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Monetary Policy Challenges in Emerging Markets: Sudden Stop, Liability Dollarization, and Lender of Last Resort

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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 temporarily 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-art literature summarized by Woodford (2003) or even more heterodox approaches exemplified by Stiglitz and Greenwald (2003) are likely fall short of providing a satisfactory guide for monetary policy in EMs.

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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 both the level and volatility of interest rate spreads 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,[1] 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 less than fully incorporated into central banks' tool kit—which remains replete with sophisticated analyses on how to implement Inflation Targeting, for example, with little or no reference to financial imperfections in EMs.[2]

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[1] The expectation that the Fed would further tighten monetary policy caused a major fall in EM stock market prices and rise in credit spreads. Interestingly, the episode carried no noticeable cost in terms of output and employment.

[2] 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. The recent book by Mishkin (2006) offers a balanced and cogent exposition of the central issues that motivate the present note.

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 Dollarization (foreign-exchange denominated debts).[3] 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 they have been largely ignored in the literature which, true to form, has focused on issues relevant to mature economies.[4]

Section II will start by defining LOLR, arguing 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 on 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 reasonably 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).

[3] In what follows, "dollar" will be identified with "foreign exchange." In Eichengreen et al. (2005) Liability Dollarization is instead called Original Sin. The expression "Original Sin" invokes the thought that EMs may not be able to clean the slate, which is still a highly debated issue. To be fair, Liability Dollarization is not free from semantic imprecision either (e.g., is the US Liability Dollarized?), but I will stick with it for the present, albeit with some uneasiness.

[4] For example, the expression Lender of Last Resort does not appear in the Index of Woodford (2003), a masterful state-of-the-art exposition of monetary theory. Neither is the LOLR or related DLD issue addressed in Stiglitz and Greenwald (2003), a book that otherwise places great emphasis on domestic financial imperfections.

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 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, for example, 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 Mejía, 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 potentially 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.[5] The situation would be different, however, if some of the liquidity held by the private sector consisted of foreign exchange, for example, a phenomenon called Currency Substitution in the literature, which is highly prevalent in developing countries (see Calvo and Végh, 1999).

[5] Notice that in this instance the central bank can lend without borrowing because the episode corresponds to a situation in which there is a sudden higher demand for central bank liquidity. Perhaps a better characterization of the central bank in this instance would be as Liquidity Provider instead of LOLR.

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 exchange rates and prices.[6]

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 means such as 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

[6] 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 may be a major factor behind the creation of DLD.

Sudden Stop episodes since 1980 (see Data Appendix). Central banks lost large quantities of international reserves, and neither reserve losses nor exchange rate depreciations are significantly different across exchange rate regimes prevailing prior to Sudden Stop.[7]

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 one-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 and Sturzenegger's (2005) three-way classification.

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

[7] Thus, under Sudden Stop there is no such a thing as "fixers" or "floaters," they are all "mixers!"

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 on 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.[8]

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

[8] How common have been these types of directed credit operations in response to incipient Sudden Stop are unknown to me. It is an interesting research topic. Márcio Garcia, incidentally, suggests (personal communication) that in the case of Brazil the central bank may have been prompted to provide export credit because exporters had been forced to surrender to the central bank a large share of export proceeds.

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 can help to coordinate a "good" equilibrium and/or has better information than the market, limited as it might 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 like Brazil attempted to do in 2002, although in each individual case not necessarily involving the export sector).[9] 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, for this operation to be effective time is of the essence. Moreover, every possible measure should be taken to prevent Moral Hazard. Moral Hazard is a key issue, since even 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 debt management regulations under normal conditions.

These considerations suggest that, in order to manage monetary policy (including international reserves) properly, it is important for a central bank to take action on a

[9] This issue will be revisited in Section III.2 below.

moment's notice. Thus, a sort of Sudden Stop Drill (much like Fire Drills) should be included in central bank activities during normal times. 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 a long-lasting growth decline, which can result in large welfare losses. 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 (hereafter Interest Rate Tweaking, or 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.[10] For an illustration of such central bank sleight of hand one needs to go no further than the recent turmoil episode in May/June of 2006.[11] Unfortunately, IRT is generally identified with "floating exchange rates." Thus, to the man in the street, pegging the exchange rate during market turbulence may be tantamount to abandoning floating exchange rates. Since pegged exchange rates have

[10] See BIS (2005) for an interesting collection of central bankers' views on foreign exchange intervention.
[11] 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 called for floating exchange rates.

been demonized by the Fund as a key factor 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.

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 transitory instrument switching as the economy transitions between tranquil and turbulent periods in normal times. Hopefully, greater conceptual clarity will help to make transitory 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.[12] 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, if 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 whose price index is targeted by IT consists exclusively of foreign exchange (or only pure tradable goods); then IT is equivalent to

[12] Assuming equilibrium uniqueness, an issue that will be discussed below.

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.[13] 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 (which need not be permanent) involves no fundamentally different monetary policy because objectives are unchanged; the switch is only prompted by cost considerations. This theme, namely, that a transitory switch from IRT to exchange-rate pegging could just be a technicality and not a major monetary policy change, will be a leitmotif in 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, like

[13] 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.

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

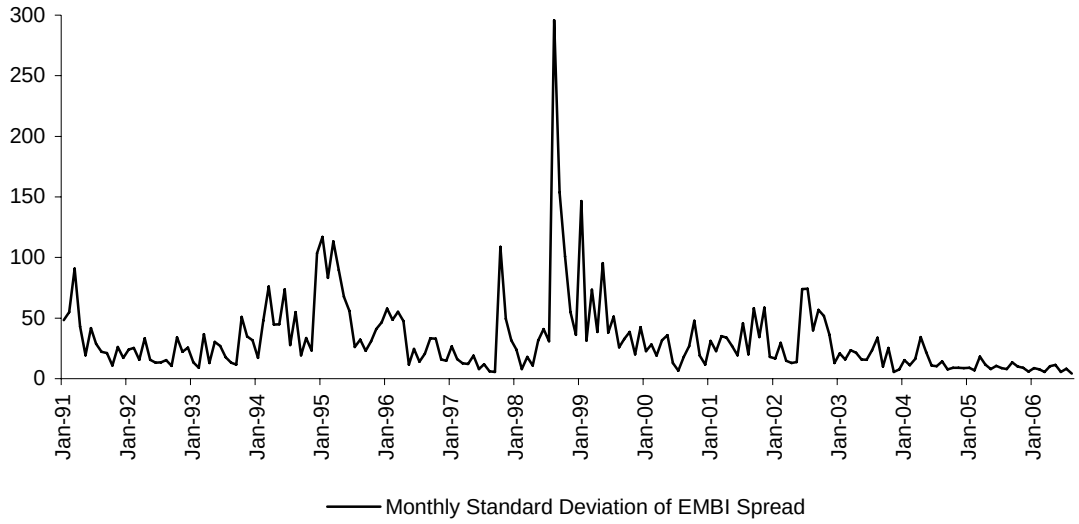
$$\varepsilon_{t+1} = \kappa_t + i_t, \qquad (1)$$

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, conditional on κ_t, 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.[14] Under the above conditions, the resulting swings in tradables' expected rate of inflation would be totally 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 (see Calvo and Reinhart, 2000), 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 would be well advised to find another instrument that is more effective in

[14] 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 $R^2 = 0.35$.

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

Figure 1: Volatility of EMBI



the (now) market-determined i_t.[15,16] 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"

[15] 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 in the study corresponds to a period in which developing countries relied more on pegging than on IRT.

[16] 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.

equilibrium.[17] 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 are perfectly flexible and the demand for money is given by function $L(i)$, where, again, i is the policy interest rate. At equilibrium,

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

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 function φ is the central bank's policy function, and π and c stand for inflation and output, respectively. Embedding this central bank reaction function in the closed-economy model in Calvo (1983), for example, it is easy to show (proof in the Technical Appendix) that if $\varphi_\pi < 1$, nonuniqueness holds. Moreover, to

[17] 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.

ensure (local) uniqueness, we must have $\varphi_\pi > 1$ and $\varphi_c > 0$, which is in line with Taylor's rule, for example.[18]

Is this enough reason for comfort? I don't think so. In the first place, notice that nominal anchoring is achieved as a result of price stickiness, not nominal money supply or pegging of the exchange rate. Although evidence from the North suggests that price-setting mechanisms are stable, we lack systematic studies showing that the same degree of stability is displayed in EMs, especially during market turbulence.[19]

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 it may have very little impact on *overall* liquidity. Actually, I suspect that the disconnect 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 innovations that we still do not fully understand (e.g., Credit Default Swaps). Moreover, such a disconnect is likely to be more common in EMs, given that they are undergoing a deep process of financial development (as the expression "Emerging Markets" is intended to suggest). To illustrate these possible complications, consider the case in which the policy interest rate, denoted by i^{cb}, is the interest rate on money. Thus, the demand for money (2) would become:

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[18] 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.

[19] Burstein, Eichenbaum and Rebelo (2005) show compelling evidence that price stickiness cannot be ruled out even in the context of large exchange rate devaluations. However, they stop short of arguing that the price-setting mechanism remains invariant during those episodes.

$$\frac{M}{P} = L(i - i^{cb}). \tag{3}$$

Under these circumstances, setting i^{cb} puts at best a lower bound on i but otherwise leaves i completely unhinged, implying equilibrium indeterminacy. It can easily be verified that indeterminacy would also hold if i^{cb} applied to any other financial asset yielding "liquidity" services.[20]

Therefore, the good news is that there are some reaction functions that ensure uniqueness under stable price-setting mechanisms. But, on the other hand, the bad news is that IRT may possess "birth defects" yet to be discovered.[21] In contrast, Calvo and Végh (1993), for example, show in an open-economy version of the same sticky prices model where, in general, 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 interest rate tweaking.[22]

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 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 closed economies like

[20] E.g., assets that directly or indirectly enter as arguments in utility functions. See Calvo and Végh (1995) for a discussion.

[21] In the literature there are examples in which uniqueness is ensured even under interest rate targeting. For instance, Woodford (2001) shows that uniqueness can be recovered if the primary fiscal surplus is exogenous. However, fiscal discipline becomes highly questionable in periods of financial distress.

[22] As shown in Calvo and Végh (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.

Brazil, for example). This is a valid concern, especially under conditions of imperfect credibility (see Calvo and Végh, 1993). However, as shown in previous example, tweaking is also subject to similar concerns.

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 passing nuisance, the central bank may be justified in setting bounds to the exchange rate.[23] 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 transitory 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 a transitory instrument switch as the economy transits into choppy waters.

[23] The emphasis here is on controlling "excessive" exchange rate volatility. It should not be confused with trying to prevent real exchange rate misalignment, a policy that may result in weak nominal anchoring.

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 receives some support in the literature (see, e.g., Calvo, 1998 and 2005; and Obstfeld, 1996). Under equilibrium multiplicity, policy can help coordinate "good" or "bad" equilibria. 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 wisely 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.

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 these funds could get a much higher rate of return if invested in alternative financial assets. However, this is highly debatable. The optimal 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 criterion), 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, then aggregates like export credit and/or M2 could be a more appropriate denominator than external short-term debt—and the picture that emerges could be significantly different. For example, in Latin America international reserves in 2006 are around 37 percent of M2, which is only about 10 percent higher than in 1994 (see Calvo, 1996b, for a discussion of these issues).[24, 25]

Among the conditions discussed above, item (c)—namely, that the public expects that international reserves will be efficiently spent in case of Sudden Stop, thus guaranteeing the effectiveness of the LOLR—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

[24] 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.

[25] 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 recalled, however, that as a general rule the money-printing solution brings about large nominal and real devaluation, possibly wreaking havoc in the financial sector (especially under DLD). This is an empirical issue that cannot be discussed in this paper.

reserves by subtracting from gross reserves 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, another question arises that comes closer to the heart of the issue: If reserves are accumulated by borrowing (i.e., by resorting to sterilized intervention), why would they be effective as *insurance* against Sudden Stop?[26] 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 sure, 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 international credit markets. 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, a bailout of exporters would be undertaken 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

[26] 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.

more financially vulnerable, potentially leading to domestic payments difficulties, which could actually trigger a bad equilibrium. This suggests a "net" concept that would subtract from gross reserves 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 default episode illustrates, *domestic* financial difficulties could far outweigh those of external origin. Argentina's freezing of deposits in domestic banks (labeled the "*corralito*," the Spanish word for "playpen") proved to be much more troublesome for Argentine policymakers than the default on obligations held by creditors such as the Italian pensioners who 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 weighed in each individual case. Most likely, though, neither the standard gross nor net reserves definition fits 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 bailout mechanisms. The costs of this strategy may be significant, but they 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 socially 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). Nonetheless, it should be noted that fairer and more efficient insurance schemes exist. One such scheme would be some kind of Contingent Credit Line (CCL), but perhaps a version that is more agile and free of the stigma that kept the original CCL proposal from being implemented when it was first offered by the IMF.[27]

IV. Conclusions

Many EMs are at a serious disadvantage relative to developed economies in that they lack an effective Lender of Last Resort, a disadvantage that becomes more acute under Domestic Liability Dollarization. The economy's fragility may not be noticeable in normal and tranquil times, but its fault lines are revealed during turbulent periods, even in the absence of a major crisis. This paper has focused on the use of a reference or policy interest rate as an instrument for monetary policy. Although this is the instrument of choice for developed economies, the paper claims that the instrument is inherently weak, and in the case of EMs it could become uncomfortably weaker during periods of high volatility. Thus, in choppy waters it may be advisable momentarily to switch to more robust instruments such as 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 of when that

[27] 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 of doing this for the world's poorest countries could prove politically appealing in this era of MDGs.

switch becomes necessary. 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 eliminating Domestic Liability Dollarization and 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.[28]

[28] Absent from these notes, incidentally, is any reference to banking regulation, and issues such as restrictions 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, a few countries were dropped. The final list of countries includes 161 countries. The sample period spans from 1990 to 2004. Data are 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 the 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.

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