This draft: October 29, 2006

MONETARY POLICY CHALLENGES IN EMERGING MARKETS: Sudden Stop, Liability Dollarization, and Lender of Last Resort

Guillermo A. Calvo[*]

Abstract: The paper argues that Emerging Market economies, EMs, face financial vulnerabilities that weaken the effectiveness of a domestic Lender of Last Resort, LOLR. As a result, monetary policy is inextricably linked to the state of the credit market. In particular, the central bank should be ready to operate as LOLR during Sudden Stop (of capital inflows) by releasing international reserves in an effective manner. These conditions also impact on optimal monetary policy in normal but high volatility periods. The paper further argues that during those periods interest rate rules may engender excessive volatility of exchange rates and, thus, that it may be advisable to supplement those rules by foreign exchange market intervention or outright exchange rate pegging. At a fundamental level, the analysis suggests that the state-of-the-arts literature summarized by Woodford (2003) or even more heterodox approaches exemplified by Stiglitz and Greenwald (2003) fall short of providing an adequate guide for monetary policy in EMs.

[*] I am grateful to José De Gregorio, Ugo Panizza, Andrew Powell, John B. Taylor, Rodrigo Valdés, and participants in the Latin American Network of Central Banks and Finance Ministries at the Inter-American Development Bank, Washington DC, October 19-20, 2006, for helpful comments; and especially to Gonzalo Llosa for research assistance and literature search. Usual caveats apply.

I. Introduction

"A nice art collection and quiet surroundings do not a First World central bank make" should be the motto of every central banker in Emerging Market economies, EMs. This is especially true during tranquil times in which interest-rates spreads, both level and volatility, are low, and the central bank easily forgets its role as Lender of Last Resort, LOLR—thus entirely focusing on its role as guarantor of price stability in a full-employment setting. Unfortunately, as the high-volatility episode in May/June 2006 reminded us, tranquil times may quickly turn into periods in which an EM central banker looks more like a high-wire performer without a safety net than a sedate analyst whose primary objective is to find the best specification for a Taylor Rule.

Fortunately, experienced central bankers are well aware of these facts, and have acted accordingly. Since 1998, for example, Latin America has increased its stock of international reserves twofold, while Asia (including China) did so by a factor of three. This followed the Asia 1997 and Russia 1998 crises which left no doubt that a Sudden Stop (of capital inflows) and attendant liquidity crunch can hit both saints and sinners. However, this type of policy reaction is still not totally incorporated in central banks' tool kit—replete with sophisticated analyses on how to implement Inflation Targeting, for example, with little or no reference to financial imperfections in EMs.[1]

The objective of this note is to help to redress the balance by bringing to the fore two distinguishing characteristics of EMs, namely, Sudden Stop and Liability

[1] Céspedes, Chang and Velasco (2001), and Caballero and Krishnamurthy (2005) are exceptions in which the incidence of Liability Dollarization and Sudden Stop are explicitly taken into account.

Dollarization (foreign-exchange denominated debts).[2] Special emphasis will be placed on Domestic Liability Dollarization, DLD, i.e., domestic residents' dollar debts vis-à-vis the domestic banking system. These financial features seriously weaken the central bank's role as LOLR, but have been largely ignored in the literature which, true to form, has focused on issues relevant to mature economies.[3]

Section II will start defining LOLR, and argue that EMs are likely to have a somewhat ineffective LOLR. The discussion will then turn to the use of international reserves during Sudden Stop. It will be argued that proper management of Sudden Stop episodes should be high in the central bank's agenda, because they may deteriorate long-term growth prospects, despite the fact that those episodes are not everyday events. Section III will discuss some aspects of monetary policy under normal conditions, but under the assumption of a largely ineffective LOLR. Section IV concludes.

II. Lender of Last Resort in EMs

1. Lender of Last Resort, LOLR. A LOLR is an institution that is able to lend at reasonable low rates of interest to sectors (public or private) that are seriously credit constrained. Typically, this role is carried out by the central bank (and this will be assumed in what follows).

An effective LOLR either has resources of its own (e.g., international reserves) or is able to borrow in the open market at reasonable interest rates. The US Fed is an example of the latter type. Under these circumstances, the LOLR does not interfere with

[2] In what follows "dollar" will be identified with "foreign exchange." In Eichengreen et al (2005) Liability Dollarization is called Original Sin, instead.
[3] For example, the expression Lender of Last Resort is not in the Index of Woodford (2003), a masterful state-of-the-arts exposition of monetary theory. Neither is the LOLR or related DLD issue treated in Stiglitz and Greenwald (2003), a book that otherwise places great emphasis on domestic financial imperfections.

its role as guarantor of price stability. To a large extent, the two types of activities are independent of one another. This has not been the case in most EMs.

Consider a Sudden Stop episode. The economy as a whole—including the central bank and the other branches of government—undergoes a sudden, highly unexpected, curtailment of international credit (see Calvo, Izquierdo and Mejia (2004) for an empirical definition). Thus, beyond international reserves, central bank loans have to be financed by *seigniorage*, i.e., money printing, interfering with the central bank's role as guarantor of price stability.

The LOLR in EMs may also be ineffective in less extreme cases. Suppose, for example, that there is a run on domestic banks in response to rumors of a financial crisis (i.e., a potential self-fulfilling banking crisis). This is an episode akin to the bank run during the US Great Depression (see Friedman and Schwartz (1963)). An effective LOLR would quickly gain control of the situation by extending necessary loans to banks in order for the run not to cause costly withdrawals of credit lines to the private sector. This operation need not have any impact on prices or the exchange rate because the central bank would simply be accommodating a higher demand for liquidity. The situation would be different, however, if some of the liquidity held by the private sector consisted of foreign exchange, for example, a phenomenon that is denominated Currency Substitution in the literature, and is highly prevalent in developing countries (see Calvo and Vegh (1999)). In that case, increasing *domestic* liquidity may not be neutral as in the previous instance. Unless this operation is swiftly accompanied by foreign exchange

intervention, the increase in domestic liquidity could give rise to a sharp increase in the exchange rates and prices.[4]

Let us now consider the situation one period before the LOLR is called into action, and assume that the private sector is fully aware of this. Under an effective LOLR, the expectation that the LOLR will go into action will come as a relief, since it ensures that a major financial accident will be avoided. However, if the LOLR is ineffective, the situation is radically different. The private sector would realize that very soon the money-printing press will likely go into overdrive, pushing prices and exchange rates sharply upwards. Moreover, if the situation is triggered by Sudden Stop or domestic prices are sticky, the *real* exchange rate will also increase which, combined with DLD, compromises the health of the banking system, potentially paralyzing the payments system. Thus, just a basic understanding of this scenario will drive the private sector to take precautionary action by, e.g., withdrawing bank deposits. Most likely, this will be reflected in higher and more volatile interest-rate spreads, having a negative impact on the credit market, and possibly triggering some early LOLR activity.

2. Sudden Stop: The role of international reserves. A Sudden Stop is, first and foremost, a credit event. Typically, the country as a whole finds itself bereft of dollar credit, and it makes perfect sense that the international reserves of the central bank are made available to the public. Table 1 shows that this has been the general practice during Sudden Stop episodes since 1980 (see Data Appendix). Central banks lost large quantities of international reserves, and neither reserve losses nor exchange rate

[4] To prevent that a change in liquidity composition will bring about a bank run, some central banks have allowed foreign-exchange deposits. Thus, individuals could change liquidity composition from "peso" to "dollar" without withdrawing their bank deposits. A major drawback of allowing dollar deposits is that they are a major factor behind the creation of DLD.

depreciations are significantly different across exchange rate regimes prevailing prior to Sudden Stop.

Table 1: Media Test

EXCHANGE RATE	Maximum Loss of Reserves [a/]	Maximum Loss of Reserves/GDP [b/]	Maximum Nominal Depreciation [c/]
FLEXIBLE			
Mean	-15.435	-1.625	26.435
Standard Error	(3.512)***	(0.365)***	(7.162)***
Observations	30	30	30
FIXED			
Mean	-19.238	-2.267	20.495
Standard Error	(2.246)***	(0.326)***	(8.795)**
Observations	90	87	90
DIFFERENCE BETWEEN FLEXIBLE AND FIXED[d/]			
Mean	3.802	0.643	5.940
Standard Error	(4.388)	(0.595)	(15.816)

[a/] Percentage difference between the minimum level of international reserves during a sudden stop and the pre-crisis level.

[b/] Calculated using 1-year lagged GDP.

[c/] Percentage difference between the maximum exchange rate during a sudden stop and its pre-crisis level.

[d/] Test t of difference in medias.

Note: The exchange rate regime correspond to 1-year lagged of Levy-Yeyati & Sturzenegger's (2005) 3-way classification.

* significant at 10%, ** significant at 5%, *** significant at 1%

Under normal central bank operations, reserves are made available to the public through what is usually called Foreign Exchange Intervention, FXI, which in this case amounts to selling foreign exchange for domestic currency at an exchange rate lower than the one that would prevail *if* the central bank did not intervene. Thus, at the margin,

FXI is tantamount to *fixing* or *pegging* the exchange rate. Table 1 thus implies that, as a general rule, during Sudden Stop central banks are likely to switch to some form of fixed or pegged exchange rate system. Notice that if, contrariwise, the central bank insisted in letting the exchange rate *do all the work*, then international reserves would remain in its vaults, unless, of course, the central bank devises less standard schemes for disposing of international reserves.

An interesting example of non standard ways for disposing of international reserves is an operation carried out by Brazil in August 2002 (see Financial Times (2002)) when the central bank employed some of its international reserves to make loans to the export sector through commercial banks. This operation took place during an incipient Sudden Stop episode triggered by statements from incoming president Lula to the effect that his government might engage in some kind of public debt repudiation. The operation appears to have been very successful.[5]

Assuming that during Sudden Stop it is optimal for the central bank to make its reserves available in order to cushion the effects of international credit crunch, what is better: FXI or directing credit to some critical sectors? FXI has the advantage that the central bank needs to have only limited information about credit markets. But a major disadvantage is that international reserves may just become Capital Flight, and have no positive effect on the real economy. This instance cannot be discounted because during Sudden Stop the private sector operates under "poor visibility"—the Sudden Stop creates serious information gaps that militate against an efficient allocation of resources. Thus, if the central bank believes that it has better information than the market, limited as it might

[5] How common have been these types of directed credit operations in response to incipient Sudden Stop is unknown to me and constitutes an interesting research topic.

be, it may be advisable for the central bank directly to channel international reserves to sectors which, on net, display a positive marginal social return to the use of international reserves (much what Brazil attempted to do in 2002, although in each case not necessarily involving the export sector). Clearly, for the success of this 'surgical' operation, it is necessary for the central bank to be well on top of developments in domestic credit markets, given that, in addition, this operation should be timely. Moreover, every possible measure should be taken to prevent Moral Hazard. Moral Hazard is a key issue, since just the expectation that the central bank will provide "cheap" credit during a Sudden Stop may induce inordinately large risk-taking by the private sector. This is a well known phenomenon in the banking sector, and stands as an important rationale behind bank regulation. Thus, if non-bank sectors are routinely bailed out during Sudden Stop, their debt management procedures should also be subject to government regulation. In this respect, one possible market-friendly type of arrangement might be to ensure credit lines during Sudden Stop only to firms that would be ready to abide by central bank's debt management regulations under normal conditions.

These considerations suggest that for a proper management of monetary policy (including management of international reserves) it is important that the central bank can come into action on the spur of the moment. Thus, a sort of Sudden Stop Drill (much like Fire Drills) should be part of the activities of the central bank during normal conditions. Its payoff could be very large. Not being ready for action could be very costly. According to a recent study by Cerra and Chaman Saxena (2005), deep financial crises are likely to result in long lasting growth decline, which immediately places these crises

in the list of those that are suspect to cause large welfare effects. These are not "purely cyclical" fluctuations that, as argued by Lucas (1995), are likely to entail small welfare losses (equivalent to just fractions of 1 percent of steady-state consumption). Contrariwise, even a small decline in growth potential may bring about large welfare loss, especially if, realistically, growth and discount rates are approximately equal. Therefore, proper management of monetary policy during Sudden Stop may be worth more than long periods of impeccable monetary policy under normal conditions (where fluctuations are likely to be purely cyclical).

III. Normal Conditions but Imperfect LOLR

There is a growing consensus in EMs that some form of Inflation Targeting, IT, implemented by the central bank by means of a reference or policy interest rate (hereon Interest Rate Tweaking, IRT) is a good system for normal and tranquil periods. When volatility is high, though, typically IRT is replaced by other monetary policy instruments—FXI being at the top of the list.[6] For an illustration of this central bank sleight of hands one needs to go no further than the recent turmoil episode in May/June.[7] Unfortunately, IRT is generally identified with "floating exchange rates." Thus, to the man in the street, pegging the exchange rate during market turbulence is tantamount to abandoning floating exchange rates. Since pegged exchange rates have been demonized by the Fund as key factors behind the string of financial crises that started with Mexico's 'Tequila' crisis in 1994/5, the change of monetary policy instruments raises suspicions that policymakers may have lost their way, further contributing to market volatility.

[6] See BIS (2005) for an interesting collection of central bankers' views on foreign exchange intervention.
[7] For example, in June 2006 the central bank of Turkey's net foreign exchange position declined by almost US$ 3 billion in a short span of time, even though the IMF program calls for floating exchange rates.

It seems to me that time is high to clear the air about some concepts that are poorly defined or just wrong, and to try to provide some rationale for instrument switching as the economy transitions between tranquil and turbulent periods in normal times. Hopefully, greater conceptual clarity will help to make instrument switching in the face of high volatility less traumatic.

In the first place, IRT is not equivalent to floating exchange rates. The standard textbook definition of floating exchange rates is a system in which the central bank sets money supply (e.g., monetary base) and exchange rates are determined by market forces. In contrast, IRT sets an intertemporal price, i.e., an interest rate, not a monetary aggregate. It is not hard to show, for example, in standard open-economy models (and abstracting from uncertainty or assuming complete contingent markets) that one could tweak the policy interest rate in order to keep the exchange rate or money supply constant—giving rise to fixed or floating exchange rates as the case may be. Thus, as a first approximation, during tranquil times IRT is a system that encompasses most of the systems discussed in the literature, going from fixed to floating exchange rates. Moreover, when IRT is used to implement Inflation Targeting, then the line between the resulting system and pegged exchange rate becomes really blurry. To illustrate, consider the polar case in which the basket of goods which price index is targeted by IT consists exclusively of foreign exchange (or only pure tradable goods), then IT is equivalent to exchange rate *tablitas* (i.e., preannounced exchange rates) made famous (or infamous) by exchange-rate-based stabilization plans in the Southern Cone during the 1970s and 1980s (see Calvo and Végh (1999)).

There is, however, a subtle difference between exchange rate pegs and IRT, namely, the type of bond being employed. In IRT domestic bonds are typically employed, e.g., central bank debt instruments, denominated in domestic or foreign currency. In contrast, for exchange rate pegs the central bank buys or sells foreign exchange, i.e., it employs foreign bonds.[8] Both procedures yield identical results if domestic and foreign bonds are perfect substitutes—but would be different, otherwise. For example, if the probability of Sudden Stop goes up, interest-rate spreads on domestic bonds may rise sharply, making IRT significantly more costly than pegging. This is an example in which, if authorities believe that the market overestimates the probability of Sudden Stop, it might be optimal to switch from IRT to exchange-rate pegging. If anything, this type of instrument switching would reinforce the implementability of government's targets because it would result in a stronger fiscal stance. In this example the instrument switch involves no fundamentally different monetary policy because objectives are unchanged; the switch is only prompted by cost considerations. This theme, namely, that a switch from IRT to exchange-rate pegging could just be a technicality and not a major monetary policy change, will be a leit motif of the ensuing discussion.

1. Interest Rate Tweaking: A weak instrument during market turbulence? In tranquil times many instruments are good for achieving monetary objectives. Instruments, as captains, are really tested in choppy waters. As noted, IRT can be so effective in tranquil times as to be able to closely mimic any standard exchange-rate system. However, the situation could be quite different during market turbulence if capital markets are

[8] As shown in Calvo (1998) central banks could erase their tracks by recovering the stock of (gross) international reserves by buying back reserves in exchange for domestic bonds. If they did so, then the fiscal implications of the two systems would be essentially the same.

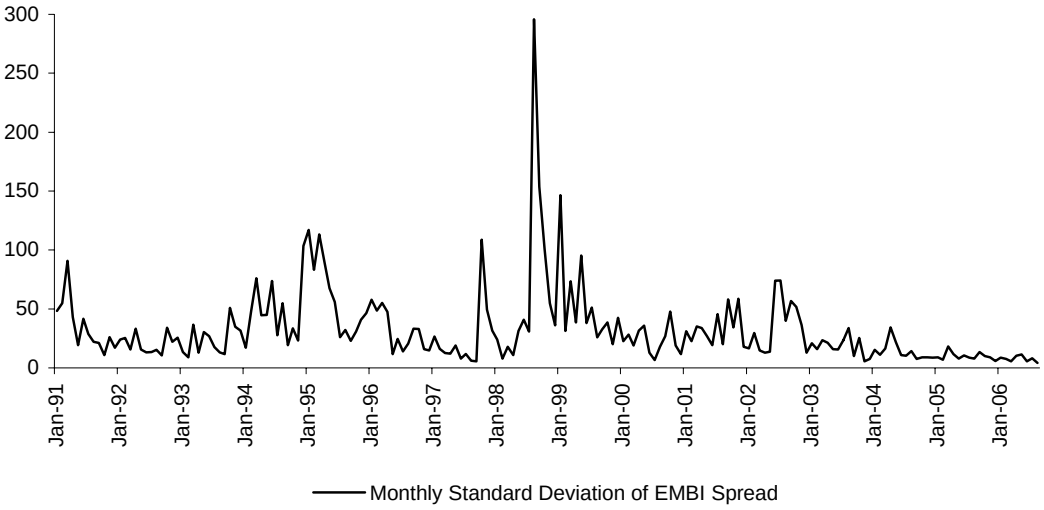
incomplete and the interest rate cannot be easily tied to random shocks. Consider, for example, a log-linearized version of uncovered interest arbitrage condition:

$$\varepsilon_{t+1} = \kappa_t + i_t, \tag{1}$$

where ε_{t+1} is the expected rate of devaluation between periods t and t+1, i_t is the policy interest rate from period t to t+1, and κ_t is a risk premium in period t (for simplicity, the international interest rate is set equal to zero). Notice that ε_{t+1} would also be the expected rate of inflation of purely tradable goods (assuming, for simplicity, that dollar inflation is zero). Thus, if i is set prior to knowing κ, the variance of expected inflation of tradable goods would equal that of κ. If, for example, one proxies κ by the EMBI (as computed by J.P. Morgan), Figure 1 shows that κ's monthly standard deviation has suffered major swings since 1991, reaching a staggering 300 basis points around the 1998 Russian crisis.[9] Under the above conditions, the resulting swings in the tradables' expected rate of inflation would totally be outside the control of the monetary authority. This is especially worrisome in developing countries, because empirical studies suggest that exchange rate volatility is detrimental to trade. Since trade and growth appear to go hand in hand, one is led to the conclusion that if the policy instrument (in this case the policy interest rate) cannot prevent high volatility, the central bank should be well advised to find another instrument that is more effective in that respect, albeit on a temporary basis. FXI/exchange-rate-pegging is a natural candidate. Pegging the exchange rate in a credible manner would significantly lower the volatility of ε_{t+1}, shifting its volatility to

[9] See Data Appendix for definition of variables. Incidentally, EMBI and its volatility are positively correlated. An ols of these two variables measured in basic points and on monthly intervals for the period Jan 1991-August 2006 with EMBI as dependent variable yields a coefficient of 0.06 on EMBI with a t-statistic of 9.16 (significant at 1% level). The number of observations is 188, and $R^2 = 0.35$.

Figure 1: Volatility of EMBI



the (now) market-determined i_t.[10,11] A central bank that follows IT may thus have strong incentives to peg the exchange rate during market turbulence, if tradable goods' prices are a major item in their price index and/or there is a large pass-through coefficient. Moreover, unless the pass-through coefficient is very close to unity, pegging will become even more attractive in the presence of DLD, because high exchange rate volatility is more likely to trigger serious financial turmoil, possibly driving the economy into a "bad" equilibrium.[12] Furthermore, it should be recalled that IRT is, by nature, a poor nominal anchor. To show this in a simple manner, consider the case in which the central bank accommodates money supply in order to satisfy an exogenous interest rate target (for a thorough discussion of IRT rules, see Woodford (2003)). First, let us assume that prices

[10] Calvo and Reinhart (2000) shows that in developing countries interest rates are substantially more, and exchange rates substantially less, volatile than in developing countries. This is in line with the above observations since the data corresponds to a period in which developing countries relied more on pegging than on IRT.

[11] In general, κ will be a function of the exchange rate regime. However, this does not invalidate the statement made in the text, unless the exchange rate peg is subject to serious credibility problems.

[12] There appears to be a worldwide trend towards smaller pass-through coefficients. This is typically seen as a desirable development because it makes it easier to decouple inflation from exchange rate fluctuations. However, under DLD, small pass-through coefficients may increase the probability of financial distress.

are perfectly flexible and the demand for money is given by function $L(i)$, where, again, i is the policy interest rate. At equilibrium,

$$\frac{M}{P} = L(i). \tag{2}$$

where M and P are, respectively, money supply and the price level. Thus, given i, any ratio M/P which satisfies equation (2) would be consistent with equilibrium. Uniqueness is recovered in some sticky-price models, but non-uniqueness is still an implication in many models with rational expectations under interest-rate targeting (see, e.g., Calvo (1983)).

The above remarks do not directly apply to IRT, but they suggest that if the reference interest rate is not sufficiently responsive to other macro variables, equilibrium multiplicity could result, making IRT ineffective. The conjecture is right. Consider an IRT rule in which $i = \varphi(\pi,c)$, where π and c stand for inflation and output, respectively. Imbedding this central bank reaction function in the closed-economy model in Calvo (1983), it is easy to show (proof in the Technical Appendix) that if $\varphi_\pi < 1$, nonuniqueness holds. Moreover, to ensure (local) uniqueness, we must have $\varphi_\pi > 1$ and $\varphi_c > 0$, which is in line with Taylor's rule, for example.[13] Thus, the good news is that there are some reaction functions that ensure uniqueness. But, on the other hand, the bad news is that 'birth defects' of IRT may still be lurking in the background.[14] In contrast, Calvo and Vegh (1993) shows in an open-economy version of the same sticky prices model that

[13] In Calvo (1983), π stands for expected inflation (i.e., the right-hand derivative of log price level). Hence, the rule is made contingent on *expected* inflation. However, as argued in Benhabib et al (2003), nonuniqueness problems do not go away if i is set to react to lagged inflation.

[14] In the literature there are examples in which uniqueness is ensured even under interest rate targeting. For example, Woodford (2001) shows that uniqueness can be recovered if the primary fiscal surplus is exogenous, while Calvo and Vegh (1995) ensures uniqueness by assuming that the asset which interest rate is set by the central bank yields liquidity services. However, both fiscal discipline and assets' liquidity become highly questionable in periods of financial distress.

equilibrium is unique under pegged exchange rates, giving additional grounds for the belief that pegging (with enough international reserves, of course) could offer a more robust nominal anchor than tweaking.[15]

There is an important parallel between pegging and tweaking. In both cases money supply is endogenously determined. This is an attractive feature given that the rapid pace of financial innovation has made it very hard to assess the impact that individual monetary aggregates (M1, M2, etc.) have on prices and wages. Advocates of flexible exchange rates, though, criticize pegging by arguing that, at best, it controls a small set of prices (i.e., prices of purely tradable goods and services), leaving plenty of room for real exchange rate misalignment (especially for large and relatively close economies like Brazil, for example). This is a valid concern, especially under conditions of imperfect credibility (see Calvo and Vegh (1993)). However, tweaking is also subject to similar concerns. The policy interest rate which is controlled by the central bank is just one of a number of interest rates existing in the market. If, as is typically the case, the policy interest rate corresponds to short-term interest rates on central bank paper or its interbank equivalent, IRT will certainly affect the cost of that kind of liquidity, but may have very little impact on *overall* liquidity. Actually, I suspect that the disconnect that we have recently seen between short and long rates of interest in the US and other advanced economies (called "a conundrum" by former Fed Chairman Greenspan) may reflect financial innovation that we still do not fully understand (e.g., Credit Default Swaps). Moreover, such disconnect is likely to be more common in EMs, given that they

[15] As shown in Calvo and Vegh (1993) imperfect credibility could impair the effectiveness of exchange-rate-based inflation stabilization plans. But the same applies to IRT, as can easily be shown in terms of Calvo (1983) or the model discussed in the Technical Appendix.

are undergoing a deep process of financial development (as the expression "Emerging Markets" is intended to suggest).

Taylor (2000), for example, recognizes these difficulties but appears to be more optimistic than my remarks convey. Maybe, after all, simple IRT rules work for unruly EMs. There is, however, an aspect of the whole issue that we may have ignored, namely, financial market volatility. Again, measuring it by EMBI's volatility (see Figure 1), it is clear that it has shown a marked declining trend since its 1998 heights. Thus, the recent apparent success of IRT rules in EMs could partly be a consequence of a more stable financial environment.

Two clarifications are in order. First, the above remarks should not be taken to imply that the central bank must freeze the exchange rate at the first sign of high volatility. The implication is only that if high volatility is not just a transitory nuisance, the central bank may be justified in setting bounds to the exchange rate. Thus, my remarks are consistent with a situation in which, for example, in the face of high volatility the currency is allowed to devalue sharply but the central bank eventually resorts to FXI to lower exchange rate volatility. Second, it should be noted that exchange rate pegging is not without problems either. If the public is not prepared for the policy change, the latter may contribute to even higher volatility and, possibly, to the emergence of Sudden Stop. This underlies the importance of fully alerting the public that they should expect an instrument switch as the economy transits into choppy waters.

2. International Reserves and Multiple Equilibria. The above discussion suggests that FX Intervention could offer an effective remedy against excessive exchange rate volatility in the short run—which, by the way, provides a rationale for the *fear of floating*

highlighted in Calvo and Reinhart (2002). A strong believer in "fundamentals," however, is likely to object arguing that if IRT is ineffective, then FXI is bound to fail. Although the argument cannot easily be dismissed when equilibrium is unique, it faces serious challenges when the economy displays multiple equilibria—a situation that gets considerable support in the literature (see, e.g., Calvo (1998, 2005), Obstfeld (1996)). Under equilibrium multiplicity, policy can help coordinate "good" or "bad" equilibriums. International reserves could play a key role in this coordination game, since, as pointed out above, they could help to cushion destructive financial spillovers of Sudden Stop. But, of course, for that to be the case, (a) the stock of reserves has to be large enough, (b) reserves have to be smartly spent during crisis (as discussed in Section II), and (c) the public has to trust that the government is prepared to use this kind of ammunition (including the use of external credit lines) to the full extent possible.

Incidentally, as noted at the outset, several EMs have substantially increased their international reserves since 1998. Some critics suggest that the stock is already too large by showing that they could get a much higher rate of return if invested in alternative financial assets. However, what is a reasonable stock of international reserves is a function of their potential use. For example, if reserves are intended to fill the financing gap in case there are problems in rolling over external short-term debt (the so-called, Greenspan-Guidotti rule), then the levels prevailing in 2006 for Latin America, for example, could easily be claimed to be excessive, since the ratio of reserves to such debt hovers around 2.7 (about 30 percent more than in 1994, prior to the 'Tequila' crisis). However, if reserves are intended to reinforce the LOLR, which in light of the previous discussion should be a preeminent policy objective—in which case M2 could be a more

appropriate denominator than external short-term debt—the region's reserves in 2006 are around 37 percent of M2, which is only about 10 percent higher than in 1994 (see Calvo (1996 b) for a discussion of these issues).[16,17]

In regard to item (c), namely, ensure that the public expects that in case of Sudden Stop international reserves will be efficiently spent, thus guaranteeing the effectiveness of the LOLR—this is an issue that requires good rapport between the central bank and the public. Assuming an adequate level of reserves, the central bank should be able to explain to the public that reserves are there to be used in case of *incipient* Sudden Stop, and in order to prevent a *full-fledged* Sudden Stop. Thus, the central bank should be able to convince the public that a loss of reserves is part of the solution, not part of the problem.

The above discussion employed the phrase "international reserves" without providing a rigorous definition. It is now time to try to be somewhat more precise (a more thorough discussion will be left for another occasion). Let me begin with a couple of questions: What is the relevant concept, *gross* or *net* international reserves; and, if the relevant concept is *net*, net of what? The IMF, for example, defines net international reserves by subtracting official short-term foreign-exchange denominated official debt. These questions are highly relevant because a large share of the impressive accumulation of international reserves that took place in EMs since 1998 was carried out by increasing official debt (variously denominated in foreign exchange or local currency). Thus,

[16] These figures are regional simple averages, and are based on data from the IMF's World Economic Outlook, September 2006. See Data Appendix for more information.

[17] It could be argued that if M2 is in local currency then international reserves are not needed, because the LOLR could always bail out banks by printing local currency. It should be noted, however, that as a general rule the money-printing solution brings about large nominal and real devaluation, wrecking havoc in the financial sector (especially under DLD). This is an empirical issue that cannot be discussed in this paper.

another question arises that goes closer to the heart of the issue: If reserves are accumulated by borrowing, why would they be effective as *insurance* against Sudden Stop?[18] This is an important question that cannot be fully addressed in this paper. Instead, I will focus on the particular case highlighted by the heading of this section, namely, multiple equilibria. Suppose that international reserves are held in order to stave off "bad" equilibria. This would tend to privilege "gross" over "net," because gross reserves can be utilized to bail out exporters, for instance, even if those reserves had been acquired by issuing government obligations of equal value, currency denomination and maturity. To be true, this operation may not be a completely successful—as the 1994/5 'Tequila' crisis in Mexico illustrates (see Calvo (2005))—but using international reserves may still be preferable to the grinding stop in exports that would otherwise inevitably follow if exporters (in the present example) are suddenly excluded from the international credit market. On the other hand, I would not subscribe to an unqualified "gross" reserves concept. Suppose, for instance, that the central bank accumulates reserves by placing debt in domestic banks' balance sheets (a common fact in EMs). In that case, exporters' bailout would be done at the expense of banks' balance-sheet deterioration. The latter, in turn, may give rise to bank runs, as depositors realize that banks have become more financially vulnerable, and consequent domestic payments difficulties, which could actually trigger a bad equilibrium. This suggests a "net" concept that would subtract the stock of short-term debt held by *domestic* banks. In contrast, I do not see much sense in subtracting *external* short-term debt as implied by the popular Greenspan-Guidotti criterion. Not paying external debt carries costs but, as the recent Argentine

[18] Some observers conclude from the fact that much of the stock of international reserves is matched by government obligations that a *mercantilist* objective is behind the large accumulation of reserves—more concretely, a desire to generate an artificially high real exchange rate.

default episode illustrates, *domestic* financial difficulties could far outweigh those of external origin. Argentina's freezing of deposits in domestic banks (labeled "corralito," i.e., playpen, in Spanish) proved to be much more troublesome for the Argentine policymaker than the default on obligations held by, for instance, Italian pensioners, who, after all, ended up venting their rage against their financial advisors, namely, Italian banks. In sum, the relevant concept of international reserves as insurance against Sudden Stop depends on domestic and international financial/political conditions that have to be determined in each individual case. Most likely, though, neither the standard gross or net reserves definitions fit the bill.

In conclusion, the stock of (the relevant concept of) international reserves (or credible international credit lines) should be large enough to prevent a major credit crisis that paralyzes exports and threatens to cripple the domestic banking system, and the public should be well informed about the mechanisms involved in the bailout. The costs of this strategy may be significant, but these costs have to be weighed against the benefit of avoiding deep financial crises, which as Cerra et al (2005) and the previous discussion suggest, could also be large. Of course, this is unlikely to be the social optimum for the world as a whole. The counterpart of self-insurance is seigniorage accruing to developed economies (to the extent that the interest rates on developed economies' treasury bills, for example, fall short of the opportunity cost of international reserves). Thus, developed economies would be making monopoly profits that are distorting and unfair (especially if one looks at the issue from a Rawlsian perspective). There are insurance schemes that are more fair and efficient. One such scheme would be some kind of Contingent Credit

Line, CCL, but perhaps more agile and without the stigma that kept it from being implemented when it was first proposed by the IMF.[19]

IV. Conclusions

Many EMs are at a serious disadvantage relative to developed economies in that they lack an effective Lender of Last Resort. This disadvantage becomes more acute under Domestic Liability Dollarization. The economy's fragility may not be noticeable in normal and tranquil times, but it begins to show its faulty lines during turbulent periods, even in absence of major crisis. The paper centered the discussion on the use of a reference or policy interest rate as an instrument for monetary policy. This is the instrument of choice for developed economies, but the paper claims that the instrument is inherently weak, and could become uncomfortably weaker during high volatility. Thus, in choppy waters it may be advisable momentarily to switch to more robust instruments, like some kind of exchange rate peg. To ensure that instrument switching is not a source of confusion for the private sector, the central bank should explain the nature of the policy switch, hopefully well in advance it becomes necessary to apply it. However, the paper stops short of discussing what kind of rules are optimal for switching instruments back and fore. I suspect that this issue will depend on country-specific considerations although global variables, like the EMBI, are likely to be common to most optimal policy rules.

Needless to say, countries that aspire to have an independent monetary policy should aim at creating the conditions for extirpating Domestic Liability Dollarization and

[19] Ugo Panizza (personal communication) proposes to rebate to the world's poorest countries seigniorage collected on account of their international reserve holdings. A similar proposal was unsuccessfully bandied about in Washington when Argentina considered the possibility of adopting the US dollar as local currency. However, the twist to do if for the world's poorest countries could prove powerful in this era of MDGs.

other financial vulnerabilities. This is not an easy task if it is going to be carried out on a voluntary basis. In the meantime, EMs will have to grapple with the kind of financial vulnerabilities highlighted in these notes.[20]

[20] Absent from these notes, incidentally, is any reference to banking regulation, and issues like control on capital mobility, which may attenuate or exacerbate financial vulnerabilities. These are important issues that are better left for a separate note.

Data Appendix

The sample covers all developing countries included in World Development Indicators (WDI). Due to lack of data on Reserves, Exports or Imports, few countries were dropped. The final list of countries includes 161 countries. The sample period spans from 1990 to 2004. Data is collected on a monthly basis unless otherwise stated. The following table contains all data definitions and sources.

Variable	Definitions and Sources
EMBI Index	Emerging Markets Bond Index Spread (daily.) (Source: JP Morgan)
Volatility of EMBI	Constructed by calculating the standard deviation of daily EMBI spread within a given month.
International Reserves in USD (RES)	International Reserves minus Gold in USD. International Reserves minus Gold in SDR multiplied by USD per SDR exchange rate. (Source: IFS, |line 1L.SZF|*|line 111..AA.ZF...|)
Nominal Exchange Rate (EXR)	Exchange Rate National Currency per USD. (Source: IFS |line AE.ZF|)
Exports	Value of Exports in USD. (Source: IFS |line 70DZF| or DOTS |line 70..DZD001|)
Imports	Value of Imports in USD. (Source: IFS |line 71DZF| or DOTS |line 71..DZD001|)
Capital Flows Proxy	Trade balance minus changes in international reserves. All figures are expressed in 2000 US dollars.
Sudden Stop Dummy (SSD)	Episodes of Sudden Stop (SS) were detected in a country-by-country basis by selecting periods of large and unexpected falls in Capital Flows Proxy; see Calvo et al (2004) for a general discussion of the methodology. Different from Calvo et al (2004), the SS dummy was calculated without imposing any requirement about economic activity.
Exchange Rate Regime (EXRR)	3-way De Facto Classification of Exchange Rate Regimes (annual) (Source: Levy-Yeyati and Sturzenegger (2005))
Gross Domestic Product (GDP_USD)	Gross Domestic Product current prices in USD (annual) (Source: WDI)
Pre-crisis level of RES (PCRES)	Level of RES one month prior a SS, i.e. SSD=1.
Minimum level of RES during SS (MINRES)	Minimum level of RES during a window of continuum SS, i.e. SSD=1.
Maximum Loss of Reserves during SS	Calculated as the percentage difference between MINRES and PCRES: 100*(MINRES/PCRES-1)
Maximum Loss of Reserves/GDP during SS	Calculated as: 100*(MINRES-PCRES)/GDP_USD. To avoid endogeneity problems, 1-year lagged GDP_USD is used.
Pre-crisis level of EXR (PCEXR)	Level of EXR one month prior a SS, i.e. SSD=1.
Maximum level of EXR during SS (MAXEXR)	Maximum level of EXR during a window of continuum SS, i.e. SSD=1.
Maximum Nominal Depreciation	Calculated as the percentage difference between MAXEXR and PCEXR: 100*(MAXEXR/PCEXR-1)

Technical Appendix

Consider the model in Calvo (1983). According to equations (39), (40a) and (40b) in that paper:

$$\frac{v'(m)}{u'(c)} = i, \qquad \text{Demand for money} \qquad \text{(A1)}$$

$$\dot{c} = -\frac{u'(c)}{u''(c)}[i - \rho - \pi], \quad \text{Euler equation} \qquad \text{(A2)}$$

and

$$\dot{\pi} = b(\bar{y} - c), \qquad \text{Staggered prices,} \qquad \text{(A3)}$$

where instantaneous utility function is given by $v(m) + u(c)$; m and c stand, respectively, for real monetary balances and consumption (there is no capital accumulation). Moreover, i, ρ, π and $\bar{y}$ stand, respectively, for the central bank interest rate, the subjective rate of discount, the rate of inflation, and full-capacity output. Calvo (1983) shows that if i is exogenously given and money supply is endogenous (strict interest rate targeting), then, by (A1), m is determined once c is known. Moreover, by (A2) and (A3), the determination of c and π is independent of m. Thus, one can solve for c and π from equations (A2) and (A3). Notice that the initial values of c and π are not predetermined. Hence, uniqueness requires that system (A2) and (A3) in c and π be unstable around the steady state. However, Calvo (1983) shows that the system displays saddle-path stability, implying that there is a continuum of initial conditions (c_0 , π_0) that give rise to a convergent equilibrium path, even though prices are sticky.

Consider now the case mentioned in the text in which $i = \varphi(\pi,c)$. If $\varphi_\pi > 1$ and $\varphi_c > 0$, then the sign pattern of the Jacobian, J, associated with the linear expansion of (A2)-(A3) around the steady state, satisfies:

$$\begin{pmatrix} + & + \\ - & 0 \end{pmatrix}. \qquad \text{(A4)}$$

Thus, Determinant $J > 0$ and Trace $J > 0$, implying that the two characteristic roots have positive real parts. Hence, system (A1)-(A2) is locally unstable, and the unique initial vector (c_0 , π_0) consistent with an equilibrium that converges to the steady state (the standard rational expectations' local equilibrium definition) is the steady state. On the other hand, if $\varphi_\pi < 1$, the upper right cell in (A4) is negative, implying saddle-path stability and, hence, that equilibrium nonuniqueness prevails. This proves the contention in the text.

References

BIS, 2005, "Foreign Exchange Market Intervention in Emerging Markets: Motives, Techniques and Implication," BIS Papers No. 24, May.

Benhabib, Jess, Stephanie Schmitt-Grohé, and Martín Uribe, 2003, "Backward-Looking Interest Rates, Interest Rates Smoothing, and Macroeconomic Stability," *Journal of Money, Credit, and Banking*, vol. 35, No. 6, pp. 1379-1412.

Caballero, Ricardo, and A. Krishnamurthy, 2005, "Inflation Target and Sudden Stops," in *The Inflation Targeting Debate"* edited by Ben Bernanke and Michael Woodford. Chicago, IL: Chicago University Press.

Calvo, Guillermo A., 1983, "Staggered Prices in a Utility-Maximizing Framework," *Journal of Monetary Economics,* 12, September, pp. 383-98. Reprinted in Calvo (1996 a).

Calvo, Guillermo A., 1996 a, *Money, Exchange Rates, and Output*; Cambridge, MA: MIT Press.

Calvo, Guillermo A., 1996 b, "Capital Flows and Macroeconomic Management: Tequila Lessons," *International Journal of Finance Economics*, 1, pp. 207-223. Reprinted in Calvo (2005).

Calvo, Guillermo A., 1998, "Varieties of Capital Market Crises," in G. Calvo and M. King (eds.) *The Debt Burden and its Consequences for Monetary Policy*, Macmillan; reprinted in Calvo (2005).

Calvo, Guillermo A., 2005, *Emerging Capital Markets in Turmoil: Bad Luck or Bad Policy?*; Cambridge, MA: The MIT Press.

Calvo, Guillermo A., Alejandro Izquierdo, and Luis F. Mejía, 2004, "On the Empirics of Sudden Stops: The Relevance of Balance-Sheet Effects," *NBER Working Paper* 10520, May.

Calvo, Guillermo A., and Carmen Reinhart, 2000, "Fixing for your Life," *Brookings Trade Forum 2000*; reprinted in Calvo (2005)

Calvo, Guillermo A., and Carmen Reinhart, 2002, "Fear of Floating," *Quarterly Journal of Economics*, pp. 379-408; reprinted in Calvo (2005).

Calvo, Guillermo A., and Carlos A. Végh, 1993, "Exchange-Rate-Based Stabilisation under Imperfect Credibility," *IEA Conference on Open-Economy Macroeconomics*, editors H. Frisch and A. Worgötter; Hampshire, UK: Macmillan Press, Ltd. Reprinted in Calvo (1996 a).

Calvo, Guillermo A., and Carlos A. Végh, 1995, "Fighting Inflation with High Interest Rates: The Small-Open-Economy Case under Flexible Prices," *Journal of Money, Credit, and Banking*, March, pp. 49-66.

Calvo, Guillermo A., and Carlos A. Végh, 1999, "Inflation Stabilization and BOP Crises in Developing Countries," in Chapter 24, Vol. 1C, *Handbook of Macroeconomics*, edited by J. Taylor and M. Woodford; Amsterdam, Holland: North-Holland.

Cerra, Valerie, and Chaman Saxena, Sweta, 2005, "Growth Dynamics: The Myth of Economic Recovery," *IMF Working Paper* WP/05/147.

Céspedes, Luis F., Roberto Chang, and Andrés Velasco, 2001, "Dollarization of Liabilities, Net Worth Effects, and Optimal Monetary Policy," manuscript.

Eichengreen, Barry, Ricardo Hausmann, and Ugo Panizza, 2005, "The Pain of Original Sin," in Eichengreen, B., and Ricardo Hausmann, eds., *Other People's Money:*

Debt Denomination and Financial Instability in Emerging Market Economies; Chicago, IL: University of Chicago Press.

Financial Times, 2002, "Brazil pledges loans to companies," reported by Raymond Colitt, August 13, p. 1.

Friedman, Milton, and Anna J. Schwartz, 1963, *A Monetary History of the United States, 1867-1960*; Princeton, NJ: Princeton University Press.

Levy-Yeyati, Eduardo, and Federico Sturzenegger, 2005, "De Facto Classification of Exchange Rate Regimes," manuscript, Di Tella University, December.

Lucas, Robert E. Jr., 1985, *Models of Business Cycles*; Yrjo Jahnsson Lectures, Oxford, UK: Basil Blackwell.

Obstfeld, Maurice, 1996, "Models of Currency Crises with Self-Fulfilling Features," *European Economic Review*, March, pp. 72-81.

Stiglitz, Joseph E., and Bruce Greenwald, 2003, *Towards a New Paradigm in Monetary Economics*, Raffaele Mattioli Lectures; Cambridge, UK: Cambridge University Press.

Taylor, John, 2000, "Recent Developments in the Use of Monetary Policy Rules," given at the conference "Inflation Targeting and Monetary Policies in Emerging Economies," Central Bank of the Republic of Indonesia, Jakarta, Indonesia, July 13-14.

Woodford, Michael, 2001, "Fiscal Requirements for Price Stability," *Journal of Money, Credit and Banking*, 33, pp. 669-728.

Woodford, Michael, 2003, *Interest and Prices: Foundations of a Theory of Monetary Policy*. Princeton, NJ: Princeton University Press.