

# STERILIZED FOREIGN EXCHANGE INTERVENTIONS UNDER INFLATION TARGETING

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Inflation targeting needs exchange rate flexibility. If the policy interest rate is geared to achieving the inflation target, the central bank must be willing to accept the resulting exchange rate. Simply put, if the central bank has both an inflation target and an exchange rate target, the private sector will not know which will take precedence in cases where they conflict; at most, therefore, the central bank should react to exchange rate movements only to the extent that they affect expected inflation.

In practice, however, emerging market economies have never followed this textbook approach. Regardless of their formal exchange rate regime, most emerging economy central banks do intervene in the foreign exchange markets. Against the backdrop of most modern models of open economies, this behavior by emerging economy central banks (including those with formal inflation-targeting frameworks) is puzzling. In these models, influencing the exchange rate without changing the monetary stance is neither feasible nor desirable. Such models typically assume that uncovered interest parity (UIP) holds.

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If that is the case, sterilized intervention will not have any effect on the exchange rate. The only tool for monetary policy is the policy rate—but that is already assigned to meeting the inflation target. Even in cases where it is possible to affect the exchange rate through sterilized intervention (for instance, because domestic and foreign assets are not perfect substitutes), doing so may not improve welfare.

In this paper, we examine whether such benign neglect is the optimal policy for inflation-targeting emerging market economies—and argue that it is not. In particular, there are reasons to question both the applicability of the standard model and its policy conclusions. In emerging economies, borrowing often involves currency mismatches, firms are more likely to be credit constrained, and financial fragilities are often present. When the exchange rate appreciates, the tradable sector will lose competitiveness. There are large adjustment costs associated with movements from the tradable to the nontradable sector. These costs cannot be avoided in the case of permanent shocks, but large sectoral reallocations can be inefficient if driven by temporary movements in the exchange rate. Sharp depreciations of the exchange rate can amplify financial fragilities in the presence of currency mismatches. For example, an otherwise profitable nontradable firm with foreign currency debt may become distressed if the local currency value of its liabilities were to increase sharply following a large depreciation. Currency mismatches are particularly dangerous if present in the banking system, and they can quickly become a source of systemic risk.<sup>1</sup>

Even if some management of the exchange rate may be desirable in emerging market economies, it does not necessarily follow that it is feasible (that is, without changing monetary policy). Again, there is a marked contrast between advanced economies (where sterilized intervention is rarely viewed as being effective) and emerging economies, where the very thinness of the currency markets, together with imperfect capital mobility and asset substitutability, means that sterilized intervention is more likely to be a viable policy tool. As an empirical matter, emerging economy central banks do undertake sterilized intervention, suggesting that they believe this instrument to be effective.

We conclude that some currency intervention is both desirable and feasible in emerging market economies. Consequently, even inflation-

1. For a detailed discussion of currency mismatches and their potential causes, see Chamon (2013).

targeting central banks in these countries should make use of both instruments—the policy interest rate and sterilized intervention—to achieve the inflation target while offsetting disequilibrium movements of the exchange rate. Crucially, the existence of two instruments—the policy rate and sterilized intervention—means that managing the exchange rate should not undermine the credibility of the inflation target; on the contrary, it may strengthen it.

The crux of our argument is laid out in the next section. We do not model the actual underlying channels through which sterilized intervention could have an impact on the exchange rate, which would be beyond the scope of this paper. Instead, we take the effect on the exchange rate as given and analyze how the presence of this second instrument affects policy decisions. We survey evidence on the effectiveness of sterilized intervention in emerging markets, since our argument is predicated on the central bank having two independent instruments. While the evidence is mixed, it is at least suggestive of the central bank's scope for influencing the path of the exchange rate. We then examine how the central bank would wish to deploy its two instruments in response to shocks under inflation targeting with or without sterilized foreign exchange intervention. Key results from our analysis are that intervention should only be used in the face of shocks that push the currency away from its medium-run warranted value; and that it should be two-way (that is, involving, at different times, purchases or sales of official reserves, with no net accumulation or loss). Such a strategy is not without costs or potential drawbacks, and these are discussed alongside the benefits. A final section draws out the main policy implications.

## **1. TWO TARGETS, TWO INSTRUMENTS**

Modern macroeconomics, dating back at least to the Mundell-Flemming-Dornbusch model (Flemming, 1962; Mundell, 1963; Dornbusch, 1976), tends to assume perfect capital mobility. That assumption is embodied in an uncovered interest parity (UIP) condition, which is one of the cornerstones of the open economy macroeconomic literature (for example, Obstfeld and Rogoff, 1995; Galí and Monacelli, 2005). With perfect asset substitutability, central bank swaps of assets can have no effect, and there is no role for sterilized intervention. An exception is Benes and others (2013), where sterilized interventions lead to deviations from UIP through

portfolio effects in an otherwise standard new Keynesian framework. Moreover, in many modern models of advanced economies, welfare depends on inflation and the output gap (that is, the exchange rate only affects welfare through its impact on inflation and output), and there are no benefits from sterilized intervention even if it were possible. For example, in Galí and Monacelli (2005), the output gap is also stabilized when domestic inflation is stabilized, which a central bank with sufficient credibility can achieve with the interest rate alone (what Blanchard and Galí, 2007, call as divine coincidence). If that is the case, the resulting exchange rate fluctuations are equilibrium movements, and welfare would not be improved by smoothing them—so there is no need for a second instrument such as sterilized intervention.

The situation in emerging market economies may be quite different. First, even if divine coincidence holds for inflation and the output gap, there may be good reasons to try to offset large, temporary movements of the exchange rate from its medium-term equilibrium, as discussed in the introduction. The second crucial difference between advanced and emerging economies is that sterilized intervention is more likely to be an effective tool in the latter.

There are two main ways through which sterilized intervention (that is, purchases and sales of foreign exchange that leave the central bank's interest rate unchanged) can affect the exchange rate: the portfolio balance and the signaling channels. The former stems from the change in the relative supply of domestic and foreign currency assets following the intervention. If the two types of assets are perfect substitutes (that is, if uncovered interest parity holds), then changes in the relative supply would not affect the exchange rate. Under imperfect substitutability, the exchange rate adjusts as investors demand compensation to shift their portfolio holdings toward the asset that has become relatively more abundant. There are reasons to be skeptical about the quantitative importance of this channel in the case of advanced economies, where bond markets are so huge that even massive intervention barely makes a dent on the relative supply of assets (Ghosh, 1992), although the recent Swiss experience suggests that large-scale intervention can be successful even in a reserve currency (a signaling channel also helped achieve that outcome). In the case of emerging markets, however, interventions can amount to a significant share of local bond markets, and the portfolio balance channel can be stronger.

The signaling or expectation channel affects the exchange rate through a change in market expectations about future fundamentals (including the stance of monetary policy). If the central bank has better information about fundamentals (which is certainly the case, at least regarding the future stance of monetary policy), then intervention can be perceived as a signal of future exchange rate movements. The strength of that signal may depend on how sporadic or frequent interventions are. For example, all else equal, an intervention by a central bank that rarely intervenes may send a stronger signal than an intervention by a central bank that intervenes often. Unlike the portfolio balance channel, it is not clear *a priori* whether this channel should be stronger in emerging or advanced economies.

Figure 1 reports the size of reserves relative to different metrics for a sample of emerging economies in 2007 and 2012. The ratio of reserves to M2 (first panel) and reserves to GDP (second panel) are, on average, comparable between inflation-targeting and non-inflation-targeting countries, with inflation targeters being more likely to have experienced an increase in the ratio during that period. But perhaps the most indicative gauge for the potential strength of a portfolio balance effect is the ratio of reserves to domestic currency government debt (third panel). That ratio is above 50 percent for nine of the 12 inflation-targeting countries in that sample, and it is also large among nontargeters. Therefore, the portfolio balance channel of sterilized intervention is likely to be much stronger in emerging markets than in advanced economies. One crude measure of the extent of foreign exchange intervention is the standard deviation of the change in reserves relative to the sum of the standard deviations of the change in reserves and of the change in the real exchange rate. That ratio ranges from zero (when there is no intervention) to one (when there is no variation in the real effective exchange rate). The average of that ratio over 2007–12 is 0.62 and 0.76 among the inflation targeters and nontargeters in figure 1, respectively. Thus, not only is the stock of reserves comparable among targeters and nontargeters, but so is a measure, albeit crude, of activism in the use of foreign exchange intervention.

Sarno and Taylor (2001) provide a survey of the literature on sterilized intervention. The earlier literature, which typically focuses on advanced economies, generally concludes that sterilized intervention—except possibly by signaling future monetary policy—is unlikely to be effective in the advanced economy context, not least because the magnitude of outstanding assets means that the central bank would need to undertake implausibly large interventions to

materially affect the exchange rate through any portfolio balance channel (Ghosh, 1992). The existing literature does suggest that such intervention is more likely to be effective in emerging than in advanced economies (especially the large reserve currency countries).

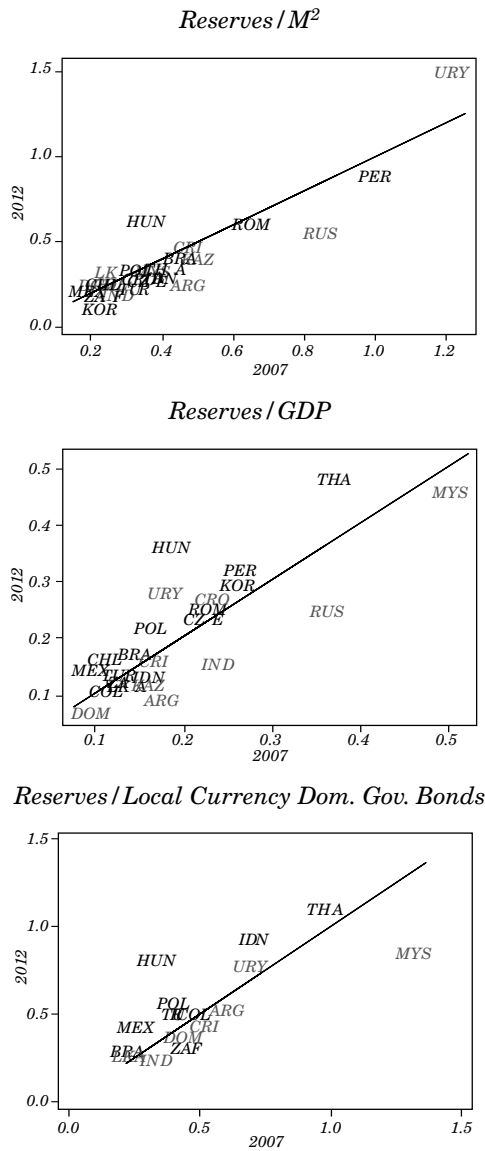
A number of empirical studies find evidence of an effect of sterilized intervention on exchange rates in emerging economies. Some of the countries for which an effect is found include Brazil (Stone, Walker and Yosuke, 2009); Chile (Tapia and Tokman, 2004); Colombia (Kamil, 2008); Czech Republic (Disyatat and Galati, 2005); India (Pattanaik and Sahoo, 2003); South Korea (Rhee and Song, 1999); Mexico and Turkey (Domaç and Mendoza, 2004; Guimarães and Karacadag 2004). Adler and Tovar (2011) analyze a cross-country sample of mainly Latin American countries and also find supportive evidence of an effect. Nordstrom et al. (2009) survey intervention practices in 14 inflation targeting emerging markets.

How does the use of both instruments (the policy rate and sterilized intervention) compare to the use of just the policy rate? To fix ideas, it is useful to contrast the response of the central bank to aggregate demand and capital inflow shocks under alternative policy regimes. If the economy exhibits divine coincidence (in the sense that the inflation target is consistent with a zero output gap) and the exchange rate does not affect welfare (other than through output and inflation), then inflation targeting would imply that the policy interest rate should be lowered in the face of capital inflows or negative shocks to aggregate demand. Under a floating exchange rate regime, the central bank does not intervene in the foreign exchange markets, allowing the exchange rate to appreciate when there are capital inflows and depreciate when there are negative demand shocks.

If policymakers do care about the exchange rate, can they do better than the strict inflation-targeting-cum-floating-exchange-rate regime implies? The answer is yes. Indeed, in a limiting case, there is a clear policy assignment rule: the interest rate should be used to meet the inflation target, while sterilized intervention should be geared to the exchange rate objective.<sup>2</sup> Thus, the policy interest rate would be lowered in the face of negative demand shocks but would not react to capital flow shocks, while intervention would be used to resist appreciation pressures from inflows and depreciation from negative demand shocks (depending on the cost of undertaking such an intervention). How extensively intervention is used will also depend on the costs associated with that instrument.

2. See De Gregorio (2010) for a discussion of the Chilean case.

**Figure 1. Size of Foreign Exchange Reserves Relative to Different Metrics for IT and non-IT Emerging Markets**



Notes: Inflation Targeting countries indicated by a black font; Non-Inflation Targeting countries indicated by a grey font. Peru and Russia are outside of the range in the third panel, and their ratios for 2012 were 293 and 364 percent, respectively.

Sources: IMF International Financial Statistics, World Economic Outlook, and IMF Desk Estimates.

Despite its simplicity, this argument embodies a basic truth: if policymakers have multiple objectives (which they surely do), and if the central bank has multiple instruments (which it probably has), then in general it makes sense to use the full set of available instruments. While it is difficult to argue against this point in the abstract, in our particular context, three objections can be raised: first, that modern emerging market central banks (like their advanced economy counterparts) are largely indifferent to the level of the exchange rate provided they are meeting their inflation objective; second, that central banks do not really have two instruments because sterilized intervention is ineffective; and third, that the flexibility afforded by an active exchange rate policy is not costless because it potentially sends confusing signals about the primacy of the inflation target, undermining its credibility.

On the first objection, while modern emerging market central banks can afford to ignore small movements in the exchange rate away from its equilibrium, there are a host of financial stability considerations involved in the case of a more significant misalignment, as discussed in the introduction. On the second objection, while the evidence on foreign exchange intervention remains mixed, in practice emerging market central banks do tend to intervene in the foreign exchange market regardless of their regime (as documented above). Implicitly, they must believe that such (costly) intervention is effective at least to some degree. Otherwise there would be no point in intervening.

Finally, on whether having a second policy objective undermines the credibility of the inflation target, we would argue that it does not—provided the central bank indeed has two instruments and clearly communicates the primacy of the inflation target over other objectives. In such a case, explicit recognition of the central bank's preferences over the exchange rate might actually strengthen the credibility of the central bank's inflation target. This is because policy is not made in a vacuum. When the exchange rate moves strongly out of line with fundamentals, the central bank inevitably comes under pressure to do something about it. Obstinate refusal to acknowledge the problem and the need for policy adjustments likely undermines policy credibility, because the public realizes that the stance is untenable. By acknowledging that the exchange rate has moved too far or too abruptly, and by openly undertaking foreign exchange intervention, an inflation-targeting central bank's claim that it will respect its inflation target arguably becomes more—not



less—credible. At the same time, aiming for an exchange rate that deviates substantially from the level consistent with medium-term fundamentals (itself never easy to estimate) may have consequences for inflation that ultimately undermine the central bank's inflation target. This underscores the importance of limiting any intervention to instances where the exchange rate is clearly deviating from its medium-term warranted value.

Accepting the logic of this argument still leaves a number of complications that need to be taken into account. For example, sterilized intervention is not costless, so the central bank will not want to intervene in arbitrarily large amounts—especially if the intervention is not very effective or the inflows are highly persistent.

## 2. INFLATION TARGETING AND FOREIGN EXCHANGE INTERVENTION

Given its objectives of maintaining low inflation and avoiding large movements in the exchange rate away from its medium-run equilibrium, what is the best policy regime for an emerging market central bank? While fully discretionary monetary and exchange rate policies allow maximum flexibility, they can also send confusing signals about central bank objectives that may ultimately undermine policy credibility. For this reason, the central bank may opt for an inflation-targeting regime, subordinating its monetary policy to achieving the inflation objective. If, as discussed above, emerging market central banks also have available a second instrument (foreign exchange intervention), they can limit temporary movements of the exchange rate without prejudicing attainment of their primary target, the inflation rate.

Here we consider how the central bank would respond to various shocks in a small open economy model of an emerging market economy with imperfect capital mobility, such that capital flows are specified as a partial adjustment process, responding positively to the interest differential (taking account of any expected appreciation of the currency), but at a finite pace:

$$\Delta k_t = \gamma_r (r_t - r_t^* + E_t \Delta e_{t+1}) - \gamma_k k_{t-1} ,$$

where  $e$  is the real exchange rate (an increase is an appreciation),  $r$  and  $r^*$  are the domestic and foreign real interest rates, and  $k$  is the stock of the foreign liability position. All variables are expressed in logs unless otherwise indicated, and all parameters (Greek letters) are positive. In a world without frictions, the capital stock should adjust instantaneously, arbitraging away any expected return differential, but we assume uncovered interest rate parity (UIP) does not hold (as is the case in practice, where, if anything, a currency tends to appreciate in the presence of an interest rate differential, the forward premium puzzle). Note that the term on the lagged stock of foreign liabilities implies that capital flows eventually stop even in the presence of a positive expected return differential.

Shocks to the foreign real interest rate can “push” capital flows, and these shocks are assumed to follow a first-order autoregressive, or AR(1), process:

$$r_t^* = \rho_r r_{t-1}^* + \eta_{r^*t}.$$

The remaining equations in the model follow standard assumptions. We assume the current account balance is inversely proportional to domestic demand and the real exchange rate, and that the current account balance plus capital flows is equal to the change in reserves:

$$CA_t = -\varphi_e e_t - \varphi_y y_t$$

and

$$CA_t + \Delta k_t = \sigma \Delta R_t,$$

where  $CA$  is the current account balance, measured as a ratio to  $k$ ,  $y$  is domestic demand,  $R$  is the stock of reserves, and  $s = R/k$ . Demand depends on the current real exchange rate and real interest rate (the IS curve), and inflation depends on expected future inflation and contemporary demand (the Philips curve):

$$y_t = -\varphi_r r_t - \varphi_e e_t + u_t;$$

$$\pi_t = \beta E_t \pi_{t+1} + \kappa y_t.$$

The shocks to aggregate demand also follow an AR(1) process:

$$u_t = \rho_u u_{t-1} + \eta_{ut}.$$

The central bank's objectives, which are assumed to be the same regardless of the policy regime, are threefold: to minimize the deviation of inflation from its target; to minimize the output gap around the economy's potential level of output; and to minimize the deviation of the exchange rate from the level implied by its medium-term fundamentals.<sup>3</sup> Our assumption of costly exchange rate deviations is motivated by concerns about competitiveness on the appreciation side and balance sheet risks of unhedged foreign currency exposure on the depreciation side (which can also be present on the appreciation side, since the eventual depreciation toward the equilibrium can pose risks).<sup>4</sup> In principle, the risks from an overvaluation and an undervaluation are likely to be asymmetric, but for the sake of simplicity and modeling convenience, we treat the loss as symmetric. In addition, recognizing that there are costs to holding reserves, the central bank is assumed to minimize its accumulation of excess reserves (relative to the coverage required for country-insurance purposes).<sup>5</sup> Thus, the central bank's objective function is

$$\min_{r,R} \text{EPDV} \left[ \left( y_t - \bar{y}_t^e \right)^2 + a \pi_t^2 + b e_t^2 + c R_t^2 \right],$$

where  $\bar{y}_t^e$  is the public's estimate of the central bank's inflationary bias, and  $a$ ,  $b$  and  $c$  are the parameters that determine the relative loss from inflation, exchange rate and reserve deviations from their steady-state values.

3. See De Paoli (2009) for a micro-founded model in which welfare would be captured by this objective function.

4. The central bank's objective can be specified as penalizing the (log) level deviation of the real exchange rate or its rate of change. Though conceptually distinct, it makes little qualitative difference to the simulations, as in either case the central bank seeks to limit the movement of the exchange rate. The reported simulations assume the targeting of the real exchange rate level around the value implied by medium-run fundamentals.

5. The literature typically assumes that the cost of holding reserves is given by the interest rate differential, but that comparison fails to take into account credit and currency risk (see Jeanne and Rancière, 2011, for a detailed discussion of the opportunity cost of reserves).

Under discretionary policies, the central bank is unable to commit to not trying to inflate the economy above its nonaccelerating inflation potential; a measure of the central bank's (lack of) credibility is the public's perception of its incentive to do so. The latter imparts an inflationary bias under discretion.

For simplicity, inflation targeting is modeled as a constraint that inflation must remain zero at all times. That is, the central bank commits to a lexicographical ordering of objectives such that its inflation target is always met (in the sense that target and expected inflation are equal). This keeps inflation expectations firmly anchored at  $\pi = 0$  throughout, so there is no inflationary bias under inflation targeting.<sup>6</sup> In what follows, we restrict attention to inflation-targeting regimes, with and without foreign exchange intervention, and the objective function becomes

$$\min_{r,R} \text{EPDV} \left( be_t^2 + cR_t^2 \right),$$

subject to  $\pi_t = 0$  for all  $t$ .

We calibrate the model assuming the following initial ratios and parameters:

- Capital flow parameters:  $\gamma_r = 1.0$ ;  $\gamma_k = 0.5$ ;  $\rho_{r^*} = 0.9$ ;
- Balance-of-payment parameters:  $\phi_\varepsilon = 0.15$ ;  $\phi_y = 0.3$ ;  $\sigma = 0.5$ ;
- Inflation and aggregate demand parameters:  $\beta = 0.99$ ;  $\rho_u = 0.9$ ;
- $\varphi_r = 1.0$ ;  $\varphi_e = 0.25$ ;
- Objective function weights:  $a = 1.0$ ;  $b = 0.1$ ;  $c = 0.01$ .

## 2.1 Benefits of Using Two Instruments

We initially consider the impact of a positive aggregate demand shock, equivalent to 2.5 percentage points of output, which occurs in period 1 and dies out gradually (figure 2). The central bank responds by raising the policy interest rate in order to cool domestic demand. Comparing the interest rate response across regimes shows that the central bank raises the interest rate more when it also intervenes in the foreign exchange market. The higher policy rate attracts capital inflows and appreciates the exchange rate. When the central bank intervenes, those appreciation pressures are attenuated, causing the

6. If inflation targeting was modeled in more flexible terms, for example as a range for inflation, then the central bank would have more flexibility to accommodate other objectives than in our setting.

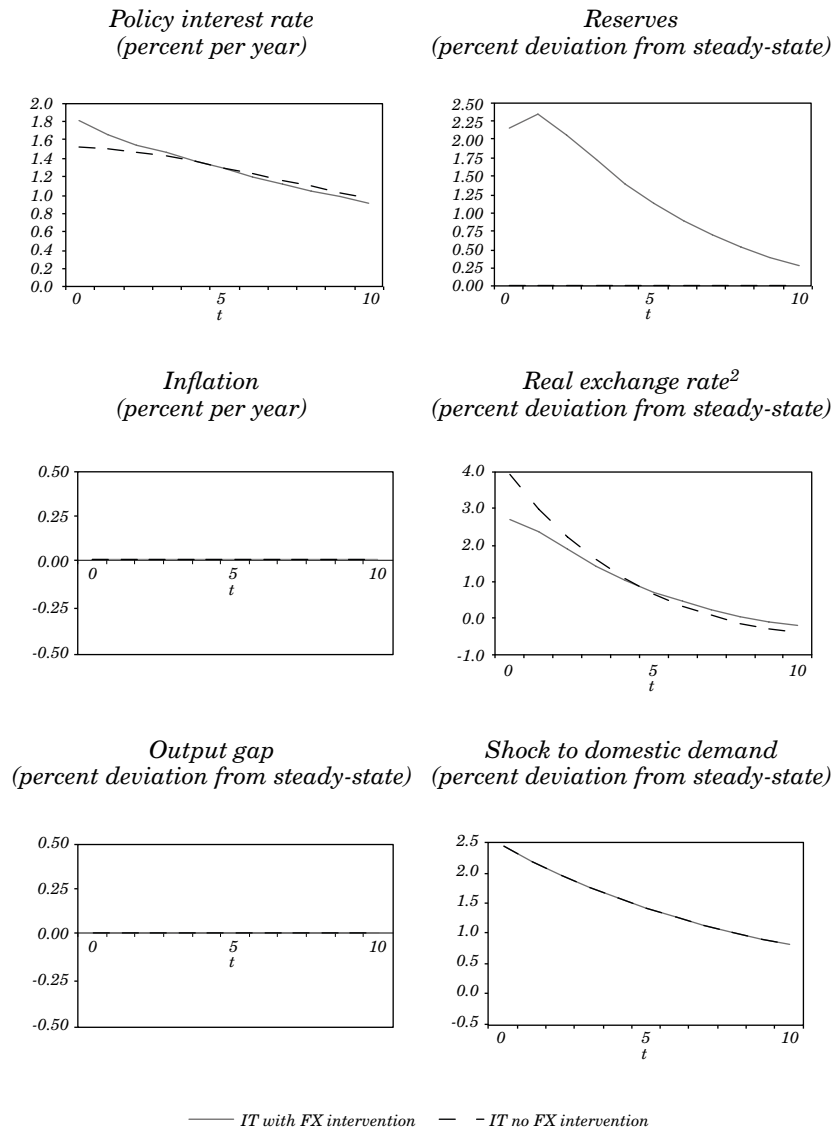
exchange rate to appreciate less even though the central bank raises the policy rate more when it also intervenes. The initial accumulation of reserves is gradually reversed, as they return to their steady-state value (normalized to zero). That is, the optimal response involves only a transitory accumulation of reserves, with no change in their steady-state stock.

A capital inflow shock is driven by an exogenous decline in foreign interest rates, which pushes capital into the domestic economy. That decline is also assumed to gradually reverse (figure 3), and the central bank responds by lowering the policy rate (so as to reduce the return differential and discourage flows) and accumulating reserves (in the regime where it intervenes). The central bank lowers the policy rate less when it also intervenes, but it is still able to achieve a lower appreciation of the exchange rate since sterilized intervention is helping to absorb part of the inflows. Inflation remains stabilized at its target under both regimes. Again, the build-up in reserves is temporary, with the initial accumulation being followed by a gradual reversal, as the stock of reserves reverts to its steady-state.

The use of reserves as a temporary tool is driven by the assumptions on the cost of reserves in our model. It is very costly to accumulate reserves in the steady-state, since that cost would be incurred in every period, so the build-up is temporary. Moreover, whereas the accumulation of reserves appreciates the exchange rate, the eventual decline in reserves will contribute to depreciation in the future, and that expectation will affect capital flows. As a result, reserve accumulation should be countercyclical. An attempt to depreciate the exchange rate by accumulating reserves in the absence of any shock would attract capital flows both because of the expectation of appreciation following the initial depreciation of the exchange rate and because of the increase in the policy rate required to meet the inflation target following that initial depreciation. If the cost of holding reserves was set to the return differential, which goes to zero in steady-state, then reserves would become costless in steady-state. That would lead to a much more aggressive use of that instrument. For the purposes of our model, setting the cost of reserves to a constant ensures that they remain costly in steady-state, which seems an empirically relevant assumption and yields more plausible results for the use of that instrument.<sup>7</sup>

7. While in our model both the domestic and foreign interest rates are zero in steady-state, in practice many emerging market economies have had interest rates persistently higher than the world interest rate. Capital flows would eventually converge to zero in our model even in the presence of a persistently higher domestic interest rate (because flows are assumed to depend negatively on the accumulated stock of foreign capital).

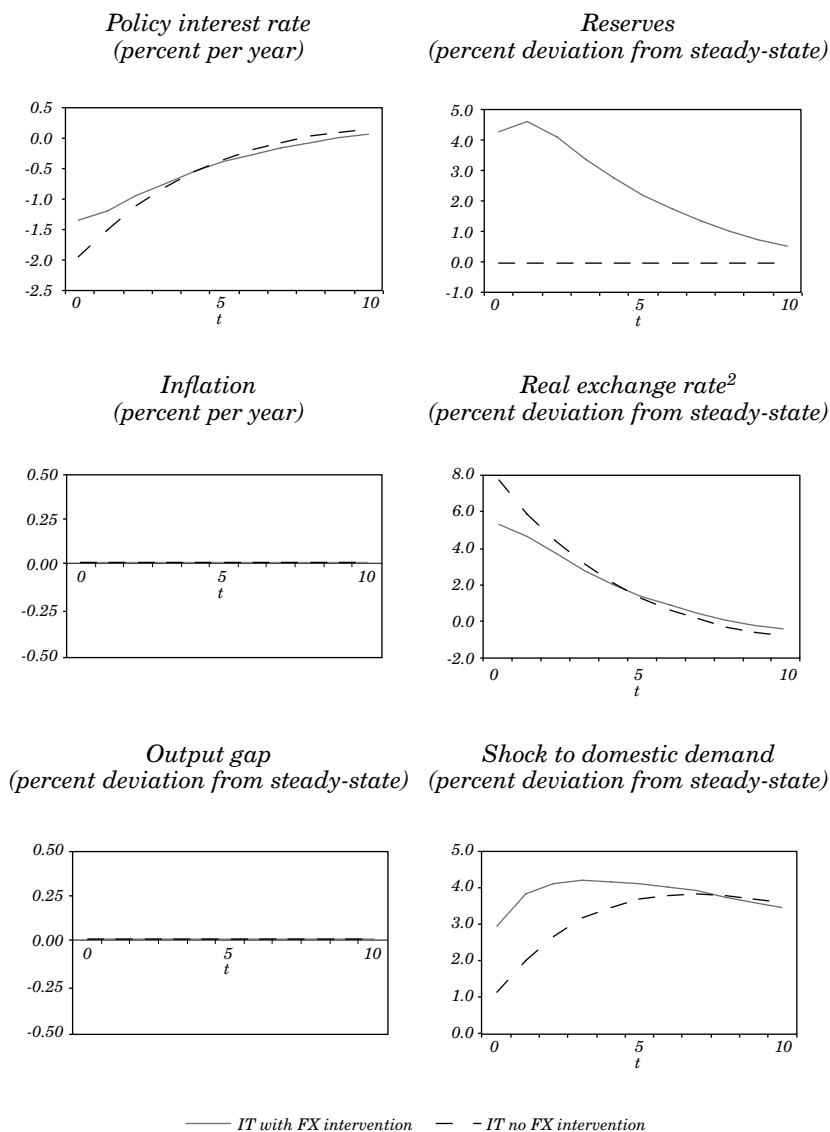
**Figure 2. Policy Response to a Demand Shock<sup>1</sup>**



1. The shock is based on a 2.5 percentage point increase in domestic demand.  
2. An increase in the exchange rate is an appreciation of the domestic currency.

Source: Authors' elaboration.

**Figure 3. Policy Response to a Capital Inflow Shock<sup>1</sup>**



1. The capital inflow shock is based on a 5 percentage point decline in the world interest rate.
2. An increase in the exchange rate is an appreciation of the domestic currency.

Source: Authors' elaboration.

The central bank is able to deliver on its inflation target throughout. When it does not intervene, inflation is stabilized by the combination of a deeper cut in the policy rate and stronger appreciation. When it intervenes, the inflation target can be achieved by a smaller reduction in the policy rate and more modest appreciation. However, the more appreciated exchange rate in the nonintervention regime will lead to a lower welfare given the deviation of the exchange rate from its fundamental value. Thus, even though intervention is costly, the convex nature of that cost and objective function implies that it will always be optimal to deploy that additional instrument. Intervention will be deployed to a larger (smaller) extent when the cost is small (large), but the optimal response will always involve at least some intervention.

The benefits of sterilized intervention depend on the specific assumptions of the model. We illustrate this point by showing how the policy response varies depending on the sensitivity of flows to the return differential and the persistence of the capital flow shock.

Figure 4 plots the response of the policy rate and foreign exchange intervention as a function of the sensitivity of flows to the return differential ( $g_r$ ). The higher that sensitivity, the larger the reduction in the policy rate in response to the inflow shock, and the smaller the size of the intervention (relative to the initial capital inflow). This sensitivity is the key parameter that determines how strong the deviation from UIP can be. The smaller that parameter, the larger the role for intervention. But the larger that parameter, the closer we approach a setting where UIP holds and intervention is not effective. In absolute terms, the effect of that parameter on intervention can be nonmonotonic: when that sensitivity is small, intervention is small because there is not much capital coming in to begin with. As that sensitivity increases, the capital inflow shock becomes stronger, which leads to more intervention in absolute terms (but corresponding to a smaller proportion of the capital inflow). For large enough values of that sensitivity, the amount of intervention starts to decline even in absolute terms, as we converge to the limit where UIP holds and intervention loses traction.

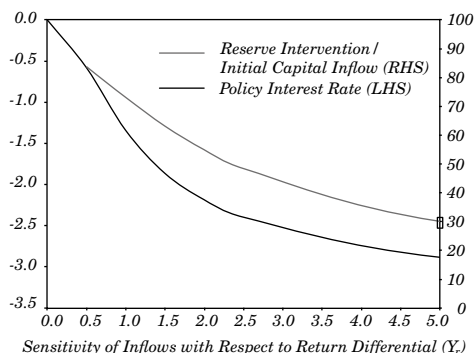
Figure 5 plots the response of the policy rate and foreign exchange intervention as a function of the persistence of the shock to the world interest rate. When that shock is relatively short-lived, the adjustment in the policy rate is small, and foreign exchange intervention plays a relatively large role in the response (helping absorb most of the initial inflows). But the larger the persistence



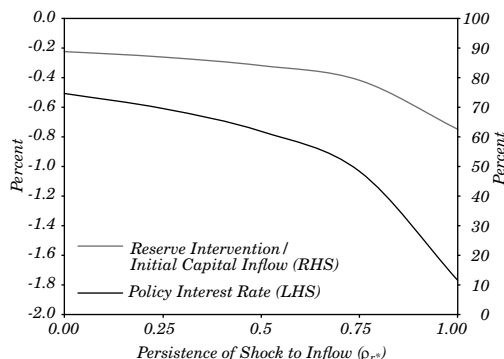
of the shock, the stronger the adjustment in the policy rate and the smaller the intervention as a share of the initial inflows. This result emerges from the assumptions regarding the cost of foreign exchange intervention, which makes their sustained use very costly to the central bank. It also conforms to the usual intuition that an economy should adjust to permanent shocks (in this case a lower policy rate in response to persistently low world interest rates) but intervene to absorb transitory shocks that move it away from its equilibrium. While the logic is clear, in practice the central bank may have significant difficulty judging whether the shock is likely to be temporary or persistent, especially given its likely dependence on a host of factors, including global risk aversion and the behavior of monetary policy in industrial countries.

The discussion above pertains to capital inflows, though many of the same arguments apply to outflows (the response to an outflow shock is the mirror image of the response to an inflow shock of a similar magnitude). In the face of temporary capital outflows, the central bank would raise policy interest rates to keep the output gap at zero (and inflation at its target level), raising them more aggressively in the non-foreign-exchange-intervention regime. Despite the more aggressive interest rate policy, the central bank would need to tolerate a larger exchange rate depreciation when it does not intervene. Again, inflation targeting keeps the output gap at zero and inflation at its targeted level.

**Figure 4. Policy Response and Sensitivity of Inflows with Respect to Return Differential (\*)**



(\*) Response under an IT regime with FX intervention. The capital inflow shock is based on a 5 percentage point decline in the world interest rate. All parameters other than  $\rho_{p,s}$  are kept constant at their baseline values.

**Figure 5. Policy Response and Persistency of Inflow (\*)**

(\*) Response under an IT regime with FX intervention. The capital inflow shock is based on a 5 percentage point decline in the world interest rate. All parameters other than  $\rho_{r,s}$  are kept constant at their baseline values.

The logic of the simulations is thus symmetric to the case of capital inflows. Yet there is one crucial difference in that the central bank can run out of reserves, whereas there is no obvious limit to how much it can accumulate in the face of inflows. When it comes to outflows, therefore, it is particularly important to distinguish between temporary shocks and more persistent outflows, financing the former but relying more heavily on the policy interest rate for the latter (or just letting the currency depreciate). As in the case of capital inflows, an inflation-targeting central bank should only intervene when the exchange rate has clearly moved away from its medium-run equilibrium. If anything, the central bank will want to be especially cautious before intervening in the foreign exchange markets (as opposed to just raising interest rates) in the face of outflows, unless these are sufficiently large and abrupt (and perhaps more reflective of developments in capital-sending countries) that they threaten severe economic dislocation.

## 2.2 Some Costs

By construction, given our model's assumptions and the central bank's objective function, a policy of inflation-targeting-cum-sterilized-intervention is superior to inflation-targeting alone. In this setting, being able to optimize using two instruments will always yield a higher welfare than optimizing with a single instrument. It

is important to recognize, however, that there is no time consistency/credibility problem in our model (any such problems are assumed to be addressed by the inflation-targeting framework).<sup>8</sup> In a richer setting, the use of the second instrument (namely, foreign exchange intervention) to help stabilize the exchange rate could lead the market to update its beliefs about the central bank's commitment to its inflation-targeting framework. While this can be a potentially large deterrent to the systematic use of the foreign exchange intervention as a second instrument, this need not be the case provided the central bank clearly articulates the primacy of its inflation objective.

There may be concerns about using two instruments in the face of real-time uncertainty. The central bank does not know with certainty what the equilibrium exchange rate is, whether the shocks it faces are persistent or transitory, and perhaps even how effective foreign exchange intervention is at affecting the exchange rate. This could lead to an outcome where the second instrument ends up being used less (or more) than it should have been and does not yield the desired effects. But similar challenges apply when the central bank implements inflation targeting with a single instrument. For example, any inflation-targeting central bank already has to take into account how persistent shocks to the exchange rate are likely to be, which affects their corresponding impact on future inflation. While the second instruments adds an additional dimension to this problem, limited real-time information is a challenge that central banks already have to cope with.

Another possible concern is that the use of foreign exchange intervention could affect investor behavior. A smaller adjustment in the policy rate (and smaller initial appreciation) provides investors with a larger expected return differential. In our model, the parameter that determines the sensitivity of flows to that return differential is fixed, but in practice, it may vary with the size of that differential. It may also vary with the risk around the expected return. Flows could respond to a decrease in that risk (for a given expected return differential). For example, if foreign exchange intervention succeeds in stabilizing the exchange rate despite a sizable interest rate differential, it could encourage more carry trade flows (since investors

8. Ghosh, Ostry and Chamon (2014) solve a two-period model with imperfect capital mobility, characterizing how welfare varies across regime (discretion versus inflation targeting) and use of foreign exchange intervention, as a function of the importance of shocks to capital flows and domestic demand and the degree of inflationary bias.

could reap the return differential while facing limited exchange risk). Similar concerns apply in the case of outflows, where intervention can facilitate capital flight, leading to a larger outflow than would be observed if the exchange rate was allowed to adjust more rapidly.

### **3. CONCLUSIONS**

Inflation targeting has served well the many emerging market economies that adopted it. It helped them lower and stabilize inflation, and many central banks built their credibility around that framework. Even the emerging market inflation targeters that enjoy the most credibility would not contemplate abandoning that framework. At the same time, benign neglect of the exchange rate is not a viable option for most of these economies, where borrowing constraints, currency mismatches and other sources of financial fragility can compound the vulnerabilities caused by large swings in the exchange rate. Consequently, their inflation targeting needs to be sufficiently flexible to accommodate, at least to some extent, the smoothing of large shocks to the exchange rate. In this paper, we have argued that foreign exchange intervention can provide that needed flexibility.

Inflation-targeting emerging economies often intervene in the foreign exchange market. By many measures, they have intervened to a larger extent during the recent capital flow bonanza than their non-targeting counterparts. Since that intervention is often costly—at least if measured by the interest rate differential—these central banks must believe that intervention does have traction, or they would not pursue it. Some may worry that the use of foreign exchange intervention could eventually undermine the credibility of the inflation-targeting framework. In this paper, we have argued that that need not be the case, provided the central bank clearly communicates the primacy of its inflation target over the desire to stabilize shocks that move the exchange rate away from its fundamental value. Moreover, by acknowledging that a second instrument can be deployed (namely, foreign exchange intervention), the central bank can actually enhance its credibility, since the use of this second instrument provides more room to smooth shocks to the exchange rate in a way that is fully consistent with the inflation target.

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