Volume Title: The Inflation-Targeting Debate

Volume Author/Editor: Ben S. Bernanke and Michael Woodford, editors

Volume Publisher: University of Chicago Press

Volume ISBN: 0-226-04471-8

Volume URL: http://www.nber.org/books/bern04-1

Conference Date: January 23-26, 2003

Publication Date: December 2004

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URL: http://www.nber.org/chapters/c9565

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Inflation Targeting and Sudden Stops

Ricardo J. Caballero and Arvind Krishnamurthy

10.1 Introduction

Underlying weaknesses in the domestic financial sector and limited integration with world financial markets make emerging market economies vulnerable to "sudden stops" of capital inflows. Without much warning, the capital flows that support a boom may come to a halt, exposing the country to an external crisis.

Monetary policy in this context has often been seen as an additional source of problems rather than as a remedy. Countries with a history of inflation problems have limited central-bank credibility. The currency pressures of the sudden stop test this credibility, so that either the loss of credibility or the attempt to regain it in the middle of the crisis exacerbates the contraction.

However, there is a group of countries for which the problem of high and unstable inflation is no longer present but the problem of sudden stops persists. These countries include Chile, Mexico, and many of the Asian economies. Moreover, looking toward the future, this group is bound to grow, as hopefully Brazil, Turkey, and countries of Eastern Europe establish discipline over seigniorage and fiscal policies.

Many of these advanced emerging economies are now in the process of

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We are grateful to Ben Bernanke, Andrew Hertzberg, and conference participants for their comments. We thank Donna Zerwitz for editorial assistance. Caballero thanks the National Science Foundation for financial support. Krishnamurthy thanks the International Monetary Fund for their hospitality while this paper was being written. All errors are our own.

designing their monetary policy framework. Given the success of "inflation targeting" in a wide range of economies, it seems only natural that this framework be contemplated for these economies as well. In this paper, we study how inflation targeting should be adapted to countries whose primary macroeconomic concern is the presence of sudden stops in capital inflows.

The starting point of our analysis is the observation from Caballero and Krishnamurthy (2002) that, during a sudden stop, monetary policy loses its potency. The principal constraint on output is a shortage of *external* resources. The main effect of domestic money, on the other hand, is on agents' *domestic* borrowing capacity. Thus, the knee-jerk reaction of the central bank to the outflow of capital, of raising domestic interest rates—dubbed "fear of floating" by Calvo and Reinhart (2002)—within our model is the natural consequence of a central bank that is concerned with inflation and output. Raising interest rates reduces the exchange rate depreciation, with limited effects on output beyond the impact of the external constraint. However, while fear of floating may seem optimal from this contemporaneous perspective, it is suboptimal ex ante.

The reason for this suboptimality is that the *anticipation* of the central bank's tight monetary policy during the sudden stop has important effects on the private sector's incentives to insure against sudden-stop events. Insuring against these events means taking prior actions that increase the total dollar assets of the country (decrease the total dollar liabilities of the country) in the sudden-stop event. Since a contractionary monetary policy reduces the domestic scarcity value of dollars, it also lowers the returns to hoarding net dollar assets. Simply put, contracting dollar debt is less costly in an environment where the peso is expected to be supported in the event of a crisis. Thus, the anticipation of a tight monetary policy leaves the economy less insured against the sudden stop.

In this context, expectations shape policy, not in whether inflation is anticipated or unanticipated, but in how the private sector views its rewards to insuring against sudden stops. For incentive reasons, the optimal monetary rule is to expand during external crises, even if the expansion has a limited contemporaneous effect on output.

It should be apparent that time inconsistency is a serious issue in this context. A central bank that cannot commit will ignore the insurance aspect of monetary policy and follow a procyclical, rather than the optimal countercyclical, policy. This bias is made worse by the presence of an expansionary bias a la Barro and Gordon (1983). The reason is that the central bank only sees a benefit from expanding during normal times. As a result, it lowers interest rates during these times, leading to higher inflation (as in Barro and Gordon). When the sudden stop occurs, the central bank has even more reason to defend the exchange rate as it inherits high inflation.

In our framework, since crises are characterized by dollar shortages, there is scope for managing international reserves in order to ease these

shortages. Our model provides a natural motivation for both centralized holding of reserves and holding reserves in the form of dollars. However, we show that a central bank that cannot commit will be too aggressive in injecting dollar reserves during a crisis. Moreover, this distortion interacts with the monetary policy problem. A more suboptimal monetary policy will lead to a more severe crisis, and a greater incentive for the central bank to inject reserves.

Given the time inconsistency of the central bank, what should its mandate be? That is, how should the central bank's objectives be modified so that it internalizes the insurance dimension of the sudden-stop problem? We propose modifying inflation targeting so that the central bank follows state-contingent inflation targets, overweights nontradable inflation in the measure of inflation that is targeted, and explicitly weighs reserves holdings in its objectives.

Since the no-commitment central bank loosens during good times and tightens during bad times, we suggest that its mandate should make the inflation target countercyclical (i.e., low during good times and high during sudden stops). In practice, the state contingency may be implemented by making inflation targets contingent on external factors such as commodity prices, U.S. interest rates or U.S. corporate bond spreads, and the Emerging Markets Bond Index Plus (EMBI+).

Tradables experience strong inflationary pressures during crises as the exchange rate depreciates. On other hand, the pass-through to nontradables is more limited. Thus, targeting a measure of inflation that overweights nontradables also will reduce the central bank's incentive to raise interest rates during crises.

Finally, since the central bank injects reserves too aggressively during crises, we suggest that its objectives be modified to place weight on the stock of reserve holdings. Choosing an appropriate weight for reserves will help the central bank to internalize the effect of its exchange interventions on the private sector's insurance incentives.

Our paper is most directly related to the literature on monetary policy in economies with financial frictions (e.g., Bernanke and Blinder 1988; Bernanke, Gertler, and Gilchrist 1999; Christiano, Gust, and Roldos forthcoming; Diamond and Rajan 2001; Gertler, Gilchrist, and Natalucci 2001; Holmstrom and Tirole 1998; Kiyotaki and Moore, 2001; and Lorenzoni, 2001). Unlike most of this literature, we are concerned with monetary policy in emerging markets, so we model the presence of two distinct financial constraints: one between domestic agents and one between domestic agents and foreign investors.[1]

1. Of the preceding literature, the Diamond and Rajan paper (2001) is the closest to our analysis in the sense that they also model two distinct constraints: a bank solvency constraint and an aggregate liquidity constraint, in their case.

The recent emerging-markets literature has identified sudden stops of international capital flows as an important part of external crises (see, for example, Calvo 1998 and Calvo and Reinhart 2002). Our model shares this feature. We model the sudden stop as a tightening of international financial constraints. The importance of international financial constraints for emerging markets was first identified in the sovereign debt literature (see, for example, Bulow and Rogoff 1989).

Calvo and Reinhart (2002) offer another perspective on fear of floating. They argue that, since so much of debt in emerging markets is in dollars, a central bank will recognize that the output cost of allowing the exchange rate to depreciate during a crisis is too high, and will therefore raise interest rates. In one sense, the mechanism in our model complements their explanation. An open question in the Calvo and Reinhart model is why firms take on so much dollar debt (i.e., Calvo and Reinhart take stocks of foreign debt as exogenous). We show that stabilizing the exchange rate will reduce the private sector's incentive to insure against sudden stops, and naturally leads to increasing liability dollarization (see Caballero and Krishnamurthy 2003). On the other hand, our central bank stabilizes the exchange rate because it focuses on inflation costs, as opposed to Calvo and Reinhart's output costs. The emphasis on insurance is central to our analysis and links us more closely to Dooley (2000), who also emphasizes insurance effects.

Our monetary policy analysis is conducted in a standard inflation-targeting framework (e.g., King 1994; Svensson 1999; or Woodford 2002). Svensson (2000) has extended the inflation-targeting framework to open economies that fit the usual small-open-economy assumption, in which countries face no international financial constraint. His analysis is most applicable to countries such as Australia or Canada, but less so to the emerging markets that are the focus of this paper.

The next two sections develop a model of monetary policy in an environment of sudden stops. Section 10.4 then studies optimal monetary policy in this environment. Section 10.5 focuses on the central bank's behavior when it cannot commit to its monetary policy choices. Section 10.6 considers two modifications to the central bank's objectives that result in the optimal monetary policy being implemented. Section 10.7 adds international reserves to the model. Section 10.8 concludes.

10.2 A Model of Sudden Stops

In this section we sketch a model of sudden stops. This serves as a prelude to the monetary policy analysis of the next section. The model we outline is developed more rigorously in Caballero and Krishnamurthy (2002).

Firms have assets at time t of A_t. These are domestic assets (i.e., they gen-

erate peso revenues), so that their peso value is $A_t(i_t)$, where i_t is the peso interest rate and A_t is a decreasing function.[2]

We assume that firms need dollars for investment. That is, they need dollars in order to import some investment goods that are inputs to production. This is justified by noting that at the margin, firms in developing countries are borrowers in international markets. We are extrapolating this demand, so that firms always have to borrow from abroad.

Moreover, we assume that firms are financially constrained so that the aggregate demand for investment goods can be written as $D(A_t, i_t^d)$. As in most models of financial constraints, the net worth of firms influences their demand. Firms sell their peso assets, worth A_t, along with any other peso funds they are able to borrow, in order to raise dollars for investment goods. The dollars are borrowed at interest rate of i_t^d, which is the price in the demand schedule. D is decreasing in i_t^d and increasing in A_t.

The supply of dollars comes from two sources. First, we assume that domestic lenders have a supply of R_t dollars (small). The rest are capital inflows, CF_t. Thus, in equilibrium,

$$D(A_t(i_t), i_t^d) = R_t + CF_t. \tag{1}$$

A supplier of dollars earns a return of

$$\frac{\varepsilon_t(1 + i_t)}{\varepsilon_{t+1|t}},$$

where ε_t is the peso-dollar exchange rate. Supplying one dollar yields ε_t pesos today. Invested at the peso interest rate of i_t and converting back into dollars tomorrow at $\varepsilon_{t+1|t}$ yields the above expression.

Supplying one dollar is profitable as long as this return exceeds the international interest rate $(1 + i_t^*)$. Define

$$i_t^d \equiv \frac{\varepsilon_t(1 + i_t)}{\varepsilon_{t+1|t}} - 1.$$

For $i_t^d \geq i_t^*$ there is an excess return on supplying dollars to domestic firms. The spread $i_t^d - i_t^*$ is a liquidity premium.

The usual small-open-economy assumption is that the supply of dollars is perfectly elastic at the price of $i_t^d = i_t^*$. In this case, the equilibrium level

2. In the next section we derive a more explicit sticky-price mechanism that justifies using the nominal interest rate as an argument. Note that if *domestic* liabilities are extensively dollarized, then A_t also becomes a decreasing function of the exchange rate. In this case, monetary policy is less effective in influencing the peso value of domestic assets since the expansionary effect of lowering i_t is offset by the depreciation such policy causes. See Caballero and Krishnamurthy (2002) for a discussion of constrained monetary regimes in an environment with sudden stops. On the other hand, dollarization of *external* liabilities can be seen as an endogenous response to the mechanism we discuss in this paper and is described in detail in Caballero and Krishnamurthy (2003).

of investment is simply $D(A_t, i_t^*)$. Fixing the foreign interest rate, a fall in the domestic net worth of firms (say, through an increase in i_t) decreases investment.

The sudden-stop assumption is that there are times when the country is quantity constrained in borrowing from international markets. That is,

$$CF_t \leq L_t,$$

where L_t is the maximum quantity of funds that foreign investors will supply to this country. If this constraint binds, equilibrium is

$$D(A_t, i_t^d) = R_t + L_t \Rightarrow i_t^d > i_t^* \tag{2}$$

Note here that an increase in A_t has no effect on investment. This is because investment is determined by the sudden-stop supply of $L_t + R_t$. Instead the only effect of A_t is on i_t^d.

Defining e_t as the log exchange rate, we can rewrite the *domestic* interest parity condition as

$$e_{t+1|t} - e_t \approx i_t - i_t^d. \tag{3}$$

When $i_t^d = i_t^*$ this is the usual interest parity condition. In that case, fixing $e_{t+1|t}$, a decrease in the peso interest rate of i_t, depreciates the exchange rate. In the sudden-stop case, where $i_t^d > i_t^*$, the current exchange rate is depreciated relative to the future exchange rate by the size of the liquidity premium. In this case, a decrease in i_t has the additional effect of causing the interest parity condition to shift upward, reinforcing the depreciation in the exchange rate.

The model we have outlined embeds two principal ideas. First, there are times when an emerging economy is financially constrained in the international market. In this instance, the supply of dollars is inelastic and the limited supply determines domestic investment and output. The second idea is that the main effect of monetary policy is on the domestic borrowing capacity of firms. In particular, decreasing interest rates during a sudden stop does not attract more capital inflows. It has a potentially very large effect on the exchange rate but limited contemporaneous effect on output. The last part of this statement follows from the right-hand side of equation (2), which is fixed. The earlier part of the statement follows from the left-hand side of the same expression and the fact that A_t rises as i_t falls. Thus i^d must rise to ensure equilibrium; by the interest parity condition, this implies that the exchange rate depreciates to offset not only the reduction in i_t but also the rise in i_t^d.

We denote the sudden-stop state as the V regime. In the V regime, $L_t + R_t$ fully determines investment. Let us imagine shifting to date $t - 1$, to a point in time where private and central bank actions may influence this stock.

Suppose that at date $t - 1$ the economy is not in a sudden stop. The supply

of funds it faces is horizontal at i^*_{t-1} (H regime). A domestic agent with some dollars at this date can either lend these funds for domestic investment or can save them in an international bond. By opting to save, the agent will be able to lend the dollar at t and earn an excess return of $i^d_t - i^*_t$. That is, the fact that $i^d_t > i^*_t$ will induce domestic agents to "insure" against the sudden stop (raising R_t).

We have shown elsewhere (see Caballero and Krishnamurthy 2001) that when domestic financial markets are underdeveloped, there is an externality—akin to a free-rider problem—whereby the market value of this benefit, $i^d_t - i^*_t$, is less than its social value. In this circumstance, the private sector will underinsure against sudden stops. This underinsurance may take many forms: for example, borrowing too much, contracting foreign currency–denominated debt, choosing short-term debt maturities, or contracting too few credit lines (see Caballero and Krishnamurthy 2003).

Aside from direct (and costly) regulation of capital inflows and the private sector's insurance decisions, there are two instruments at the central bank's disposal to offset the externality. First, it can increase its own holding of foreign reserves and thereby increase R_t. Our model provides a natural motivation for both centralized holding of reserves and holding them in the form of international liquidity. We will return to this mechanism before concluding the paper. Second, and most important for the purpose of this paper, the central bank can commit to *expanding* monetary policy during the sudden stop. Since lowering i_t during the sudden stop raises i^d_t, this increases the private sector's incentive to self-insure. We develop this idea fully in the next sections.

10.3 Sudden Stops and Monetary Policy

We now extend the preceding model to incorporate monetary policy and private-sector price setting. Our goal is to study optimal monetary policy in an environment of sudden stops.

At date $t-1$, we assume that the economy is in the H regime. That is, the external supply of funds it faces is elastic at the interest rate of i^*. At date t, the economy either remains in the H regime or transits to the V regime. The probability of remaining in H is q, while that of entering V is $1-q$. Finally, at date $t+1$, the crisis episode passes, and the economy is in the H regime. We denote the nominal exchange rate at date $t+1$ as $\bar{e}$, and fix this to be independent of all events at the prior dates. At prior dates, the exchange rates are e_t and e_{t-1}.

We are mainly interested in what happens at date t. At this date, aggregate demand is given by

$$\tilde{y}^d_t = -b(r_t - i^*), \tag{4}$$

where $\tilde{y}_t^d$ is the output gap and i^* is the constant foreign interest rate (only a normalization in this equation). Foreign inflation is equal to zero.

The domestic real interest rate, r_t, is defined by

$$r_t = i_t - \pi_{t+1|t} \tag{5}$$

where i_t is the (peso) nominal interest rate and $\pi_{t+1|t}$ is the expectation of inflation between periods t and $t + 1$, conditional on information at date t.

On the supply side, we assume that the economy is composed of two types of price setters. Slow price setters set their prices to grow at a constant rate of $\overline{\pi}$ over both periods (i.e., from $t - 1$ to t and from t to $t + 1$). They choose this average growth rate to be equal to the expected rate of depreciation of the exchange rate:

$$\overline{\pi} = E_{t-1}\left[\left(\frac{e_t - e_{t-1}}{2}\right) + \left(\frac{e_{t+1} - e_t}{2}\right)\right]. \tag{6}$$

Fast price setters index their prices to the exchange rate. Putting these two groups together and assigning positive weights of α and $1 - \alpha$ to the slow and fast price setters, respectively, yields an inflation rate between t and $t + 1$ of

$$\alpha\overline{\pi} + (1 - \alpha)(e_{t+1} - e_t).$$

The expected change in the exchange rate between any two dates satisfies the *domestic* interest parity condition we derived in equation (3),

$$e_{t+1|t} - e_t = i_t - i_t^d. \tag{7}$$

Substituting the interest parity condition into the inflation expression yields

$$\pi_{t+1} \equiv \pi_{t+1|t} = \alpha\overline{\pi} + (1 - \alpha)(i_t - i_t^d). \tag{8}$$

We now rewrite the aggregate-demand equation to account for the inflation term we have derived in equation (8). First note that

$$r_t - i^* = \alpha(i_t - i_t^d - \overline{\pi}) + (i_t^d - i^*).$$

Substituting this into the aggregate-demand expression yields

$$\tilde{y}_t^d = -b(\alpha\tilde{i}_t + \tilde{i}_t^d), \tag{9}$$

where

$$\tilde{i}_t \equiv i_t - i_t^d - \overline{\pi}, \qquad \tilde{i}_t^d \equiv i_t^d - i^*.$$

The aggregate-demand equation, (9), is a simple parameterization of the aggregate demand in the prior section, equation (1). Note that it is decreasing in both the domestic (peso) real interest rate and the domestic interest rate on dollar borrowing.

Equilibrium and policy determine the domestic dollar (i_t^d) and peso (i_t) rates. Beginning with the former, in the H regime domestic dollar rates must be equal to international interest rates because the supply of dollars is perfectly elastic at i_t^*. Thus:

$$\tilde{\imath}_t^{d,H} = 0.$$

In the V regime, the sudden stop implies that $i^{d,V} > i^*$ (see equation [2]). We impose the sudden-stop constraint directly as a constraint on output:

$$\tilde{y}_t^V = -a_y + a_d \tilde{\imath}_{t|t-1}^{d,V} \qquad a_y > 0.$$

The first term indicates that output falls below the natural level. The second term reflects the private sector's incentives to insure against the sudden stop. If the private sector anticipates a high value of $\tilde{\imath}_t^{d,V}$ during the sudden stop, it will be inclined to take precautionary steps. We argued earlier that in emerging markets the private value of precautioning is typically too small relative to its social value (see Caballero and Krishnamurthy 2002 for a model showing this). Thus, in our monetary policy analysis we are concerned with ways in which the central bank can increase the incentive to take precautions.

Finally, we consider the average depreciation of the exchange rate over both periods in order to derive an expression for the $\overline{\pi}$ set by the slow price setters. First note that

$$e_{t+1|t} - e_t = i_t - i_t^d = \tilde{\imath}_t^{\omega} + \overline{\pi}.$$

Next, from the interest parity condition at date $t-1$,

$$e_{t|t-1} - e_{t-1} = i_{t-1} - i^*.$$

We need to make an assumption about the central bank's behavior at date $t-1$. We make the simplest one, and assume that it sets the real domestic interest rate equal to the international interest rate (recall that foreign inflation is normalized to zero): $i_{t-1} - \overline{\pi} = i^*$. Note that this policy choice is consistent with attaining a zero output gap if the aggregate-demand relation in equation (9) also applied at date $t-1$.

Substituting the exchange rates back into the expression for $\overline{\pi}$ from equation (6) gives

$$\overline{\pi} = \frac{\overline{\pi}}{2} + \frac{E[\tilde{\imath}_t^{\omega}] + \overline{\pi}}{2},$$

which implies that

$$E[\tilde{\imath}_t^{\omega}] = 0. \tag{11}$$

Relation (11) is central to what follows. The rate $\tilde{\imath}^{\omega}$ is the deviation between the average domestic real interest rate ($i_t^{\omega} - \overline{\pi}$) and the liquidity-

adjusted international interest rate ($i_t^{d,\omega}$). Constraint (11) arises from rational-expectations price setting by the private sector. It tells us that if the central bank chooses a low real interest rate in one of the states, in equilibrium, the real interest rate in the other state must be high.

We can rewrite the expression for π_{t+1} more concisely using the tilde notation as

$$\pi_{t+1} = \overline{\pi} + (1 - \alpha)\tilde{i}_t^{\omega}. \tag{12}$$

By symmetry with inflation at $t + 1$, the inflation rate between date $t - 1$ and date t is

$$\pi_t = \alpha\overline{\pi} + (1 - \alpha)(e_t - e_{t-1}).$$

Since $e_t = \overline{e} - (\tilde{i}^{\omega} + \overline{\pi})$ (from interest parity condition and the assumption $e_{t+1} = \overline{e}$) and $\overline{e} - e_{t-1} = 2\overline{\pi}$ (see the definition of $\overline{\pi}$), we find that

$$\pi_t = \overline{\pi} - (1 - \alpha)\tilde{i}_t^{\omega} \tag{13}$$

10.4 Optimal Policy

Maximizing social welfare for this economy is achieved by minimizing the expected value, given information at $t - 1$, of the loss function, L:

$$L = \lambda\tilde{y}_t^2 + \pi_t^2 + (1 - \delta)\pi_{t+1}^2, \tag{14}$$

where $0 < \delta < 1$ is a discount rate.

These terms are fairly standard in the inflation-targeting literature. The first term is the cost of output fluctuations around potential output, while the other terms reflect the cost of inflation. The parameter λ determines the relative weight on output gap stabilization.

We now derive the optimal monetary policy when the central bank can commit to its choices of $(\tilde{i}_t^H, \tilde{i}_t^V)$ in advance.

The output equation in H follows directly from equation (9), with $\tilde{i}_t^d$ set to zero:

$$\tilde{y}_t^H = -b\alpha\tilde{i}_t^H.$$

In V, we solve for the equilibrium $\tilde{i}_t^{d,V}$. Analogous to equation (2), in the V regime, $\tilde{i}_t^{d,V}$ must be such that y_t from equation (9) is consistent with y_t^V from the external financial constraint (10). That is,

$$-b\tilde{i}_t^{d,V} - b\alpha\tilde{i}_t^V = -a_y + a_d\tilde{i}_{t|t-1}^{d,V}.$$

Since $\tilde{i}_t^{d,V} = \tilde{i}_{t|t-1}^{d,V}$ under rational expectations, we see that the relation between $\tilde{i}_t^{d,V}$ and $\tilde{i}_t^V$ for *anticipated* changes in the latter is

$$\tilde{i}_t^{d,V} = \Psi(a_y - b\alpha\tilde{i}_t^V), \qquad \Psi \equiv \frac{1}{b + a_d}. \tag{15}$$

Note that the external constraint (10) has y_t increasing in $\tilde{\imath}_t^{d,V}$. Since $\tilde{\imath}_t^{d,V}$ is decreasing in $\tilde{\imath}_t^V$, this means that lowering $\tilde{\imath}_t^V$ has a beneficial effect on output in V. The effect is through an "insurance" channel. By anticipating a lower $\tilde{\imath}_t^V$ during the sudden stop, the expectation of $\tilde{\imath}_t^{d,V}$ rises. That is, the return to insuring against the sudden stop increases, and this relaxes the aggregate financial constraint. On the other hand, the usual aggregate-demand effect of lowering interest rates—the contemporaneous effect of $\tilde{\imath}_t^V$ on y—is absent in the V regime. Ex post, since $\tilde{y}_t^V$ is fixed at date t, the positive effect on aggregate demand of a reduction in $\tilde{\imath}_t^V$ is fully offset by the negative effect of the corresponding rise in $\tilde{\imath}_t^{d,V}$.

When state-contingent monetary policy is fully anticipated, output in V is

$$\tilde{y}_t^V = -\Psi b(a_y + \alpha a_d \tilde{\imath}_t^V).$$

We assume throughout that $\tilde{y}_t^V < 0$, so that increasing $\tilde{y}_t^V$ lowers the objective in equation (14).[3]

The objective for the central bank is

$$\min_{(\tilde{\imath}_t^H, \tilde{\imath}_t^V, \overline{\pi})} qL^H + (1-q)L^V,$$

where

$$L^V = \lambda(b\Psi)^2(a_y + \alpha a_d \tilde{\imath}_t^V)^2 + [\overline{\pi} - (1-\alpha)\tilde{\imath}_t^V]^2 + (1-\delta)[\overline{\pi} + (1-\alpha)\tilde{\imath}_t^V]^2$$

and

$$L^H = \lambda(b\alpha\tilde{\imath}_t^H)^2 + [\overline{\pi} - (1-\alpha)\tilde{\imath}_t^H]^2 + (1-\delta)[\overline{\pi} + (1-\alpha)\tilde{\imath}_t^H]^2$$

subject to the rational expectations constraint that

$$E[\tilde{\imath}_t^{\omega}] = 0.$$

Let us start with the first-order condition with respect to $\overline{\pi}$, which is straightforward:

$$\begin{aligned}\frac{\partial L}{\partial \overline{\pi}} &= 2(1-q)[\overline{\pi} - (1-\alpha)\tilde{\imath}_t^V + 2(1-\delta)(1-q)[\overline{\pi} + (1-\alpha)\tilde{\imath}_t^V] \\ &\quad + 2q[\overline{\pi} - (1-\alpha)\tilde{\imath}_t^H] + 2(1-\delta)q[\overline{\pi} + (1-\alpha)\tilde{\imath}_t^H] \\ &= 2\overline{\pi} - 2(1-\alpha)E[\tilde{\imath}_t^{\omega}] + 2(1-\delta)\{\overline{\pi} - (1-\alpha)E[\tilde{\imath}_t^{\omega}]\} \\ &= 2(2-\delta)\overline{\pi} = 0 \Rightarrow \overline{\pi}^c = 0,\end{aligned}$$

3. This means assuming that

$$\frac{1}{\alpha}\frac{a_y}{a_d} > -\tilde{\imath}_t^V.$$

Although $\tilde{\imath}_t^V$ is an endogenous variable, it is possible to show that the assumption can always be met by choosing a_y large enough.

where the superscript c stands for the commitment solution. Thus, in the full commitment case, the central bank chooses policy so as to achieve a zero average rate of inflation. Since all price setters take into account average inflation, there is no benefit, only costs, for the central bank to choose a positive average inflation.

This does not mean that monetary policy is impotent. If we compute the marginal benefit of increasing $\tilde{\imath}_t^V$ at neutral interest rates and $\overline{\pi}$, we find

$$\frac{\partial L}{\partial \tilde{\imath}_t^V}_{|\tilde{\imath}_t^H=\tilde{\imath}_t^V=\overline{\pi}=0} = 2(1-q)\lambda\alpha a_d a_y (b\Psi)^2 > 0,$$

which implies that the central bank will choose $\tilde{\imath}_t^V < 0$ (since we are minimizing the objective).

The exact solution is

$$\tilde{\imath}_t^V = -a_y \frac{q\lambda\alpha a_d (b\Psi)^2}{\lambda(b\alpha)^2[q(\Psi a_d)^2 + 1 - q] + (2-\delta)(1-\alpha)^2}. \tag{16}$$

The central bank sets i_t^V below $i_t^{d,V}$ in order to increase the private sector's incentives to insure against the sudden stop. The cost of this policy is that the exchange rate depreciates in the V regime. To offset the effect of this policy on average inflation, the central bank chooses $\tilde{\imath}_t^H > 0$ (see equation [11]), so that policy is tighter in the H regime and output is lower.

Note that as a result of its attempt to increase precautioning against the V regime and hence increase $\tilde{y}^V$, the central bank tolerates some instability in inflation and exchange rates.

10.5 The Central Bank Without Commitment

Let us now study a central bank that cannot commit to the interest rate choices of date t, prior to this date. Two biases arise from the lack of commitment. First, if the central bank's preferences are as stated in equation (14) it will choose interest rates to completely stabilize the exchange rate ("fear of floating"). Second, if the central bank's preferences are distorted so as to always prefer to increase output, as in Barro and Gordon (1983), then the fear-of-floating problem is made worse. The central bank loosens in the H state and tightens in the V state, while inducing a positive average rate of inflation. This is exactly the opposite of the policy dictated in the commitment solution.

10.5.1 Fear of Floating

Suppose that the central bank chooses interest rates in each state (H or V) to minimize the loss function in equation (14). Then in H it solves

$$\min_{\tilde{\imath}_t^H} L^H = \lambda(b\alpha\tilde{\imath}_t^H)^2 + [\overline{\pi} - (1-\alpha)\tilde{\imath}_t^H]^2 + (1-\delta)[\overline{\pi} + (1-\alpha)\tilde{\imath}_t^H]^2$$

while in V it solves

$$\min_{\tilde{\imath}_t^V} L^V = [\overline{\pi} - (1-\alpha)\tilde{\imath}_t^V]^2 + (1-\delta)[\overline{\pi} + (1-\alpha)\tilde{\imath}_t^V]^2.$$

Compared to the loss function in V of the previous section, the main change is that there is no output term. This follows from our assumption in equation (10) that there is no aggregate demand channel whereby lowering interest rates increases output. The loss function in H is the same as in the previous section.

It is easy to verify that the solution to these two problems (that is consistent with the rational-expectations requirement that $E[\tilde{\imath}_t^{\omega}] = 0$ is to set $\tilde{\imath}_t^H = \tilde{\imath}_t^V = 0$, with $\overline{\pi} = 0$. Note that at $\overline{\pi} = 0$, inflation and the exchange rate are fully stabilized by choosing $\tilde{\imath}_t^H = \tilde{\imath}_t^V = 0$, with $\overline{\pi} = 0$. In addition, the output gap in H is equal to zero.

While the policy stabilizes both inflation and the exchange rate, the cost is that output drops too much in the sudden-stop state, V. The central bank essentially ignores the insurance channel of monetary policy and focuses purely on maintaining a stable exchange rate.

10.5.2 Exacerbating the Problem: Barro-Gordon

We now modify the central bank's objective function to introduce an expansionary bias a la Barro and Gordon (1983):

$$L = -\lambda\tilde{y}_t + \pi_t^2 + (1-\delta)\pi_{t+1}^2. \tag{17}$$

The $\tilde{y}_t$ term now reflects the central bank's preference to always raise output. We drop the squared-output term since it does not change our message.

The choice problem in H is

$$\min_{\tilde{\imath}_t^H} L^H = \lambda b\alpha\tilde{\imath}_t^H + [\overline{\pi} - (1-\alpha)\tilde{\imath}_t^H]^2 + (1-\delta)[\overline{\pi} + (1-\alpha)\tilde{\imath}_t^H]^2.$$

This gives the first-order condition

$$\tilde{\imath}_t^H = \frac{\delta}{2-\delta}\frac{1}{1-\alpha}\left[\overline{\pi} - \frac{\lambda b\alpha}{2(1-\alpha)\delta}\right]. \tag{18}$$

Note that a larger value of λ (greater preference for increasing output) leads to a lower interest rate choice. A higher value of $\overline{\pi}$ offsets this tendency.

The choice problem in V remains the same as in the fear-of-floating case since output, as of date t, is fixed:

$$\min_{\tilde{\imath}_t^V} L^V = [\overline{\pi} - (1-\alpha)\tilde{\imath}_t^V]^2 + (1-\delta)[\overline{\pi} + (1-\alpha)\tilde{\imath}_t^V]^2.$$

The first-order condition is

$$\tilde{\imath}_t^V = \frac{\delta}{2-\delta}\frac{\overline{\pi}}{1-\alpha}. \tag{19}$$

Since in equilibrium, we must have that $E[\tilde{\imath}_t^{\omega}] = 0$, it follows from equations (18) and (19) that

$$\overline{\pi} = \lambda \frac{qb\alpha}{2(1-\alpha)\delta} > 0.$$

Replacing this expression back into equations (18) and (19), we find that $\tilde{\imath}_t^H < 0$ and $\tilde{\imath}_t^V > 0$:

$$\tilde{\imath}_t^H = -(1-q)\lambda \frac{qb\alpha}{2(1-\alpha)^2\delta} < 0,$$

$$\tilde{\imath}_t^V = \lambda \frac{qb\alpha}{2(1-\alpha)^2\delta} > 0.$$

The central-bank preference for increasing output has a perverse effect in our model. Since lowering interest rates in H increases output, the central bank sets $\tilde{\imath}^H < 0$. As in Barro-Gordon, the anticipation of the low interest rate in H raises the private sector's inflation expectations and leads to $\overline{\pi} > 0$. In V, the central bank sees no output benefit to changing interest rates since output is predetermined by the sudden-stop supply. However, since the average rate of inflation is now positive, the central bank is faced with an exchange rate that depreciates at date t. To counter this, the central bank raises the interest rate in V. In equilibrium, this leads to a lower $\tilde{\imath}_t^{d,V}$ and an even tighter sudden-stop supply. The crisis is thereby exacerbated.

10.6 Implementing Optimal Policy through Inflation Targets

Given the time inconsistency of the central bank, what should its mandate be? That is, how should the central bank's objectives be modified so that it internalizes the insurance dimension of the sudden-stop problem? In this section we highlight two possibilities. First, inflation targets can be made state dependent: stringent (low) in H and loose (high) in V. Second, the central bank's mandate can overweight the inflation of nontradables in the measure of inflation that it targets. Since output contracts in the V regime, there is deflation in nontradables. The inflation-targeting central bank offsets this by lowering interest rates and causing the exchange rate to depreciate (leading to inflation in tradables). This incentive increases by placing a larger weight on nontradables.

10.6.1 State-Contingent Inflation Targets

We continue with the linear-output specification but modify the central bank's objective function to introduce a state-contingent inflation penalty term of κ^{ω}, for $\omega \in \{H, V\}$:

$$L = -\lambda \tilde{y}_t + (\pi_t - \kappa^{\omega})^2 + (1-\delta)(\pi_{t+1} - \kappa^{\omega})^2. \tag{20}$$

A positive κ means that inflation is less costly for the central bank, while a negative κ penalizes inflation further.

The choice problem in H is

$$\min_{\tilde{i}_t^H} L^H = \lambda b\alpha \tilde{i}_t^H + [\overline{\pi} - \kappa^H - (1-\alpha)\tilde{i}_t^H]^2 + (1-\delta)[\overline{\pi} - \kappa^H + (1-\alpha)\tilde{i}_t^H]^2.$$

This gives the first-order condition

$$\tilde{i}_t^H = \frac{\delta}{2-\delta}\frac{1}{1-\alpha}\left[\overline{\pi} - \kappa^H - \frac{\lambda b\alpha}{(1-\alpha)\delta}\right].$$

Note that, everything else being constant, a larger value of κ^H leads to a lower interest rate in H.

The choice problem in V is

$$\min_{\tilde{i}_t^V} L^V = [\overline{\pi} - \kappa^V - (1-\alpha)\tilde{i}_t^V]^2 + (1-\delta)[\overline{\pi} - \kappa^V + (1-\alpha)\tilde{i}_t^V]^2.$$

The first order condition is now

$$\tilde{i}_t^V = \frac{\delta}{2-\delta}\frac{\overline{\pi} - \kappa^V}{1-\alpha}.$$

As before, since in equilibrium we must have that $E[\tilde{i}_t^{\omega}] = 0$, we obtain

$$\overline{\pi} = \lambda\frac{qb\alpha}{2(1-\alpha)\delta} + (1-q)\kappa^V + q\kappa^H.$$

We note that in the commitment solution $\overline{\pi}$ is equal to zero. Imposing $\overline{\pi} = 0$ yields a constraint across κ^{ω}:

$$\kappa^H = -\frac{\lambda b\alpha}{2(1-\alpha)\delta} - \frac{1-q}{q}\kappa^V.$$

If there is a strong Barro-Gordon inflation bias (high λ), then κ^H can be made low in order to offset this bias. Similarly, to the extent that the central bank has a loose inflation target in V (if κ^V is high), κ^H can be set low so the net result is a $\overline{\pi}$ of zero.

Substituting this κ expression back into the first-order conditions for interest rate choices allows us to solve for the optimal interest rate choices

$$\tilde{i}_t^H = \frac{\delta}{2-\delta}\frac{1}{1-\alpha}\frac{1-q}{q}\kappa^V$$

and

$$\tilde{i}_t^V = -\frac{\delta}{2-\delta}\frac{1}{1-\alpha}\kappa^V.$$

By choosing $\kappa^V > 0$ (and hence $\kappa^H < 0$), the central bank will follow a state-contingent policy as dictated in the social optimum, with $\tilde{i}_t^H > 0$ and $\tilde{i}_t^V < 0$.

In equilibrium, this leads to a higher $\tilde{\imath}_t^{d,V}$ and a looser sudden-stop supply. The crisis is thereby lessened.

Before we conclude this section, note that both the state-contingent inflation target and the nontradable-inflation overweight solutions act through the inflation terms of the central-bank objective. If we were to introduce a contemporaneous output effect of a change in $\tilde{\imath}^V$, these recommendations would remain, but there would be an additional channel open: we could now also achieve the desirable effect by raising the weight of output in the central bank's objective during V regimes.

10.6.2 Nontradable Inflation Target

Let us now introduce an infinitesimal (in the sense that it does not feed back into aggregate demand) nontradable good, whose inflation is determined by a simple Phillips curve:

$$\pi_t^N = \overline{\pi} + \tilde{y}_t.$$

We modify the measure of inflation that the central bank targets to be a weighted average of π_t^N and the tradable inflation of π_t that we have been using so far. The central bank's objective function is

$$L = -\lambda \tilde{y}_t + [\beta \pi_t^N + (1-\beta)\pi_t - \kappa^{\omega}]^2 + (1-\delta)[\beta \pi_{t+1}^N + (1-\beta)\pi_{t+1} - \kappa^{\omega}]^2. \tag{21}$$

β is the weight on nontradable inflation. We normalize the $t+1$ (noncrisis) inflation rate on nontradables to be zero. Finally we set $\kappa^V = 0$ (leaving $\kappa^H \neq 0$).

The choice problem in V is

$$\min_{\tilde{\imath}_t^V} L^V = [\overline{\pi} + \beta \tilde{y}_t^V - (1-\beta)(1-\alpha)\tilde{\imath}_t^V]^2 + (1-\delta)(1-\beta)^2[\overline{\pi} + (1-\alpha)\tilde{\imath}_t^V]^2$$

The first-order condition is

$$\tilde{\imath}_t^V = \frac{\overline{\pi}[1-(1-\beta)(1-\delta)] + \beta \tilde{y}_t^V}{(1-\alpha)(1-\beta)(2-\delta)}.$$

The choice problem in H is

$$\min_{\tilde{\imath}_t^H} L^H = \lambda b \alpha \tilde{\imath}_t^H + [\overline{\pi} - \kappa^H - \beta b \alpha \tilde{\imath}_t^H - (1-\alpha)\tilde{\imath}_t^H]^2 + (1-\delta)(1-\beta)^2 \left[\overline{\pi} - \frac{\kappa^H}{1-\beta} + (1-\alpha)\tilde{\imath}_t^H\right]^2.$$

This gives a solution for $\tilde{\imath}_t^H$ that is linearly increasing in $\overline{\pi}$, decreasing in λ, and decreasing in κ^H.

As in the previous section, we can always choose κ^H so that $\overline{\pi} = 0$. That is, when we impose the equilibrium condition that $E[\tilde{\imath}_t^{\omega}] = 0$, we arrive at a relation for $\overline{\pi}$ in terms of κ^H. We simply choose κ^H so that $\overline{\pi}$ equals zero.

Given this κ^H, $\tilde{\imath}_t^V$ is proportional to $\beta\tilde{y}_t^V$. Since $\tilde{y}_t^V < 0$, we can implement $\tilde{\imath}_t^V < 0$ by choosing $\beta > 0$. Since $E[\tilde{\imath}_t^{\omega}] = 0$, this means that $\tilde{\imath}_t^H > 0$, which is achieved by setting $\kappa^H < 0$.

By increasing the weight on nontradables in the measure of inflation that the central bank targets, the central bank follows a state-contingent policy as dictated in the social optimum. Again, in equilibrium, this leads to a higher $\tilde{\imath}_t^{d,V}$ and a looser sudden-stop supply.

10.7 Reserves Management

Since crises are characterized by dollar shortages (see equation [2]), there is scope in the model for managing international reserves in order to ease these shortages. Our model provides a natural motivation both for centralized holding of reserves and for holding them in the form of dollars.

We assume that the central bank has a small amount of international reserves at date t. These reserves can be injected at date t or saved for use beyond date $t + 1$, when they yield $\gamma > 0$ utils per unit of reserves. The latter represents the opportunity cost of using the reserves early, and should be interpreted more broadly as the value of precautioning.

We contrast how the results of section 10.4 and section 10.5.1 change upon the introduction of international reserves. The loss function in both cases is modified to

$$L = \lambda\tilde{y}_t^2 + \pi_t^2 + (1 - \delta)\pi_{t+1}^2 + \gamma R_t, \tag{22}$$

with R_t the amount of reserves injected.

Recall that in section 10.4 we solve for the interest rate choices that the central bank commits to in minimizing the loss function, while in section 10.5.1 we solve for the sequentially optimal interest rate choices given this loss function.

There is no value in injecting reserves in H. Since there is no dollar shortage, the action has no effect on either prices or output. Reserves will be hoarded because failing to do so has an opportunity cost γ. In the V regime, the action increases dollar supply and relaxes the vertical constraint (10) to

$$\tilde{y}_t^V = R_t^V - a_y + a_d\tilde{\imath}_{t|t-1}^{d,V}. \tag{23}$$

One can see from this expression that R_t^V enters exactly as $-a_y$ in all the expressions. In particular,

$$\tilde{y}_t^V = \Psi b(R_t^V - a_y - \alpha a_d\tilde{\imath}_t^V). \tag{24}$$

As we discussed earlier, the optimal policy considers the dependence of $\tilde{y}_t^V$ on $\tilde{\imath}_t^{d,V}$ (which enters through expectations), while the no-commitment case does not.

The introduction of international reserves-management considerations does not change any of the main qualitative conclusions with respect to monetary policy in either the commitment or no-commitment case of sections 10.4 and 10.5.1, respectively. In particular, it is still the case that $\overline{\pi} = 0$ in both cases, that $\tilde{\imath}^H = \tilde{\imath}^V = 0$ in the no-commitment case, and that $\tilde{\imath}^H > 0$ and $\tilde{\imath}^V < 0$ in the commitment case.[4]

However, reserve injections are a substitute for (countercyclical) monetary policy. To see this, note that in the commitment solution for $\tilde{\imath}_t^V$ in equation (16), $\tilde{\imath}_t^V$ is decreasing in a_y. Since R_t^V enters as $-a_y$ in all expressions, the reserve injection increases the optimal $\tilde{\imath}_t^V$.

The most interesting new result comes from the first-order condition with respect to R_t^V. From equations (22) and (24), the solution for R_t^V in the commitment case is

$$R_t^{V,c} = -\frac{\gamma}{2\lambda(b\Psi)^2} + a_y + \alpha a_d \tilde{\imath}_t^V. \tag{25}$$

From equations (22) and (23), the solution for R_t^V in the no-commitment case is

$$R_t^{V,nc} = -\frac{\gamma}{2\lambda b\Psi} + a_y + \alpha a_d \tilde{\imath}_t^V \tag{26}$$

Note that $b\Psi = b/(b + a_d) < 1$, so the first term is more negative in the commitment case. Also, since for any equilibrium level of R_t^V, $\tilde{\imath}_t^{V,c} < \tilde{\imath}_t^{V,nc}$, we have that $R_t^{V,nc} > R_t^{V,c}$. That is, the central bank with no commitment not only will use too little monetary policy but also will inject reserves too aggressively.

There are two factors behind this result. First, injecting reserves both increases output and decreases $\tilde{\imath}_t^{d,V}$. Ex post, the central bank considers the output benefit, but ignores the effect on $\tilde{\imath}_t^{d,V}$. Ex ante, the central bank accounts for the second effect: the lower $\tilde{\imath}_t^{d,V}$ decreases the private sector's incentives to insure against the sudden-stop shock. The latter effect makes the commitment central bank inject less reserves than the no-commitment one.

The second factor has to do with the time inconsistency of monetary policy. In the no-commitment solution, the central bank has to offset a larger crisis caused by the inadequate monetary policy. As a result, it overinjects its reserves.

The latter factor is remedied indirectly by solving the monetary policy time-inconsistency problem as we have discussed. The former factor, on the

4. These statements assume that $R_t < a_y$, so that there is insufficient international reserves to eliminate the sudden-stop shock.

other hand, requires further modification to the central bank's mandate so that it increases the value it assigns to hoarding reserves during the V regime.

10.8 Final Remarks

We have analyzed monetary policy in an environment of sudden stops. Sudden stops are times when a country is financially constrained in the international financial market. In this context, lowering or raising domestic interest rates has only small effects on the tightness of this financial constraint, but such action does have significant effects on the domestic borrowing capacity of agents. Moreover, the anticipation of such actions is important in determining precautionary actions that agents take against sudden stops.

From this viewpoint, we have derived positive and normative results for monetary policy and reserves management. We have highlighted a new time-inconsistency problem and its interaction with the conventional stabilization bias. Finally, we have suggested how an inflation-targeting framework can restore incentives, so that central banks behave optimally.

Our model is clearly very stylized. In particular, our assumption that the country faces a vertical supply of funds during sudden stops is extreme. But it is important to realize that our main conclusions do not depend on this extreme. We could consider a more general model in which the supply of funds was not completely inelastic in the V regime. In this case, the V regime would have both an aggregate-demand channel and the insurance channel we have highlighted (i.e., lowering $\tilde{\imath}_t^V$ leads to a contemporaneous increase in $\tilde{y}_t^V$). Importantly, relative to the H regime, the output-inflation trade-off will still turn steeper (although not vertical) during the V regime, and hence the central bank will be prone to favor inflation over output targets more than in the H regime. Moreover, as long as the insurance channel is present, this reaction will remain suboptimal.

Insurance against sudden stops affects many policy decisions in emerging markets, from reserve management to liquidity ratio requirements. It seems only natural that optimal monetary policy be analyzed in the same light, as in this paper. Moreover, it is important to understand the interaction of monetary policy with other insurance policies (as we have with reserve policies). We hope that our framework provides a starting point for such an integrated approach.

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Comment

Ben S. Bernanke

This very interesting paper highlights the potential interaction in emerging-market economies between the monetary policy regime and the effects

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of adverse shifts in the portfolio preferences of international investors ("sudden stops"). It raises the possibility that inflation targeting may serve as a form of commitment device for monetary authorities in those economies—not as a mechanism for committing to price stability per se, as is usually the case in the inflation-targeting literature, but rather as a means to commit to responding in a particular way to the sudden stop in capital inflows. Specifically, the authors argue, adopting inflation targeting can be viewed as a commitment *not* to defend the exchange rate in a crisis. If that commitment is credible, then the ex ante incentive of domestic agents to be long in dollars (by forgoing dollar-denominated liabilities as well as holding dollar assets) is increased, mitigating the severity of the dollar shortage caused by the crisis. In short, the authors argue that adopting inflation targeting before the crisis may be an antidote to the "fear of floating" problem stressed by Calvo and Reinhart (2002).

The model used to illustrate this point is highly stylized, which is both a strength and a weakness—a strength, because it makes the basic economic idea extremely clear; a weakness, because it thereby ignores some complicating aspects of the problem that are likely to be crucial in real economies. One particularly important omission is any consideration of what caused the sudden stop in the first place. (The paper assumes that sudden stops are exogenous, but as ever-more-discriminating international capital markets make episodes of pure contagion less likely, that assumption does not seem particularly attractive.) If the source of the crisis is, say, ongoing fiscal instability, then an inflation-targeting regime may well be infeasible, for reasons of fiscal dominance. Another source of crisis discussed in the literature is the combination of a poorly supervised banking system and a government that is unable to commit to not bailing out the banking system if it fails (a moral hazard problem). In such a situation a general bank run can provoke a fiscal crisis and hence a sudden stop. Monetary policy would have little power to ameliorate this type of crisis, however, because banks in particular would have no incentive to be long in dollars, knowing that they will be bailed out in any case. The correct response to this type of problem is some combination of bank supervision (e.g., limiting exposure to dollar liabilities) and fiscal commitment devices to moderate the government's moral hazard. The general point is that whatever factors create the potential for sudden stops will also likely affect the feasibility and desirability of the solution proposed here.

Another drawback of the stylized nature of the model is that its empirical plausibility is difficult to assess. For example, an implication of the model is that when the central bank defends the exchange rate (the time-consistent solution), we should see deflation in nontradables. (This result provides the basis for equating inflation targeting in nontradables prices to a commitment to devaluation.) Because in practice nontradables prices cannot be insulated from the exchange rate (a depreciation affects wage de-

mands, the costs of inputs, and inflation expectations), I would guess that a sudden stop would typically lead to inflation in nontradables as well as tradables. Some analysis of the data is called for. If a crisis does typically lead to inflation in nontradables, and if, moreover, the nontradables inflation rate in a crisis is difficult to forecast, then setting a quantitative inflation target in advance for nontradables, as recommended by the authors, may not be particularly useful. Another empirical issue relates to the ability of the central bank to hit an inflation target in the time frame relevant to an international financial crisis; generally we believe that central banks can control inflation only with a lag of months, not days or weeks. In short, determining the practical relevance of the policy recommendation of this paper will require a good deal more empirical analysis and quantification.

My remaining comments concern some issues relating to the microfoundations of the model. First, the authors appeal to models of credit-market imperfections in which collateral is used to mitigate agency costs. It seems to me that the collateral that would be relevant for borrowing from abroad would be denominated in dollars, not in pesos; but the authors assume that the assets relevant to the domestic demand for investment goods, A_t, are peso assets rather than dollar assets. This assumption would seem to be of some consequence for the analysis, since only if these assets are in pesos is the value of domestic collateral affected by devaluation. A related point concerns the ex ante holdings of dollar assets by domestic investors, which confers a social benefit (being a form of insurance) in this model. But dollar holdings by domestics may also be viewed as a form of capital flight; and in a world of capital-market imperfections, in which domestics are presumed to have superior local information, the fact that domestics are not investing in the home market should involve deadweight losses, which are ignored here.

Second, I also had some concerns about the pricing assumptions in the model. The authors distinguish two types of producers of domestic goods: "fast" pricers, who tie their prices to the exchange rate, and "slow" pricers, who set their prices in advance according to their expectation of the exchange rate. I understand the reasons for these assumptions, but I wonder if they are entirely sensible economically. First, domestic goods and imported investment goods are not perfect substitutes, so it is not evident that pricing should be such as to keep the expected real exchange rate constant. Second, because the actual exchange rate may differ radically from the expected exchange rate in a crisis, it seems unreasonable to assume that even very "slow" pricers do not reset their prices when a crisis occurs. Allowing repricing in a crisis would certainly affect some of the results of the model.

To reiterate my main impressions, I found the paper stimulating and useful. More quantitative analysis is needed to translate this stylized model into concrete recommendations for policy. But at a more qualitative level, the paper offers another compelling argument for why emerging-market

countries should abandon exchange rate pegs, which have not served them well in recent years, in favor of inflation targeting or other monetary policies that focus on domestic macroeconomic stability.

Discussion Summary

Jose De Gregorio suggested that the conclusions depended importantly upon the assumption of a model in which there is no effect of exchange rates on output. He proposed that the result might be quite different if, for example, an expenditure-switching effect were allowed for.

Mark Gertler pointed out that the main reason for the limited interest rate effects in the model was the segmentation between the markets for domestic and foreign currency funds—that is, the absence of arbitrage between these two markets.

Michael Bordo argued that financial development and a measure of fiscal stability were necessary preconditions for the successful adoption of a nominal anchor in emerging economies.

In response to Bernanke's comments, *Ricardo Caballero* pointed out that a major reason for fear of floating was the need to maintain control of inflation expectations. He stressed that the paper did not aim to explain particular historical episodes, but to provide a framework to think about inflation targeting in the presence of capital flow volatility. Credible inflation-targeting regimes are new to emerging-market economics. He emphasized that the distribution of inflation between tradable and nontradable goods depended on the response of inflation expectations to a devaluation; during currency crises the pass-through from nominal exchange rates to domestic prices could be very different from that of other periods. Regarding the importance of the domestic interest rate even when most of the borrowing occurred in foreign currency, he pointed out that during market segmentation episodes monetary policy affected the domestic dollar rate. When used correctly, monetary policy alleviated the inefficiency due to market segmentation by reallocating external resources from times of high foreign capital inflows to times of low capital inflows. The more general underlying theme was the sudden segmentation of markets during financial crises, which was most extreme during collapses of the banking sector. Because a sudden stop could be interpreted as a crash in the value of an asset—namely, the value of the country's collateral—the paper was more broadly applicable to the question of how monetary policy should respond to asset market crises. The particular challenge posed by this model was the risk that monetary policy might be losing its effectiveness during the crisis, and this risk carried implications for the conduct of policy prior to a crisis.