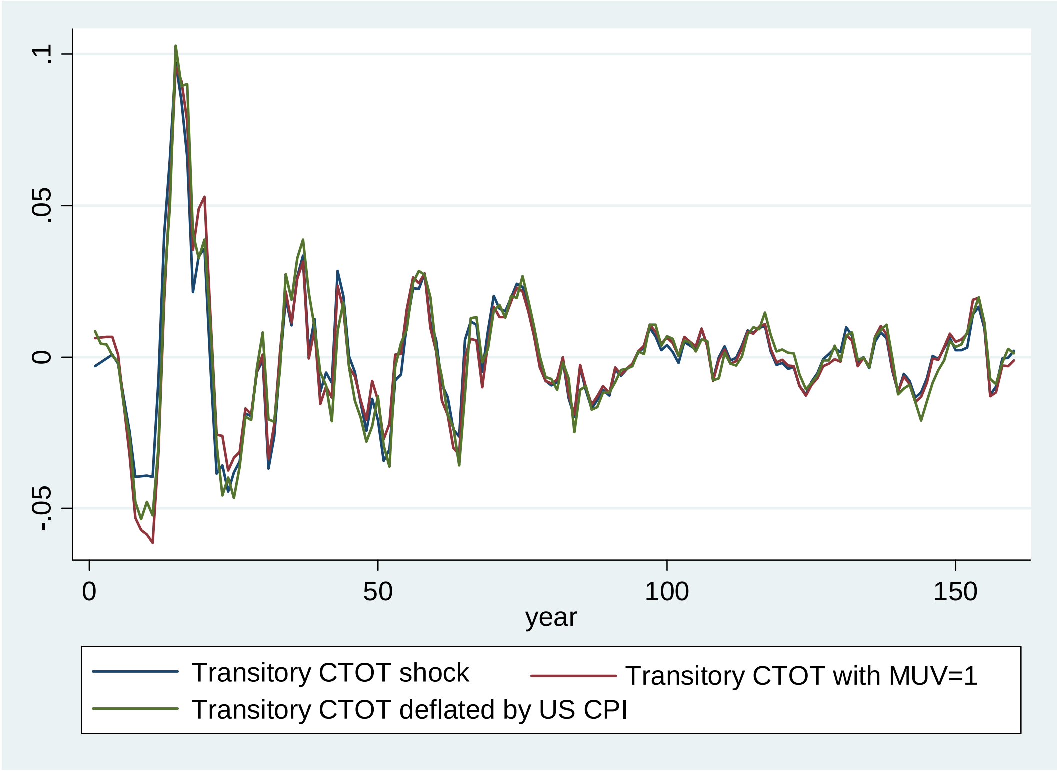
Commodity Prices are originally reported in monthly frequency. We use an average of the three months to calculate the quarterly value of each index. All indexes are rebased to 2005=100. Both, trade data and the Manufacturing Unit Value (MUV) are originally collected in yearly frequency. We use a simple interpolation technique where yearly changes in these variables are evenly spread across all quarters further smoothing these variables across our sample.

Note that using other sensible deflators does not alter the series substantially, see two examples below for Argentina and Brazil were we use MUV=100 and the US CPI index as deflators for commodity prices

ARGENTINA



BRAZIL



Sources:

The prices (Pi) of the six commodity categories are obtained from the database of the RES Commodities Unit.

Exports and imports by commodity category are obtained from the United Nations Common Format for Transient Data Exchange (COMTRADE) data at SITC IInd digit level

Manufacturing Unit Value Index (MUV) is obtained from the World Bank, contact information for this dataset: Elliot (Mick) Riordan, DECPG, eriordan@worldbank.org.

Nominal GDP is measured in $US and its obtained from UN Data

Fixed vs. Flex Exchange Regime Dummies: We use the de facto classification of Ilzetzki, Reinhart, and Rogoff (2009)[27] to determine the exchange rate regime of each country in each quarter. We divided the sample into country-episodes of predetermined exchange rates. For each country we took any 8 continuous quarters when the country had a fixed exchange rate as a "fixed" episode and any 8 continuous quarters or more when the country had flexible exchange rates as "flex". As Fixed regimes we included countries with no legal tender, hard pegs, crawling pegs, and de facto or pre-announced bands or crawling bands with margins of no larger than +/- 2%. All other episodes were classified as flexible. Based on this definition, Eurozone countries are included as having fixed exchange rates. Table 10 below shows the different periods defined as "Flex" or "Fixed" in Latin American economies.

Table 10:Summary of Exchange Rate Regimes

Fixed Exchange Regime			**Flexible Exchange Regime**		
Country	**Start**	**End**	**Country**	**Start**	**End**
Argentina	Q1 1970	Q1 1971	Bolivia	Q1 1971	Q3 1972
Argentina	Q1 1979	Q4 1980	Bolivia	Q1 1975	Q3 1979
Argentina	Q3 1985	Q1 1986	Bolivia	Q1 1987	Q3 1987
Argentina	Q2 1991	Q3 2001	Brazil	Q1 1970	Q1 1975
Argentina	Q2 2003	Q4 2007	Brazil	Q4 1999	Q4 2007
Bolivia	Q1 1970	Q4 1970	Chile	Q1 1970	Q2 1971
Bolivia	Q1 1988	Q4 2007	Chile	Q1 1983	Q4 2007
Brazil	Q2 1986	Q2 1986	Colombia	Q1 1970	Q1 1974
Brazil	Q1 1989	Q1 1989	Colombia	Q4 1983	Q4 2007
Brazil	Q3 1994	Q4 1998	Costa Rica	Q3 1971	Q1 1974
Chile	Q2 1978	Q1 1982	Costa Rica	Q4 1980	Q4 1980
Colombia	Q2 1974	Q3 1983	Costa Rica	Q1 1984	Q4 1990
Costa Rica	Q1 1970	Q2 1971	Ecuador	Q3 1984	Q1 1987
Costa Rica	Q2 1974	Q3 1980	Ecuador	Q4 1993	Q1 1997

[27] Ilzetzki, Ethan, Carmen Reinhart and Kenneth Rogoff (2009), "Exchange rate arrangements entering the 21st century: Which anchor will hold?"(mimeo, University of Maryland and Harvard University).

Costa Rica	Q1 1991	Q4 2007	Mexico	Q4 1976	Q1 1977
Ecuador	Q1 1970	Q3 1971	Mexico	Q2 1994	Q4 1994
Ecuador	Q2 1973	Q4 1981	Mexico	Q2 1996	Q4 2007
Ecuador	Q2 1997	Q3 1997	Nicaragua	Q2 1979	Q2 1982
Ecuador	Q2 2000	Q4 2007	Paraguay	Q3 1973	Q1 1985
Mexico	Q1 1970	Q3 1976	Paraguay	Q3 1986	Q4 1988
Mexico	Q2 1977	Q4 1981	Paraguay	Q3 1999	Q4 2007
Mexico	Q1 1989	Q1 1994	Peru	Q1 1970	Q2 1971
Nicaragua	Q1 1970	Q1 1979	Uruguay	Q1 2002	Q2 2005
Nicaragua	Q3 1991	Q4 2007	Venezuela, Rep. Bol.	Q2 1983	Q3 1986
Panama	Q1 1970	Q4 2007	Venezuela, Rep. Bol.	Q2 1990	Q3 1992
Paraguay	Q1 1970	Q2 1973			
Paraguay	Q2 1991	Q2 1999			
Peru	Q1 1994	Q4 2007			
Uruguay	Q1 1970	Q4 1970			
Uruguay	Q1 1979	Q3 1982			
Uruguay	Q1 1991	Q3 1991			
Uruguay	Q4 1995	Q4 2001			
Uruguay	Q3 2005	Q4 2007			
Venezuela, Rep. Bol.	Q1 1970	Q1 1983			
Venezuela, Rep. Bol.	Q3 1996	Q4 2002			

Trade Openness Dummy: Trade openness is the sum of merchandise exports and imports divided by twice the value of nominal GDP, all in current U.S. dollars. Data for Imports and Exports were extracted from the World Bank WDI database. In order to build or dummy we smoothed the series taking 5 year rolling averages and the extrapolating to obtain quarterly observations, if the value on a given quarter was above 30 percent we consider the country as an open economy and assigned a 1, if the value was below 30 we consider the country a closed economy and assigned a 0 to the dummy variable. Table 11 below shows the periods considered as Trade Open for Latin American economies. We ran robustness checks using a benchmark of 25 and 35 percent of GDP without any substantial changes in our main results.

Capital Openness Dummy: Total gross flows were calculated adding up the absolute value of all liability increases and decreases plus total asset increases and decreases from the capital and financial balance of each country. All data was extracted from the World Bank Development Indicators and from the Balance of Payments Statistics of the IMF. In order to build or capital openness dummy we smooth the series taking 5 year rolling averages and then extrapolating the data to obtain quarterly observations. If the value on a given quarter was above 25 percent of GDP we consider the country as an financially integrated economy and assigned a 1, if the value was below 25 percent of GDP we consider the country a capital closed economy and assigned a 0 to the dummy variable. Table 11 below shows the periods of

Capital Openness for Latin American economies in our sample. We ran robustness checks using a benchmark of 20 and 30 percent of GDP without any substantial changes in our main results.

Table 11: Summary of Trade and Capital Open Economies

Trade Open			**Capital Open**		
Country	**Start**	**End**	**Country**	**Start**	**End**
Argentina	Q1 2005	Q4 2009	Argentina	Q1 2003	Q4 2006
Bolivia	Q1 1970	Q4 1983	Chile	Q1 1984	Q4 1987
Bolivia	Q1 1990	Q4 2009	Chile	Q1 2001	Q4 2003
Chile	Q1 1977	Q4 2009	Chile	Q1 2007	Q4 2009
Colombia	Q1 2008	Q4 2009	Costa Rica	Q1 1982	Q4 1987
Costa Rica	Q1 1970	Q4 2009	Ecuador	Q1 1995	Q4 1999
Ecuador	Q1 1971	Q4 2009	Nicaragua	Q1 1979	Q4 2009
Mexico	Q1 1989	Q4 2009	Panama	Q1 1977	Q4 2009
Nicaragua	Q1 1970	Q4 2009	Uruguay	Q1 2002	Q4 2009
Panama	Q1 1970	Q4 1987	Venezuela, Rep. Bol.	Q1 1990	Q4 1994
Panama	Q1 1992	Q4 2009			
Paraguay	Q1 1990	Q4 2009			
Peru	Q1 2005	Q4 2009			
Uruguay	Q1 1985	Q4 1993			
Uruguay	Q1 2004	Q4 2009			
Venezuela, Rep. Bol.	Q1 1970	Q4 2009			

High Institution Quality Dummy: This dummy it's built from our Institution Quality Index. This index is based on underlying numerical evaluations relating to the rule of law, bureaucratic quality, corruption, expropriation risk, and governmental repudiation of contracts. It ranges from 0 to 7, with higher values indicating superior institutions. The main source for the numerical evaluations of the rule of law, bureaucratic quality, corruption, expropriation risk, and governmental repudiation of contracts is the ICRG dataset. To construct the Dummy variable we assign a value of one to any observation above the median, 4, and zero to the rest. Table 12 below summarizes all the periods of High Institutional Quality among Latin American Economies in our sample.

High Government Debt Dummy: Total (domestic plus external) central government debt is obtained from Reinhart, Camen M. and Kenneth S. Rogoff, "From Financial Crash to Debt Crisis," NBER Working Paper 15795, March 2010. Forthcoming in American Economic Review. To build our High Debt Dummy we assigned a one to all observation where government debt exceeds 45 percent of GDP. All other observations were filled with zeros.

Table 12 below summarizes all the periods of High Government Debt among Latin American Economies in our sample. We ran robustness checks using a benchmark of 40 and 50 percent of GDP without any substantial changes in our main results.

Table 12: Summary of Economies with relatively Good Institutions and High Gov Debt

Good Institutions			**High Government Debt**		
Country	**Start**	**End**	**Country**	**Start**	**End**
Argentina	Q2 1994	Q3 1994	Argentina	Q1 1985	Q4 1993
Argentina	Q3 1997	Q4 2000	Argentina	Q1 2002	Q4 2009
Argentina	Q2 2001	Q4 2001	Bolivia	Q1 1973	Q4 1973
Bolivia	Q3 1997	Q2 2002	Bolivia	Q1 1977	Q4 1979
Bolivia	Q4 2002	Q4 2003	Bolivia	Q1 1984	Q4 2006
Brazil	Q2 1985	Q3 1985	Bolivia	Q1 2009	Q4 2009
Brazil	Q1 1986	Q3 1986	Brazil	Q1 1980	Q4 1988
Brazil	Q2 1987	Q2 1989	Brazil	Q1 1990	Q4 1993
Brazil	Q1 1990	Q4 1990	Brazil	Q1 1996	Q4 2007
Brazil	Q3 1991	Q2 1993	Brazil	Q1 2009	Q4 2009
Brazil	Q2 2001	Q2 2001	Chile	Q1 1986	Q4 1992
Chile	Q4 1989	Q2 1990	Colombia	Q1 2001	Q4 2006
Chile	Q2 1991	Q4 1993	Costa Rica	Q1 1980	Q4 2007
Chile	Q2 1994	Q4 2009	Ecuador	Q1 1982	Q4 2005
Costa Rica	Q2 1990	Q3 2005	Mexico	Q1 1983	Q4 1992
Ecuador	Q4 1997	Q1 1998	Panama	Q1 1976	Q4 1976
Mexico	Q3 1997	Q2 1998	Panama	Q1 1978	Q4 1978
Mexico	Q4 1998	Q4 1998	Panama	Q1 1980	Q4 2008
Mexico	Q3 2000	Q4 2009	Paraguay	Q1 1987	Q4 1991
Nicaragua	Q4 1997	Q4 1998	Paraguay	Q1 2003	Q4 2005
Nicaragua	Q2 2001	Q2 2001	Peru	Q1 1983	Q4 1986
Nicaragua	Q3 2005	Q3 2008	Peru	Q1 1988	Q4 1988
Panama	Q4 1997	Q4 2009	Peru	Q1 1990	Q4 1995
Paraguay	Q1 1992	Q1 1993	Peru	Q1 1999	Q4 2003
Paraguay	Q3 1997	Q1 1998	Uruguay	Q1 1984	Q4 1994
Peru	Q3 1997	Q3 1999	Uruguay	Q1 2002	Q4 2009
Peru	Q2 2001	Q3 2001	Venezuela, Rep. Bol.	Q1 1987	Q4 1998
Uruguay	Q3 1997	Q3 2003			
Uruguay	Q2 2004	Q4 2009			
Venezuela, Rep. Bol.	Q1 1989	Q1 1989			
Venezuela, Rep. Bol.	Q4 1990	Q1 1992			

Interest Rate Spread: Domestic market reference interest rate spread from the 3-month US T-Bill. The market reference could be Treasury Bill Rates, Money Market Rates, Deposit Rates or Discount Rates depending on data availability.

Source: World Bank Development Indicators and the International Financial Statistics of the IMF

Government Expenditure: Government Consumption Share of PPP Converted GDP Per Capita at current prices (%)
Source: Penn World Tables.